TRANSACTIONS

OF THE

AMERICAN

PHILOSOPHICAL SOCIETY,

HELD AT

PHILADELPHIA,

FOR PROMOTING

USEFUL KNOWLEDGE.

VOLUME I.

THE SECOND EDITION CORRECTED.

PHILADELPHIA:
PRINTED BY *R. AITKEN & SON*, AT POPE's HEAD IN MARKET STREET.

M.DCC.LXXXIX.

PROTHONOTARY's OFFICE, Philadelphia county.

I DO certify that on the 29th day of April, 1789, *a Book entitled* "Transactions of the American Philosophical Society, held at Philadelphia, for promoting useful Knowledge," *vol.* 1. *the second edition corrected, printed at Philadelphia, by* R. Aitken & Son, *at Pope's Head, in Market-Street, was entered in my office, by* Robert Aitken.

JAMES BIDDLE, PROT.

ADVERTISEMENT.

THE promoting of uſeful Knowledge in general, and ſuch branches thereof in particular, as may be more immediately ſerviceable to the Britiſh Colonies, being the expreſs purpoſe for which the AMERICAN PHILOSOPHICAL SOCIETY was inſtituted; the Publication of ſuch curious and uſeful Papers, as may, from time to time, be communicated to them, becomes, of courſe, one material part of their deſign.

As ſoon therefore as the Society judged that they had received a ſufficient Number of Communications for a Volume, they appointed a Committee, to aſſiſt the Secretaries, in ſelecting out of them ſuch as might be moſt proper for the public view. And for their direction in the execution of this truſt, the two following rules were given, viz.

Firſt, "That the grounds of the Committee's choice of Papers for the Preſs, ſhould always be, the importance or ſingularity of the ſubjects, or the advantageous manner of treating them, without pretending to anſwer, or to make

make the Society anſwerable for the certainty of the facts, or propriety of the reaſonings, contained in the ſeveral Papers ſo publiſhed, which muſt ſtill reſt on the credit or judgment of their reſpective Authors.

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

Theſe Rules were adopted from the Rules of that illuſtrious Body the ROYAL SOCIETY of London, whoſe example the AMERICAN PHILOSOPHICAL SOCIETY think it their honor to follow, in their endeavours for enlarging the Sphere of Knowledge and uſeful Arts. And though, in Countries where the Arts and all uſeful Improvements have arrived almoſt at their maturity, the following WORK may ſcarce be conſidered as a mite thrown into the common treaſury; yet here, where they are but in their infancy, it may be received as ſome acceſſion to our ſmaller Stock.

LAWS AND REGULATIONS,

OF THE

American PHILOSOPHICAL SOCIETY

HELD AT *PHILADELPHIA*, FOR PROMOTING

USEFUL KNOWLEDGE.

TWO Societies having formerly fubfifted in Philadelphia, whofe views and ends were the fame viz. "*the Advancement of ufeful Knowledge*"—it was judged that their union would be of public advantage; and they were accordingly united *January* 2d, 1769, by a certain *Fundamental Agreement*; the chief *Articles* of which are—

Firft, That the name of the *United Society* fhall be *The American Philofophical Society, held at Philadelphia for promoting ufeful Knowledge.*

Secondly, That there fhall be the following Officers of the Society, viz. one *Patron*, one *Prefident*, three *Vice Prefidents*, one *Treafurer*, four *Secretaries*, and three *Curators*.

Thirdly, That all the above officers fhall be chofen annually by ballot, at the firft meeting of the Society in January; excepting only that inftead of electing a Patron, the Governor of the Province be requefted to be *Patron*.

Other Laws were to be made by the *United Society*; and accordingly the following LAWS, &c. were paffed *February* 3d, 1769:

I. *Of the annual Payments to be made by Members.*

EVERY Member of this Society fhall fubfcribe *Ten Shillings* yearly, to be applied by the Society to fuch purpofes as they fhall direct; and no Member fhall be entitled to a vote in the annual election of officers, unlefs it appears that he has paid into the hands of the Treafurer, the fubfcription of the preceding year, and all former arrears, if any there were.

Every Member hereafter to be chofen, agreeable to the Laws of this Society, fhall pay *Ten Shillings* admiffion money, and alfo fubfcribe for the yearly payment of *Ten Shillings*, before he is entitled to have any vote in the bufinefs of the Society at their meetings.

II. *Of the Election of Members.*

The election of new Members ſhall be by ballot, and that only on the third Friday in the months of January, April, July and October; and in order to ſuch election at leaſt twenty Members muſt be preſent.

Any Member may, at any meeting, propoſe ſuch perſon or perſons, as he thinks proper to be a Member or Members of this Society; but no perſon ſhall be ballotted for, unleſs his name, together with the name or names of the Member or Members who propoſed him, has been fixed up by the Secretaries for the view of the Society, at the two meetings preceding the time of election. Nor ſhall any perſon be deemed duly choſen unleſs three-fourths of the votes of the whole Members be in his favour.

III. *Of the Officers, and manner of their election.*

The election of ſuch Officers as are to be choſen in this Society, ſhall be on the firſt Friday in January every year, by ballot or written ticket, between the hours of Two and Five in the afternoon, at ſuch place in this city as ſhall be fixed by the Society at their previous meeting on the third Friday in December every year; of which notice ſhall be given in the Gazette, or ſuch other public Papers as the Society ſhall order, at leaſt one week before the day of election.

Before opening the election, the company that ſhall be met at half an hour after Two, ſhall appoint three Members of the Society as judges of the election, and alſo two clerks or ſecretaries, for taking down the names of the voters. And in caſe of an equality of votes for any Officer, after caſting up the ballots, the deciſion ſhall be by lots, to be drawn by one of the judges.

IV. *Of the Preſident.*

The Preſident is to preſide at all meetings, to preſerve order, to regulate the debates, and to ſtate and put queſtions, agreeable to the ſenſe and intention of the Members.

V. *Of the Vice-Preſidents.*

In the abſence of the *Preſident*, his duty ſhall devolve on the *Vice-Preſidents*, ſo that they ſhall preſide alternately at meetings. But if the Vice-Preſident, whoſe turn it is to preſide at any meeting, ſhould be abſent, his place ſhall be ſupplied by any of the other Vice-Preſidents, who ſhall be preſent, according as he may be next in turn. If only one Vice-Preſident be preſent, he ſhall of courſe preſide; and if neither the Preſident, nor any Vice-Preſident be preſent, the Members met, ſhall appoint one of their number to take the chair for that meeting.

VI. *Of the Treafurer.*

The *Treafurer* fhall receive the fubfcriptions of the Members, and all the other monies that may become due to the Society, and fhall pay the fame agreeable to their orders, certified to him by the Prefident, Vice-Prefident or Member, who was in the *Chair* when the order was made. The Treafurer fhall keep a regular account of all monies received and paid by him as aforefaid; and once every year, or oftener if required by the Society, he fhall render an account to them of the ftock in his hands, and the difburfements made by their order, and fhall deliver up to his fucceffor the books and all papers belonging to them, together with the ballance of cafh in his hands. And for the faithful difcharge of his truft, he fhall before he enters on his office, give bond and fecurity to the Prefident and Vice-Prefidents, in double the fum which they, or any three of them, fhall judge he may probably become entrufted with, during his faid office.

VII. *Of the Secretaries.*

The Secretaries fhall fo fettle matters as to take equal fhares of all all bufinefs, and fo as that two of them fhall ferve at every meeting, viz. one to take the minutes, and one to read all letters and papers that may be communicated to the Society. It is alfo the bufinefs of the two Secretaries of each particular meeting, to copy into the minute book, the proceedings of that meeting in order to produce the fame fair to the next meeting. They are further to copy into the proper books all fuch letters, papers and effays, as the Society may think fit to preferve on record, and to have the fame ready to be laid before the next meeting.

The other two Secretaries are, in the mean while, to give notice to new members of their election, and agreeable to the directions of the Society, to write or anfwer letters; and in general, to *manage all matters of Correfpondence.*

The Secretaries may, for their own eafe, change places; fo that the two who have ferved as *correfponding Secretaries*, for one month or limited time, fhall take their turn to ferve for the like time as *fitting or attending Secretaries.*

VIII. *Of the Curators.*

The bufinefs of the *Curators* fhall be to take charge of, and preferve, all *Specimens of natural Productions*, whether of the *Animal, Vegetable* or *Foffil* kingdom; all models of machines and inftruments, and all other matters and things belonging to the Society, which fhall be committed to them; to clafs and arrange them in their proper order, and keep an exact lift of them, with the names of the refpective donors, in a book provided for that purpofe; which book fhall be laid before the Society, as often as called for.

The Curators, on entering upon their office, fhall give fuch a receipt for every thing that is committed to their charge, as the Society fhall think proper; and, at the end of their term, fhall deliver up the fame to their fucceffors. For the faithful performance of their duty, and of the truft repofed in them, they fhall give bond to the Prefidents, and Vice Prefidents, in fuch a fum as they, or any three of them, fhall require.

IX. *Of the Meetings of the Society.*

The ordinary meetings of the Society fhall be on the firft and third Fridays of every month, from October to May, both inclufive, at *fix* o'clock in the evening, and on the third Friday in each of the other four months, at *feven* o'clock.

No meeting fhall be continued after ten o'clock, nor any new matter be introduced by motion or otherwife, after nine o'clock.

X. *Of the Difpofition of Money, and making new Laws.*

No part of the Society's ftock fhall be difpofed of in *Premiums*, or otherwife, nor fhall any new laws be made, until the fame have been propofed at one meeting, and are agreed to by two-thirds of twenty or more Members prefent at a fubfequent meeting.

XI. *Of other Proceedings of the Society.*

No queftion fhall be put on a *motion*, unlefs the motion be *feconded*; and the determination of any queftion fhall be by *ballot*, inftead of open fuffrage, if defired by any four Members. In cafe of an equality of votes on any queftion, the fame fhall be deferred to another meeting.

When any Member fpeaks he fhall ftand up, and addrefs himfelf to the Chair, and the reft fhall remain filent in their feats. When two or more offer to fpeak at the fame time, the prefiding Member, in that, as in other matters of order, fhall regulate and determine who fhall fpeak firft.

XII. *Of Committees.*

The Members of this Society fhall be claffed into one ot more of the following *Committees.*

1. Geography, Mathematics, Natural Philofophy and Aftronomy.
2. Medicine and Anatomy.
3. Natural Hiftory and Chymiftry

4. Trade

4. Trade and Commerce.
5. Mechanics and Architecture.
6. Hufbandry and American Improvements.

Thefe *Committees* fhall meet on their own adjournments, and at fuch other times as the Society fhall appoint, for the confideration of any matters referred to them, and fhall have power to chufe their own Chairman. But no *Committee*, as fuch, fhall take up any new bufinefs of the Society, but fhall confine themfelves only to the fubjects for which they are appointed, and to matters referred to them by the Society.

A true Copy, compared with the original Laws in the Society's Books by - - - - WILLIAM SMITH, CHARLES THOMSON, *Secretaries.*

LIST OF THE OFFICERS,

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

Held at PHILADELPHIA, for promoting ufeful Knowledge,

For the YEAR 1770.

PATRON. The Governor of the Province, for the time being.

OFFICERS, elected JANUARY 5th, 1770.

PRESIDENT.	Benjamin Franklin, LL. D. F. R. S. *Gott. S. Soc.*
VICE PRESIDENTS.	Jofeph Galloway, Efq. Speaker of the Affembly of Pennfylvania. Dr. Thomas Bond. Samuel Rhoads, Efquire.
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CURATORS.	Benjamin Rufh, M. D. Profeffor of Chymiftry, College of Philadelphia. Mr. Owen Biddle. Ifaac Bartram.

A

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B

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C

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D

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F

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G.

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Benjamin

* All those Members whose places of abode are not specified, are of the city of Philadelphia.

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H

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Mr. William Weft.
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Mr. Samuel Wharton.
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Alexander Wilcocks, Efq.
Hugh Williamfon, M. D.
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John Winthrop, Efq. F. R. S. Hollifian Prof. Mathematics, at Cambridge, in New-England.
John Witherfpoon, D. D. Prefident of the College of New-Jerfey.
Mr. James Worral.
James Wright, Efq. of Lancafter county, Pennfylvania.
Mr. Benjamin Wynkoop.

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Peter Bergius, M. D. Prof. Nat. Hift. *Stockholm.*
John Martin Butt, M. D. of *Bath, England.*
William Cullen, M. D. Prof. Med. Univerfity of *Edinburgh.*
Sir Alexander Dick, M. D. Bart. of *Edinburgh.*
Mr. Jeremiah Dixon, *London.*
Mr. James Fergufon, F.R.S. *London.*
John Fothergill, M.D. F.R.S. *London.*
Signior Famitz, of *Naples.*
Dr. John Gill, of *Kinfale, Ireland.*
Mr. William Hewfon, Prælector Anat. *London.*
Richard Huck, M.D. F.R.S. *London.*
John David Hahn, M.D. Prof. Med. and Philof. Univerfity of *Utrecht.*
Hon. Ifaac Jamineau, Efq. Britifh Conful, *Naples.*
Sir Charles à Linné, M. D. Knight of the Polar Star, Firft Phyfician to the King of Sweden, Prof. Med. and Bot. *Upfal.*
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Mr. Benjamin Weft, *London.*
Charles Magnus Wrangel, D. D. of *Sweden.*

OFFICERS *for the Year* 1771.

PRESIDENT and VICE-PRESIDENTS, the fame as for the laft Year.

TREASURER. Thomas Coombe, Efq.

SECRETARIES.
- William Smith, D. D. Provoft College Philadelphia.
- David Rittenhoufe, A. M.
- Rev. John Ewing, A. M.
- Robert Strettel Jones. A. M.

CURATORS.
- Benjamin Rufh, M. D. Prof. Chym.
- Adam Kuhn, M. D. Prof. Bot. & Mat. Med.
- William Shippen, jun. M. D. Prof. Anat.

(College Philadel.)

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Directions

* Mr. ANTILL was one of his Majesty's Council for the Province of New-Jersey, and a worthy Member of the *American Philosophical Society*; but he died before the publication of the List prefixed to this Volume.

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PREFACE.

P R E F A C E.

KNOWLEDGE is of little uſe, when confined to mere ſpeculation: But when ſpeculative truths are reduced to practice, when theories, grounded upon experiments, are applied to the common purpoſes of life; and when, by theſe, agriculture is improved, trade enlarged, the arts of living made more eaſy and comfortable, and, of courſe, the increaſe and happineſs of mankind promoted; knowledge then becomes really uſeful. That this Society, therefore, may, in ſome degree, anſwer the ends of its inſtitution, the members propoſe to confine their diſquiſitions, principally, to ſuch ſubjects as tend to the improvement of their country, and advancement of its intereſt and proſperity.

The tract of country now poſſeſſed by the *Engliſh* in *North-America* is large and very extenſive; the ſoil and climate various; and, lying between the 25th and 55th degrees of North latitude, is not only ſubject to the gradations from extreme heat to extreme cold, but ſeems capable of ſupplying almoſt all the productions of the earth. It is watered with plentiful ſtreams, accommodated with creeks, bays and havens, and interſected by rivers, which run far into the country, and not only open an eaſy communication with the ocean, but, by interlocking with each other, afford an inland navigation of ſome thouſand miles, that with no great expence might be rendered ſtill more extenſive.

By the induſtry of its inhabitants, the land in many places is cleared of its wood, reduced to arable and paſture ground, and rendered fit to receive thoſe fruits, trees, plants and grain, which are proper to every ſoil.---The *Indians* who were natives of this country, and whoſe employments were hunting and fiſhing, paid little regard to huſbandry, or the cultivation of the land. To trade and commerce they were ſtrangers. Elegance of living they deſpiſed. They depended on the bow, and were content if, with the fortune of the chaſe, the ſpontaneous fruits of the foreſt, the fiſh which they caught, and a little *Indian* corn which their women and children raiſed, they could ſupport life. Hence it was that, upon the firſt diſcovery of *America* by the *Europeans*, *Indian* corn was the only grain found here.

The fruits, trees, plants, and grain, introduced by the new inhabitants, are moſtly ſuch as were cultivated in *European* countries,

(*a*) Bell's Travels into China. Du Halde's Hiſtory of China. Kæmpfer's Hiſtory of Japan.

from whence theſe inhabitants came. But the ſoil and climate of theſe countries being different from that of *Europe*, no wonder if many of them do not ſucceed here as well as in *Europe*.

If we may truſt to the report of travellers, (*a*) this country, in the ſame degree of latitude, very nearly reſembles *China*, or the tract of land that forms the eaſtern ſide of *Aſia*, in ſoil, climate, temperature of the air, winds, weather and many natural productions. And the ſame reſemblance is remarkable between the weſtern ſide of the old world and the weſtern ſides of our continent; (*b*) whereas the eaſtern and weſtern ſides of the ſame continent differ greatly.

From the lateſt and beſt accounts, (*c*) we find that *Kamtſchatka*, and the coaſt to the north of it, are in almoſt every reſpect, ſimilar to *Labrador* in *America*; but very different from thoſe parts of *Europe* which are comprehended within the ſame degrees of latitude.

Philadelphia lies in the 40th degree of north latitude, the very ſame as *Pekin* in *China*, and nearly the ſame with *Madrid* in *Spain*, and that part of California, of which Sir *Francis Drake* took poſſeſſion. In *Philadelphia* and *Pekin*, which lie on the ſame ſides of the two continents, namely, the eaſtern, the winters are cold, and the ſummers are very warm. The ſame winds, in both places, produce the ſame effects. Thus in both, the north-weſt winds are cold and piercing; the ſouth-weſt warm and dry; the north-eaſt cold and wet; the ſouth-eaſt wet but warm. Beſides, the general winds that prevail are the north-weſt in winter, and ſouth-weſt in ſummer. But the caſe is different in *Madrid* and *California*, though theſe places agree with each other in almoſt every circumſtance.

This reſemblance is manifeſt not only in the weather and climate, but is alſo remarkable in the ſoil and natural produce. Tobacco, Phytolacca, (or poke) the perſimon tree, the mulberry tree, with ſeveral others, are natives of *China*, they are alſo the natives of this part of *America*. Ginſeng is gathered to the weſtward of *Pekin*, and as far as we know, has not been found in any other part of the world, except within the ſame degrees of latitude in *America*. Theſe obſervations give grounds to hope that, if proper enquiries were made, many more of the native plants of *China*, and very poſſibly the Tea, ſo much in uſe amongſt us, and now become ſo neceſſary a part of our diet, might be found in *America*.

Who knows whether the arrack tree, of which we read, may not be the ſame as the *American* cocoa; or as our ſugar maple, which, for many years ſucceſſively, will yield a large quantity of rich, ſweet ſap, from whence a fine ſpirit may be diſtilled? It might be worth enquiring

(*b*) *Natural and Civil Hiſtory of* California.
(*c*) Muller's *Voyages from* Aſia *to* America.

enquiring, whether the cotton of *Virginia*, which is different from that raiſed in our iſlands, is not the ſame as that of which the *Chineſe* make their fine callicoes and muſlins; whether the *Indian* hemp of *America*, or more probably, the ſilk graſs found in *Virginia*, is not the ſame as the *Chineſe* Herba; and whether the ſilk, gathered from the trees in *China*, of which poets and travellers have told marvellous ſtories, is any thing more than the cocoons, which, in many places, are to be found in great plenty, on our trees and buſhes.

The ſilk of *China* ſeems to be of different ſorts; that of which their Bandanoes and coarſe ſilks are made, is ſtrong and harſh; that which they work up into their fine damaſks is ſoft, but of a weaker thread. Hence it is probable, that they have different ſpecies of ſilk-worms. In this part of *America*, different kinds of ſilk-worms are found upon different trees and ſhrubs; the cocoons of ſome of them, particularly thoſe that feed on the ſaſſafras, are larger, and the ſilk they produce, though not ſo fine, is much ſtronger than that of the Italian ſilk-worm that feeds on the mulberry. Is there not reaſon then to believe that, if experiments were made with our own ſilk-worms, and ſuch as are moſt uſeful were propagated, this country might, in a few years, produce plenty of ſilks?

Such of the plants of *China* as have been introduced here, ſeem to agree with our ſoil and climate, and to thrive in a degree equal to our warmeſt expectations; witneſs the rice, the whiſk and the *Chineſe* vetch. Theſe may encourage us to try others. From the trials made in our iſlands of the ſugar cane, coffee, ginger, &c. there is reaſon to hope, that the ſpices of the *Eaſt-Indies* may be propagated and cultivated there.

Thus by introducing the produce of thoſe countries, which lie on the eaſt ſide of the old world, and particularly thoſe of *China*, this country may be improved beyond what heretofore might have been expected. And could we be ſo fortunate as to introduce the induſtry of the *Chineſe*, their arts of living and improvements in huſbandry, as well as their native plants, *America* might in time become as populous as *China*, which is allowed to contain more inhabitants than any other country, of the ſame extent, in the world.

We have many trees, plants, roots and herbs, to the medical virtues and uſes of which we are ſtrangers. The fruit of our perſimon tree has been uſed, to good purpoſe, in brewing beer; but it was not known before the experiment was made, by order of this Society, laſt winter, that one buſhel of this fruit will yield above a gallon of proof ſpirit, of an excellent taſte and flavour. To what uſes in pharmacy the

the gum, the bark and roots of this tree, which is ſo very aſtringent, may be applied, is unknown. The virtues of the Magnolia and ſpice-wood are not ſufficiently aſcertained, though they have been uſed, and found to be excellent remedies in ſome diſorders. There is a tree called the Xantholixum, that grows in *Maryland*, *Virginia* and both the *Carolinas*, the bark of which is of ſuch a particular quality, that the ſmalleſt bit of it, on being chewed, ſtimulates the glands of the mouth and tongue, and cauſes a flow of ſaliva equal to that of a ſlight ſalivation, while its action continues. No rational experiments have yet been made to find out its virtues and uſes. A number of other trees might be mentioned, ſuch as the ſaſſafraſs, the wild cinnamon, the magnolia altiſſima; the fragrant ſmell and aromatic taſte of which prove that they have medicinal qualities, though their uſes are not fully known. The ſumach likewiſe deſerves examination. Its ſeed or berries, if not the wood itſelf, might be uſed in dying. The *Indians* mix its leaves with their tobacco, and thereby render it more aromatic and agreeable in ſmoking. There is a ſpecies of it which yields a gum that nearly if not exactly reſembles the Gum Copal. Indeed there is reaſon to believe it is the very ſame.

Our wines and raiſins are imported from foreign countries; while nature points out, that there cannot be a country more proper than this is for producing the grape. Before our lands were cleared, and ſo many of the grape vines extirpated, foreigners who viſited this country, could not help obſerving and admiring the quantity that, like native vineyards, preſented themſelves to their view. And even now our hills, vales and level land abound with them. They grow in every ſoil, are ſuited to every climate, and without cultivation, pour forth their fruits in abundance; many of them rich and luſcious to the taſte. It is not a little ſurpriſing therefore, that the culture of the grape was not among the firſt of our improvements. Conſidering the great variety of vines we have on this continent, it is not to be doubted that, with a little care and induſtry, *America* might produce wine ſufficient, not only for home conſumption, but even for exportation; and, conſidering the richneſs of many of our grapes, in their preſent wild, uncultivated ſtate, and the improvement they muſt receive from culture, there is reaſon to hope that, in time, our wine may be much eſteemed.

It would be endleſs to recount all our plants, roots and herbs; many of which, though now neglected, might, with a little care and attention, become articles of commerce, and be of great uſe to our country. It is found from experience that flaxſeed, by reaſon of

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the drought and fcorching Sun in *May* and *June*, does not grow well, and hemp requires fo rich a foil, that few pieces of ground will produce it. There is a plant, a native of this country, which grows in many places, but delights more particularly in light fandy foils, known commonly by the name of *Indian* hemp; its bark is fo ftrong that the *Indians* make ufe of it for bow-ftrings. Could we but find a method of feparating and foftening its fibres, fo as to render it fit to be fpun into fine thread, it might ferve as a fubftitute for flax and hemp. This plant deferves to be cultivated on another account. The pod it bears contains a fubftance that, from its foftnefs and elafticity, might be ufed inftead of the fineft down. Its culture is eafy, inafmuch as its root, which penetrates deep into the earth, furvives the winter, and fhoots out frefh ftalks every fpring. Five or fix years after being fown, it is in its greateft perfection. With the roots of plants, unknown to white people, the *Indians* ftain wood, hair and fkins of a beautiful colour, that preferves its luftre for years, though expofed to the weather. With the juice of herbs they relieve many difeafes, heal wounds, and cure the bite of the moft venomous fnakes. A perfect knowledge of thefe fimples, and of many others, with which our country abounds, might be of great ufe to mankind.

The bowels of our earth are but little explored, notwithftanding the encouragement received from the experiments that have already been made. There is a great variety of clays, many of them valuable. Of fome, good crucibles have been made, and fire bricks, equal to any in the world. Others have anfwered fo well in burning, as to induce one to hope, that in time, a porcelain, equal to that brought from *China*, may be made here. Near *Newcaftle* on *Delaware*, a clay is found, which, ufed as a paint, retains its colour for years, even when expofed to the weather, without any mixture of oil. In many places is found a kind of earth, which has been ufed inftead of *Spanifh* brown, and anfwered the end. In other places there is an ochre, which dyes a wainfcot colour. May not fome of thefe clays have medicinal qualities? About eighteen miles from this city, on the banks of *Nefhameny*, is a large bed of black lead. The lands to the fouthward are fo replete with nitre, are fo favourable for producing it, that, in fundry places, it appears like a hoar froft, on the furface of the ground. We are informed that a gentleman in *Virginia* made a large quantity of faltpetre from the fweepings of his tobacco-houfe, for which he received a medal from the Society of Arts: And, to evince the importance of this difcovery, the fame gentleman afferts that, from the floor of a tobacco-houfe, fixty by forty feet, may be collected by a very fimple procefs, fixteen hundred weight of nitre in a year. Nay, it is faid there are, if the expreffion may be allowed, mines of faltpetre in the mountains.

Of

Of ores and minerals *America* produces variety, as well as plenty; iron, copper and lead are found in many places. Some ſamples of tin, antimony and biſmuth ores have been lately diſcovered, and other minerals, the nature and properties of which are not ſufficiently aſcertained.

It would be worthy of every perſon, therefore, who wiſhes to improve his country, and advance its intereſt, to try whether he cannot find at home, or introduce from abroad, new ſpecies of plants, trees, fruits, grain, &c. ſuitable to our own ſoil and climate, for the ſupport and ornament of life, and for articles of trade and commerce. Each one according to his opportunities and ability, ſhould explore the virtues of our native plants, &c. and ſearch out the treaſures which nature has concealed in the bowels of the earth.

Such diſcoveries will not only be a benefit to ourſelves, but they will render us more uſeful to our mother country. They will give full ſcope to our induſtry, without exciting her jealouſy, or interfereing in the leaſt with her manufactories; they will enlarge and give ſtability to her commerce. For if by theſe means, the continental colonies can ſupply her with the rarities of *China*, and her iſlands can furniſh the rich ſpices of the *Eaſt-Indies*, her merchants will no longer be obliged, in order to obtain theſe, to traverſe three quarters of the globe, encounter the difficulties of ſo tedious a voyage, and, after all, ſubmit to the inſolence, or exorbitant demands of foreigners.

Already has *Britain* experienced the advantage of her colonies furniſhing thoſe articles, with which ſhe uſed to be ſupplied by foreign nations. In the infancy of the colonies, and before they were ſettled, ſhe depended on *Sweden* and *Ruſſia* for naval ſtores. Theſe nations, imagining that ſhe could not procure them elſewhere, and reſolving to increaſe their gain, entered into a combination to raiſe the price: And had not her colonies furniſhed theſe articles, ſhe muſt have given up the empire of the ſea, or ſubmitted to their arbitrary impoſitions.

But to accompliſh theſe deſirable ends, it is eſteemed neceſſary, and propoſed, that men of learning and enquiry ſhould turn their thoughts and attention to theſe ſubjects. The bulk of mankind follow a beaten track. They ſeldom turn their thoughts to experiments, and ſcarcely ever adopt a new meaſure, until they are well aſſured of ſucceſs and advantage from it, or are ſet upon it by thoſe, who have weight and influence with them.

That this Society may, as far in their power, contribute to the carrying ſuch a plan into execution, it is propoſed to make it a principal part of their buſineſs to inquire, and try to find out, what our country

country is capable of producing; what improvements may be made in agriculture, farming, gardening, &c. The beſt methods of manuring land, of reſtoring ſoils, that are worn out, and of protecting and guarding our fruits, trees, plants, and grains, from worms, inſects and blaſts; how to improve the breed of uſeful animals, and introduce other ſpecies from foreign countries; how to preſerve our timber for ſhip-building and other purpoſes, and to increaſe the moſt valuable ſorts, the beſt time for felling and the beſt method of ſeaſoning it; what are the virtues and uſes of the many plants, &c. which this country produces; what exotics or medicinal plants may be introduced, and the beſt method of propagating the moſt uſeful of them; what new vegetable juices may be diſcovered, and the beſt way of managing them; what improvements may be made in the art of fermentation, making of wine, cyder, vinegar, &c. the cheapeſt and beſt methods of making highways, cauſeways and bridges, joining of rivers, and increaſing our inland navigation.

But it is not propoſed to confine the views of the Society, wholly, to theſe things, ſo as to exclude other uſeful ſubjects, either in phyſics, mechanics, aſtronomy, mathematics, &c.

The means of conveying knowledge are now become eaſy. Printing houſes are erected in all the principal towns on the continent, and regular poſts eſtabliſhed to carry letters and papers from one to another. *Philadelphia*, (the place where this Society meets) hath, by its central ſituation, not only a ready communication by land, with our continental-colonies; but likewiſe with our Iſlands, by veſſels employed in carrying on our trade. Beſides, hints thrown out in our public circulating papers are not loſt, as in this country, almoſt every man is fond of reading, and ſeems to have a thirſt for knowledge.

The Society are very ſenſible how unequal they are to the taſk of carrying into execution a plan of ſo extenſive a nature. But they hope the uſefulneſs of it will procure them the countenance and aſſiſtance of every man who wiſhes well to his country.

There are many gentlemen in different parts of the country, whom Providence hath bleſſed with affluence, and whoſe underſtanding is improved by a liberal education. From ſuch the Society promiſe themſelves great aſſiſtance, as their fortunes enable them to make experiments, which men of narrow circumſtances would not dare to attempt. The farmers employed in cultivating the lands are intelligent and ſenſible, capable of obſervation, and of making many uſeful experiments. From theſe we ſhall thankfully receive every hint and practical obſervation, relative to the improvement of their farms, the culture of trees and grain, the raiſing of ſtock, *&c.* As among

our

our mechanics many are expert and ingenious, the Society hope to be favoured with any new inventions and difcoveries they fhall make; and as many of our young men, who have turned their thoughts to philofophical fubjects, have difcovered fuch a degree of judgment and genius, as will enable them to carry their refearches far into nature, their fentiments on fuch fubjects, as they fhall be pleafed to communicate to us, fhall be received with thankfulnefs. For befides the other advantages that may redound from an inftitution of this fort, it may have a tendency to infpire our youth with a love of knowledge, to draw them gently from fcenes of diffipation, and to animate them with a laudable defire of diftinguifhing themfelves by improvements in arts and fciences, and by ufeful difcoveries that may do honour to themfelves, and promote the intereft of their country.

Every fpecimen of what is curious or valuable in forming a cabinet, or collection of foffil, vegetable or animal fubftances, that may enlarge the bounds of natural hiftory in general, and of this part of the world in particular, will be efteemed agreeable prefents, and grateful acknowledgments will be made to the refpective donors.

The Society propofe, as foon as their ftock will enable them, to reward with fuitable premiums every perfon who fhall make any valuable improvement, invention or difcovery, in any of the fubjects before mentioned. They will always be ready to incorporate as members, thofe who deferve well of their country. In fhort, the chief merit the Society mean to claim to themfelves is only that of encouraging and directing enquiries and experiments, of receiving, collecting and digefting difcoveries, inventions and improvements, of communicating them to the public, and diftinguifhing the authors; and of thus uniting the labours of many, to attain one end, namely, the advancement of ufeful knowledge and improvement of our country.

TRANSACTIONS

OF THE

American PHILOSOPHICAL SOCIETY, &c.

SECT. I.

MATHEMATICAL *and* ASTRONOMICAL PAPERS.

A deſcription of a new ORRERY, *planned and now nearly finiſhed by* DAVID RITTENHOUSE, *A. M. of Norriton, in the county of Philadelphia. Communicated by Dr.* SMITH.

Read 21ſt Mar. 1768.

THIS *machine* is intended to have three *faces*, ſtanding perpendicular to the horizon: That in the front to be four feet ſquare, made of ſheet braſs, curiouſly poliſhed, ſilvered and painted in proper places, and otherwiſe ornamented. From the center ariſes an axis, to ſupport a gilded braſs ball, intended to repreſent the *ſun*. Round this ball move others, made of braſs or ivory, to repreſent the *planets*: They are to move in elliptical orbits, having the central ball in one focus; and their motions to be ſometimes ſwifter, and ſometimes ſlower, as nearly according to the true law of an equable deſcription of areas as is poſſible, without too great a complication of wheel-work. The orbit of each planet is likewiſe to be properly inclined to thoſe of the others; and their *Aphelia* and *Nodes* juſtly placed; and

 their

their velocities ſo accurately adjuſted, as not to differ ſenſibly from the tables of aſtronomy in ſome thouſands of years.

For the greater beauty of the inſtrument, the balls repreſenting the planets, are to be of a conſiderable bigneſs; but ſo contrived, that they may be taken off at pleaſure, and others, much ſmaller, and fitter for ſome purpoſes, put in their places.

When the machine is put in motion, by the turning of a winch, there are three indexes, which point out the hour of the day, the day of the month and the year, (according to the *Julian* account) anſwering to that ſituation of the heavenly bodies which it then repreſented; and ſo continually, for a period of 5000 years, either forward or backward.

In order to know the true ſituation of a planet, at any particular time, the ſmall ſett of balls are to be put each on its reſpective axis, then the winch to be turned round 'till each index points to the given time; then a ſmall *Teleſcope*, made for the purpoſe, is to be applied to the central ball, and directing it to the planet, its longitude and inclination will be ſeen on a large braſs circle, ſilvered, and properly graduated, repreſenting the *Zodiac*, and having a motion of one degree in 72 years, agreeable to the preceſſion of the *Equinoxes*: So likewiſe by applying the teleſcope to the ball repreſenting the *Earth*, and directing it to any planet, then will both the longitude and and latitude of that planet be pointed out (by an index, and graduated circle) as ſeen from the earth.

The two leſſer *Faces* are four feet in heighth, and 2 feet 3 inches in breadth: One of them repreſents and exhibits all the appearances of *Jupiter*, and his ſatellites, their eclipſes, tranſits and inclinations: Likewiſe all the appearances of *Saturn*, with his ring and ſatellites. And the other repreſents all the phænomina of the *Moon*, particularly the exact time, quantity, and duration of her eclipſes, and thoſe of the *Sun*, occaſioned by her interpoſition; with a moſt

moſt curious contrivance for exhibiting the appearance of a *Solar Eclipſe* at any particular place on the earth: Likewiſe the true place of the *Moon* in the ſigns, with her latitude, and the place of her *Apogee* and *Nodes*, the *Sun*'s declination, equation of time, &c. It muſt be underſtood that all theſe motions are to correſpond exactly with the celeſtial motions, and not to differ ſome *Degrees* from the truth, as is common in orreries.

The whole may be adjuſted to, and kept in motion, by a ſtrong *Pendulum Clock*, nevertheleſs, at liberty to be turned by the winch, and adjuſted to any time, paſt or future.

N. B. The above machine is to be ſupported by a mahogany caſe, adorned with foilage, and ſome of the beſt enrichments of ſculpture. The part containing the mechanical aſtronomy of the *Moon*, has been ſometime finiſhed, and is found perfectly to anſwer, by many trials already made of it. The remainder of the work is now almoſt completed. The clock part of it may be contrived to play a great variety of *Muſic*.

The following CALCULATIONS *and* PROJECTIONS *of the* Tranſit *of* Venus *were laid before the Society agreeable to their Dates, and claim a Place here, as it may be of Uſe, in various Reſpects, to compare them with the* actual Obſervations *of the* Tranſit, *afterwards made in this Province; and from thence to collect the Differences between Computation and Obſervation, together with the Cauſes of thoſe Differences.*

Read 21ſt June. 1768. PROJECTION *of the enſuing* TRANSIT *of* VENUS *over the* SUN, *which is to happen* June 3d, 1769. *By* David Rittenhouſe, *A. M.*

ELEMENTS *from* Halley's *Tables, for Lat.* 40° *N. & Long.* 75 *W. from* Greenwich.

Communicated by Revd. Dr. Smith.

1769, June 3d, at 3 h. P. M. Sun's place, 2ˢ. 13°. 21′. 37″
Heliocentric place of ♀ in ecliptic, 8. 13. 18. 11 Lat. ♀ N. 4′. 29″

♀ à ⊖ 3′ 26″

At 8 Hours P. M. Sun's place, 2ˢ. 13°. 33′ 35″
Place of Venus 8. 13. 38 .2 Lat. ♀ N. 3′ 18″

⊖ à ♀ 4. 27

Log. ⊖ à ⊙	5.006568	Diſtance	10152385
Log. ♀ à ⊙	4.861095	Diſt.	7262652
Log. ♀ à ⊖	4.460858	Diſt.	2889733
Diff. Log.	.400237		

Apparent Semidiameter of ⊙ 15′. 51″=15′, 85
Apparent Semidiameter of ♀ - - 0′, 5719
Diminiſh'd * Semidiam. of ⊙ 6′,3065 } in Ratio of 7262 to 2889.
Diminiſh'd Semidiam. of ♀ 0′,2276 }

Beginning of the Tranſit, 2h. 16′
End, 8. 50

But ſuppoſing the Sun's horizontal Parallax but 8 Seconds, then for the above Lat. and Lon.

Firſt External Contact will be at 2h. 11min.

* *The Diameters were diminiſhed to anſwer the Scale to which the Lat. of Venus was ſet off in the Projection.*

See the *Projection; Plate* I.

The

The following Paper by the Revd. Mr. Ewing, *was also communicated.*

GENTLEMEN,

Read June 21, 1768.

AS you have taken under confideration, the propofal which I made to you the 19th of April laft, of obferving the enfuing Tranfit of Venus over the difk of the Sun, which will be on the 3d of June, 1769; permit me to lay before you a projection of the Tranfit, as feen from Philadelphia, together with the elements of the projection, deduced from as accurate a calculation as I could make from Dr. Halley's Tables. I find from the obfervations made on the laft Tranfit in June, 1761, that the mean motion of Venus, for the year 1769, fhould be 21″ more than thefe tables make it, and that the place of the nodes of Venus, as ftated in thefe tables, needs the following correction. At the time of the ecliptical conjunction of the Sun and Venus in June 1761, their place was $2^s\ 15°\ 36'\ 33''$, and her geocentric latitude was $9'\ 44''.9$ fouth. Then fay, as 72626.3 the diftance of Venus from the Sun : 28894.9 the diftance of Venus from the earth :: $584''.9$ her geocentric latitude : $3'\ 52''.71$ her heliocentric latitude at that time. Then fay, as the tangent of the inclination of her orbit with the ecliptic, is to rad. fo is the tangent of her heliocentric latitude to the fine of her diftance from the node; *i. e.* as T, $3°\ 23'\ 20''$: rad. :: T, $3'\ 52''.71$: S, $1°\ 5'\ 14''$; which deduct from her place June 6, 1761, at the time of the tranfit, viz. at $5^h\ 57'\ 20''$ at Greenwich; and the remainder viz. $2^s\ 14°\ 31'\ 19''$ is the place of her afcending node at that time. The motion of her nodes, as ftated by Dr. Halley, is 31″ per annum; therefore, for 8 years, add $4'\ 8''$ to the abovementioned place of her node and the fum, viz. $2^s\ 14°\ 35'\ 27''$ is the place of the node in the year 1769, June 3d. With thefe corrected elements, and others, as in the tables, the following calculations are made.

The

The apparent time of the ecliptical conjunction of the Sun and Venus, as seen from the center of the earth, 1769, June 3d, $5^h. 4' 43''$, as reckoned at Philadelphia, $5^h. 0' 32''$ west from Greenwich. The place of the Sun and Venus, at the time of the transit, is $2^s 13° 26' 32''$. The place of her descending node is $8^s 14° 35' 27''$ at that time. The geocentric latitude of Venus at that time is $10' 16''.295$ The Sun's semidiameter is $15' 45''.65$. The semidiameter of Venus $0' 29''$. Their sum $16' 14''.65$; Their difference is $15' 16''.65$. Venus's horary motion from the Sun $3' 57''.43$. The angle made by the axis of the earth and ecliptic, as seen from the Sun, $7° 3' 16''$. The angle made by the axis of Venus's visible path and the axis of the ecliptic, is $8° 34' 17''$; the angular point or node being $1° 8' 55''$ west of the Sun. The angle made by the earth's axis and the axis of Venus's visible path is equal to the sum of these, $15° 37' 35''$. The horizontal parallax of the Sun on the day of the transit is $8''.5204$, when his distance from the earth is 101521.2, his parallax at his mean distance 100000 being supposed to be $8''.65$, as found at the last transit, 1761. The horizontal parallax of Venus on the day of the transit $29''.9348$, when her distance from the Sun 72626.3, her mean distance being according to her periodic time 72333. The difference of these, viz. $21''.4144$, is the horizontal parallax of Venus from the Sun on the said day. The transit begins, as seen from the earth's center, at $2^h, 17' 20''.48$, and ends at $8^h. 41' 46''.72$. The total ingress at $2^h. 36' 31''.38$; the beginning of egress at $8^h. 22' 35''.82$; so that the whole duration between the internal contacts will be $5^h, 46' 4''.44$. But these times will be considerably altered by the parallaxes of Venus in longitude and latitude, as observed from different parts of the earth. The whole effect of the parallaxes of longitude and latitude at the time of the external contact to hasten it, being $3' 31''$, the time of it, as seen from Philadelphia, is at $2^h, 13' 49'' 28'''$ P. M. And the time of total ingress at Philadelphia is 2^h.

2^h. 32′ 27″; the total effect of these parallaxes to accelerate the internal contact being 4′ 4″.

These times depend upon the longitude of Philadelphia, west of Greenwich, which in this calculation is supposed to be 5^h, 0′ 32″, which is as near as I have yet been able to ascertain it, by comparing a number of observations made on the eclipses of the first satellite of Jupiter, with Mr. Emmerson's tables. But these cannot be depended upon for the longitude, within a minute or two of time, which will by no means answer the design of ascertaining the distances of the Sun and planets by the ensuing transit. I would therefore beg leave to propose to the Society, that provision be made, without loss of time, for erecting a small observatory in some convenient place that the occultations of some known stars by the Moon, and the eclipses of Jupiter's satellites, may be noted, and compared with the corresponding observations made at Greenwich and other places: And that some proper persons be appointed to make the observations, at the expence of the Society, that our longitude may be ascertained with the precision that is necessary. It would be proper, that at least two setts of observers be appointed to view the transit in this city, in order to guard against the fatal accident of losing the Sun out of the field of the telescope, in the critical and important moment; which I find happened to a good astronomer in the East-Indies, at the time of the last transit. It is very difficult to preserve a celestial object in the field of a telescope, that magnifies considerably.

The expence of making these observations, with sufficient accuracy, must be considerable; but it is hoped that an opportunity will not be neglected on this account, which, for its importance to the interests of astronomy and navigation, has justly drawn the attention of every civilized nation in the world, and which will not be presented again for more than a century to come.

These

These things are submitted, with all humility and deference to the judgment of this respectable Society, by

Their very humble Servant,

Philadelphia, June 14, 1768. *JOHN EWING.*

N. B. The difference between some of these Numbers and those printed in the American Magazine, was occasioned by neglecting the 21″ of correction in the place of Venus, as inconsiderable, the effect of which is here taken into the computation, and the result is set down above. See the projection, plate 2.

An Account of the TRANSIT OF VENUS *over the* SUN'S DISK, *as observed at* NORRITON, *in the County of* Philadelphia, *and Province of* Pennsylvania, June 3d, 1769.

By WILLIAM SMITH, *D. D. Provost of the College of* Philadelphia, JOHN LUKENS, *Esq; Surveyor-General of* Pennsylvania, DAVID RITTENHOUSE, *A. M. of* Norriton, and JOHN SELLERS, *Esq; Representative in Assembly for* Chester *County*——

Being the Commitee *appointed for that Observation, by the* AMERICAN PHILOSOPHICAL SOCIETY, *held at* Philadelphia, *for promoting useful Knowledge.*

Communicated to the SOCIETY, July 20*th*, 1769, *by Direction, and in Behalf of, the* Committee; *by Dr.* SMITH.

GENTLEMEN,

AMONG the various public spirited designs, that have engaged the attention of this *Society*, since its first Institution; none does them more honor than their early resolution to appoint COMMITTEES, of their own Members, to take as many observations, in different places, of that *rare Phænomenon*, the TRANSIT OF VENUS over the SUN'S DISK, as they had any probability of being able to defray the expence of, either from their own funds, or the public assistance they expected.

As

As the members of the *Norriton-Committee* live at ſome diſtance from each other, I am, therefore, at their requeſt, now to digeſt and lay before you, in one view, the whole of our obſervations in that place; diſtinguiſhing, however, the part of each obſerver; and going back to the firſt preparations. For I am perſuaded that the dependance, which the learned world may place on any particular Tranſit-Account, will be in proportion to the previous, and ſubſequent care, which is found to have been taken in a ſeries of accurate and well conducted obſervations, for aſcertaining the *going* of the time-pieces, and fixing the Latitude and Longitude of the place of obſervations, &c.

And I am the more deſirous to be particular in theſe points, in order to do juſtice to Mr. *Rittenhouſe*, one of our committee; to whoſe extraordinary ſkill and diligence is owing whatever advantage may be derived, in theſe reſpects, to our obſervation of the *Tranſit* itſelf. It is further preſumed, that aſtronomers in diſtant countries, will be deſirous to have not only the work and reſults belonging to each particular *Tranſit-Obſervation*, but the materials alſo, that they may examine and conclude for themſelves. And this may be more particularly requiſite, in a New Obſervatory, ſuch as *Norriton*, the name of which hath perhaps never before been heard of by diſtant aſtronomers; and therefore, its latitude and longitude are to be once fixed, from principles that may be ſatisfactory on the preſent, as well as on any future occaſion.

Our great diſcouragement, at our firſt appointment, was the want of proper apparatus, eſpecially good *Teleſcopes*, with *Micrometers*. The generoſity of our *Provincial Aſſembly* ſoon removed a great part of this diſcouragement, not only by their vote to purchaſe one of the beſt reflecting Teleſcopes, with a *Dollond*'s Micrometer; but likewiſe by their ſubſequent donation of *One Hundred Pounds*, for erecting Obſervatories, and defraying other incidental expences. It was foreſeen that on the arrival of this teleſcope, added to ſuch private ones as might be procured in the

 city

city, together with fitting up the inftruments belonging to the Honorable the Proprietaries of the province, *viz.* the *equal Altitude* and *Tranfit Inftrument*, and the large aftronomical *Sector*, nothing would be wanting for the *City Obfervatory* in the State-Houfe Square, but a good Time Piece, which was eafily to be procured.

We remained however ftill at a lofs, how to furnifh the *Norriton Obfervatory*. But even this difficulty gradually vanifhed. Early in *September*, 1768, foon after the nomination of our *Committees*, I received a letter from that worthy and honorable Gentleman, *Thomas Penn*, Efq. one of the Proprietaries of this Province, which he wrote at the defire of the Rev. Mr. *Mafkelyne*, Aftronomer Royal, expreffing their defire, " That we would exert our- " felves in obferving the Tranfit, for which our fituation " would be fo favourable;" and inclofing fome copies of Mr. *Mafkelyne*'s printed directions for that purpofe.

This gave me an opportunity, which I immediately embraced, of acquainting Mr. *Penn* what preparations we had already made; and what encouragement the Affembly had given in voting *One Hundred Pounds* Sterling, for the purchafe of one reflecting Telefcope and Micrometer, for the City Obfervatory; but that we fhould be at a great lofs for a telefcope of the like conftruction for the *Norriton Obfervatory*, and requefting him to order a *Reflector* of two, or two and an half feet, with *Dollond*'s Micrometer, to be got ready as foon as poffible in *London*. It was not long before I had the pleafure to hear that Mr. *Penn* had ordered fuch a Telefcope, which came to hand about the middle of May, with a moft obliging letter, expreffing the fatisfaction he had in hearing of the fpirit fhewn at *Philadelphia*, for obferving this curious Phœnomenon when it fhould happen; and concluding as follows——

" I have fent by Captain *Sparks*, a reflecting Telefcope " with *Dollond*'s Micrometer, exact to your requeft, which " I hope will come fafe to hand. After making your ob- " fervation with it, I defire you will prefent it, in my " name

" name to the college—Meſſrs. *Maſon* and *Dickſon* tell me, " they never uſed a better than that* which I formerly " ſent to the Library Company of Philadelphia, with " which a good obſervation may be made, though it has " no micrometer."

We were now enabled to furniſh the *Norriton* Obſervatory, as follows, *viz.*

1. A *Gregorian Reflector* about 2 f. focal length, with a *Dollond*'s Micrometer. This Teleſcope hath four different magnifying powers, viz. 55, 95, 130, and 200 times; by means of two tubes containing eye glaſſes that magnify differently, and two ſmall Speculums of different focal diſtances. Made by *Nairne*. Uſed by Dr. SMITH.

2. A *Refractor* of 42 f. its magnifying power about 140. The glaſſes were ſent from London with the large Reflector, and belonged to Harvard College, New-England; but as they did not arrive time enough to be ſent to that place before the Tranſit, they were fitted up here by Mr. *Rittenhouſe*; and uſed by Mr. LUKENS.

3. Mr. *Rittenhouſe*'s *Refractor*, with an object glaſs of 36 f. focus, and a convex eye glaſs of 3 inches, magnifying about 144 times. Uſed by HIMSELF.

Both theſe Refractors, as well as the Reflector, were in moſt exquiſite order.

4. An *Equal Altitude Inſtrument*, its teleſcope three and an half feet focal length, with two horizontal hairs, and a vertical one, in its focus, firmly ſupported on a ſtone pedeſtal, and eaſily adjuſted to a plummet wire 4 feet in length, by 2 ſcrews; one moving it in a North and South, the other in an Eaſt and Weſt direction.

5. A *Tranſit Teleſcope*, fixed in the Meridian on an axis with fine ſteel points; ſo that the hair in its focus can move

* Mr. OWEN BIDDLE, who was appointed by the Society to conduct the obſervation near *Cape Henlopen*, had this teleſcope; nothing being deſired there but the *contacts* and their exact time; which he obtained to great ſatisfaction, as by his report may appear. As he had but ſhort time to prepare, and there was a difficulty in getting the neceſſary apparatus for fixing, by his own obſervations, the longitude and latitude of the place choſen for his ſtation, it was reſolved to depend on the aſcertaining theſe articles, by running a line from the place of his obſervation to a known point in the work of Meſſrs. *Maſon* and *Dixon*, when employed in ſettling the boundary lines of *Pennſylvania* and *Maryland*; and in meaſuring a degree of latitude, along that fine level peninſula, between *Delaware* and *Cheſapeak Bays*.

move in no other direction than along the meridian; in which are two marks South and North, about 330 yards diſtance each; to which it can be readily adjuſted in a horizontal poſition by one ſcrew as it can in a vertical poſition by another ſcrew.

6. An excellent *Time-Piece*, having for its pendulum-rod a flat ſteel-bar, with a *bob* weighing about 12 lb. and vibrating in a ſmall arch. It goes eight days, does not ſtop when wound up, beats dead ſeconds, and is kept in motion by a weight of 5 lb.

Theſe three laſt articles were alſo Mr. *Rittenhouſe*'s property, and made by himſelf.

7. An *Aſtronomical Quadrant*, two and an half f. radius, made by *Siſſon*, the property of the *Eaſt Jerſey* Proprietors; under the care of the Right Hon. *William* Earl of *Stirling*, Surveyor-*General* of that Province; from whom Mr. *Lukens* procured the uſe of it, and ſent it up to Mr. *Rittenhouſe* for aſcertaining the latitude of the Obſervatory. Thus we were at length completely furniſhed with every inſtrument proper for our work.

As Mr. *Rittenhouſe*'s dwelling at Norriton is about 20 miles North-Weſt of Philadelphia, our other engagements did not permit Mr. *Lukens*, or myſelf, to pay much attention to the neceſſary preparations; but we knew that we had entruſted them to a gentleman on the ſpot, who had joined to a complete ſkill in *mechanics*, ſo extenſive an *aſtronomical* and *mathematical* knowledge, that the uſe, management, and even the conſtruction of the neceſſary apparatus, were perfectly familiar to him. Mr. *Lukens* and myſelf could not ſet out for his houſe till Thurſday, June 1ſt; but, on our arrival there, we found every preparation ſo forward, that we had little to do, but to examine and adjuſt our reſpective teleſcopes to diſtinct viſion. He had fitted up the different inſtruments, and made a great number of obſervations, to aſcertain the going of his Time-Piece, and to determine the latitude and longitude of his Obſervatory. The laudable pains he hath taken in theſe

these material articles, will best appear from the work itself, which he hath committed into my hands, with the following modest introduction; giving me a liberty, which his own accuracy, care and abilities, leave no room to exercise.

Norriton, July 18th, 1769.

DEAR SIR,

"*THE inclosed is the best account I can give of the* "CONTACTS, *as I observed them; and of what I* "*saw during the interval between them. I should be* "*glad you would contract them, and also the other papers,* "*into a smaller compass, as I would have done myself, if* "*I had known how. I beg you would not copy any thing* "*merely because I have written it, but leave out what* "*you think superfluous.*

I am,

With great esteem and affection,

Yours, &c.

DAVID RITTENHOUSE."

To Revd. Dr. SMITH.

Mr. Rittenhouse's *Observations at* Norriton, *before and after the* Transit of Venus, June 3d, 1769; *for fixing the Latitude and Longitude of his observatory, and the going of his clock*, &c.

"EARLY in *November*, 1768, I began to erect an "*Observatory*, agreeable to the resolutions of the "*American Philosophical Society*; but, through various "disappointments from workmen and weather, could not "complete it, till the middle of *April*, 1769. I had for "some time expected the use of an *Equal Altitude* instru-"ment from *Philadelphia*; but finding I could not depend "on having it, I fell to work, and made one of as * simple a "construction

* *It is described above, No. 4. of the Apparatus.*

" conſtruction as I could. *March 20th*, this inſtrument " was finiſhed, and put up out of doors, the Obſervatory " not being yet ready.

" I had, however, for ſome weeks before this, with my " 36 f. Refractor, obſerved eclipſes of Jupiter's ſatellites, " in ſuch a manner that, though my equal-altitude inſtru- " ment was not finiſhed, and conſequently I could not ſet " my time-peace to the true noon, I ſhould nevertheleſs " be able to tell the time of thoſe eclipſes afterwards, when " the inſtrument ſhould be ready. For this purpoſe, I " obſerved, almoſt every fair evening, the time by the " clock, when the bright ſtar in orion diſappeared be- " hind a fixed obſtacle, by applying my eye to a ſmall " ſight-hole, made through a piece of braſs faſtened to a " ſtrong poſt.

The Obſervations were as follows, *viz.*

1769. Star diſappeared, per clock.			Immer. 1ſt ſatel. per clock.			Equal altitudes of ⊙			Hence appar. noon, or ⊙'s cent. on Merid. per clock.
Feb.	D.	h. m. ſec.	*Feb.*	D.	h. m. ſec.	*Mar.* D.	*A. M.* h. m. ſec.	*P. M.* h. m. ſec.	h. m. ſec.
	15	9. 26. 39		16	14. 24. 58				
	22	8. 58. 52		23	16. 17. 41	19	8. 58. 52.	2. 56. 52	11. 57. 37.
	24	8. 50. 57	Hence, from column 3d, the apparent times of the two immerſions above, are,			19	9. 2. 12.	2. 53. 32	
Mar.	3	8. 23. 21				20	8. 56. 40.	2. 58. 26	11. 57. 18.
	12	7. 48. 26				20	8. 59. 59.	2. 55. 7	
	14	7. 40. 41							
	17	7. 29. 4							
	20	7. 17. 16	*Feb.*	D.	h. m. ſec.				
	21	7. 13. 21		16	14. 21. 10				
	28	6. 45. 44		23	16. 15. 1				

" From this time, to *May 20th*, the clock was altered " ſeveral times; once taken down and cleaned, removed " back to the obſervatory, and regulated anew. Care was, " however, taken to obſerve *equal-altitudes* of the ſun, on " the days preceding and following any viſible eclipſe of " the 1ſt ſatellite; when the wheather would permit.

" The whole obſervations, during this period, were " the following,

Equal

Equal Altitudes of ☉ *April* 3d, 1769. *A. M.* h. m. sec.	*P. M.* h. m. sec.	Hence appar. noon; or ☉'s cent. on Merid. per clock. h. m. sec.	Observed Immersions of 1st Satellite. *April* 3d. h. m. sec.
8. 5. 22 8. 8. 16	4. 1. 56 3. 59. 2	12. 3. 25	14. 52. 40
4th. 8. 3. 43 8. 6. 38	4. 3. 3 4. 0. 10	12. 3. 9	
10th. 8. 32. 8 8. 35. 6 8. 36. 31	Cloudy.		10th. 16. 46. 20 Day-Light.
11th. 8. 30. 22 8. 33. 18 8. 34. 41	3. 30. 43 3. 27. 47 3. 26. 22	12. 0. 20	
12th. 8. 28. 55 8. 31. 51 8. 33. 16	Cloudy.		12th. 11. 14. 38
14th. 8. 25. 42 Cloudy, 8. 30. 2	3. 33. 56 3. 31. 1 3. 29. 37	11. 59. 38	
May 4th. 8. 5. 15 8. 8. 3 8. 9. 23	3. 44. 6 3. 41. 18 3. 39. 58	11. 54. 32	
5th. 8. 4. 11 8. 6. 59 8. 8. 19	3. 44. 51 3. 42. 4 3. 40. 42	11. 54. 22	*May* 5th. 11. 23. 45
6th. 8. 3. 8 8. 5. 54 8. 7. 15	3. 45. 37 3. 42. 51 - - - -	11. 54. 14	
11th. 8. 34. 51 8. 36. 13 8. 37. 40 8. 39. 3	3. 17. 12 3. 15. 49 3. 14. 22 3. 12. 59	11. 55. 54	
15th. 9. 12. 59 - - - - 9. 15. 53 - - - -	2. 39. 28 2. 38. 2 2. 36. 32 2. 35. 7	11. 56. 7	*May* 14th. Emersion. 9. 58. 20

" *May* 20th, in the morning, the clock was set up for " the last time, pretty near the mean time. It had no " provision for preventing the irregularities arising from " heat and cold; nor could I find leisure to apply any con- " trivance of this sort.

" This

" This day I likewise put wires instead of hairs in the " telescope of the equal-altitude instrument; and the fol- " lowing are the observations, taken both with it, and " with the meridian or *Transit-Telescope*, in the order " wherein they were made.

" The ill state of my health would not permit me to sit up " at nights, to take equal altitudes of the stars. I was there- " fore obliged to content myself with those of the sun on- " ly.

1769.			*May* 20th.		
Equal Altitudes of ☉ *A. M.* h. m. sec.	 *P. M.* h. m. sec.	Hence appar. noon; or ☉'s cent. on Merid. per clock. h. m. sec.	Observed Emersions of ♃'s Satellites.	Observations with the Meridian Telescope. h. m. sec.	Hence appar. noon; or ☉'s cent. on Merid. per clock. h. m. sec.
8. 1. 30 * 8. 2. 52 8. 4. 15 8. 5. 36	3.51. 28 3.50. 8 3.48. 45 3.47. 24	11. 56. 23¼		☉ W. limb } on Merid. } 11.55.16 East Do. 11.57.31	11. 56. 23½
			May 21st.		
8. 1. 1 Clouds.	3.52. 11 3.50. 50 3.49. 27 3.48. 7	11. 56. 30	Em. 1st Sat. h. m. sec. 11. 51. 46	☉ W. limb, 11.55.23 E. Do. 11.57.37 ♀ center } on Merid. } 1.18.39	11. 56. 30
			May 23d.		
8. 0. 4 8. 1. 24 8. 2. 47 8. 4. 8	3 53. 36 3.52. 16 3.50. 53 - - -	11. 56. 45		☉ W. limb 11.55.39 E. Do. 11.57,53	11. 56. 46
			May 24th.		
				☉ E. limb, 11.58. 0 —pass. ☉ semidi. 1. 8 ♀ center } ditto, } 1. 2. 4	11. 56. 52.
			May 25th.		
7.59.15 8. 0.35 8. 1.58 8. 2.18	3.54. 57 3.53. 38 3.52. 15 3.50. 54	11. 57. 1.		☉ W. limb, 11.55. 53 E. Do. 11.58. 9	11. 57. 1.
			May 26th.		
7. 50.54 8. 0.15 8. 1.37 8. 2.57	3.55. 38 3.54. 18 3.52. 56 3.51. 35	11. 57. 10		☉ W. limb 11.56. 3 E. ditto, 11.58.18	11. 57. 10½
			May 27th.		
				☉ W. Limb 11.56. 12 E. Do. 11.58. 27	11. 57. 19½
			May 30th.		
				☽ E. Limb. } on Merid. } 20.20. 31	

* In the above Equal Altitudes, it may be proper to observe that those in the afternoon are set down in an inverted order, the 4th P. M. being opposite and corresponding to the 1st A.M. The 1st set, according to the order in which they stand, is the sun's upper limb at upper hair; the second is the upper limb at lower hair; the 3d the lower limb at upper hair; and the 4th the lower limb at lower hair, as the telescope inverts.

May 31st.

Equal Altitudes of ☉ A. M. P. M.	Hence appar. noon; or ☉'s cent. on Merid. per clock.	Obſerved Emerſions of ♃'s ſatellites.	Obſervations with the Meridian Teleſcope.	Hence appar. noon; or ☉'s cent. on Merid. per clock.
1769.		*May 31ſt.*		
h. m. ſec. h. m. ſec. 7. 57.29 3.58. 49 7. 58.49 3.57. 30 8. 0.11 3.56. 8 8. 1.31 3.54. 49	h. m. ſec. 11 58. 5½		h. m. ſec. ☉ W. limb 11.56. 58 +paſſ. ☉ ſemidi. 1. 8	h. m. ſec. 11. 58. 6
		June 2d.		
Put ſmaller wires in the Teleſcope; hence the difference of the intervals. 7. 57. 9 4. 0. 6 7. 58.29 3.58. 47 7. 59.53 3.57. 22 8. 1.13 3.56. 3	11. 58. 34.		☉ W. limb 11. 57. 26 E. ditto, 11. 59. 41	11. 58. 33½
		June 3d.		
TRANSIT DAY. Equal altitudes were not taken this day, as the inſtrument was to be otherwiſe employed in the afternoon.			☉ W. limb 11. 57. 41 E. ditto, 11. 59. 57	11. 58. 49
		June 4th.		
- - 4. 1. 18 7. 58.10 3.59. 59 7. 59.34 3.58. 35 8. 0.54 3.57. 15	11. 59. 1½		☉ W. limb 11. 57. 54 E. ditto, 12. 0. 10	11. 59. 2
		June 5th.		
7. 56.43. 4. 1. 50 7. 58. 3. 4. 0. 30 7. 59.27. 3.59. 7 8. 0.47. 3.57. 47	11. 59. 13½			
		June 6th.		
- - - 2.50. 12 - - - 2.48. 51 9. 11.30 2.47. 26	11. 59. 26.	Em. 1ſt Sat. h. m. ſec. 10. 11. 2	h. m. ſec. ☉ W. limb 11. 58. 18 E. ditto, 12. 0. 33	h. m. ſec. 11. 59. 25½
		June 7th.		
7. 57.52 4. 1. 25 7. 59.16 4. 0. 1 8. 0.35 - - -	11. 59. 36	Em. 2d Sat. 8. 23. 42	☉ W. limb 11. 58. 27 E. ditto, 12. 0 44 ☽ W. limb on Merid. } 3. 21. 53	11. 59. 35½
		June 8th.		
7. 56.27 4. 3. 12 7. 57.48 4. 1. 52 7. 59.10 4. 0. 28 8. 0.32 3.59. 7	11. 59. 48		☉ W. limb on Merid. } 11.58.40 E ditto, 12. 0.57	11. 59. 48½
		June 10th.		
7. 56.22 4. 4. 1 7. 57.48 4. 2. 41 7. 59.12 4. 1. 17 8. 0.32 3.59. 7	12 0 9½			
		June 12th.		
			☉ W. limb 11.59.29 E. ditto. 12. 1.45	12. 0 37

Equal Altitudes of ☉ *A. M.* *P. M.* h. m. sec. h. m. sec.	Hence appar. noon; or ☉'s cent. on Merid. per clock. h. m. sec.	Observed Emersions of ♃'s Satellites.	Observations with the Meridian Telescope. h. m. sec.	Hence appar. noon; or ☉'s cent. on Merid. per clock. h. m. sec.
1769.		*June* 13*th*.		
7. 59.13 4. 2. 30 8. 0.33 4. 1. 11	12. 0. 50	Em. 1st Sat. h. m. sec. 12. 5. 59.	☉ W. limb 11. 59. 42 E. ditto. 12. 1. 59	12. 0. 50½
		June 14*th*.		
			☉ W. limb 11. 59. 57 E. ditto, 12. 2. 13	12 1. 5
		June 16*th*.		
7. 56.52 4. 6. 16 7. 58.12 4. 4. 57 7. 59.36 4. 3. 33 8. 0.56 4. 2. 12	12 1 34		☉ W. limb 12 0. 26 E. ditto, 12 2. 42 ♃ cent. on Merid. } 9. 6. 4	12 1. 34.
		June 17*th*.		
			☉ W. limb. 12. 0. 36 +pass. semid. 1. 8,8 ♃ center on Mirid. } 9. 1. 50	12. 1. 44 8 Thermometer. } 77°
		June 19*th*.		
			☉ W. limb. 12. 0. 56 +pass. semidi 1. 8,8 ♃ c. on mer. 8.53. 24	12. 2 4,8 Therm. 77°
		June 21*st*.		
			☉ W. limb 12. 1. 17 E Do. 12. 3. 34	12. 2. 25½ Therm. 83°
		June 22*d*.		
			☉ W. limb 12. 1. 28 E. Do. 12. 3. 45	12. 2. 36½ Therm. 74°½
		June 23*d*.		
			☉ W. limb, 12. 1. 39 E. Do. 12. 3. 55	12. 2. 47 Therm. 73½
		June 24*th*.		
			☉ W. limb 12. 1. 49 E. ditto, 12. 4. 5	12. 2. 57 Therm. 84°
		June 25*th*.		
		3d sat. out of the shadow, on applying the eye at 8. 54. 39	☉ W. limb 12. 1. 57 E. ditto, 12. 4. 14	12. 3. 5½ Therm. 80°
		June 26*th*.		
			☉ W. limb 12. 2. 6 E. ditto, 12. 4. 23 ☽ E. limb on Merid. } 18.13.52	12. 3. 14½ Therm. 85°
		June 27*th*.		
			☉ W. limb 12. 2. 14 E. ditto, 12. 4. 31 ☽ E. limb on Merid, } 19. 4.19 ♃ c. on Mer. 8. 19.58	12. 3. 22 Therm. 88°.

June 28.

Equal Altitudes of ⊙ A. M. h. m. sec.	P. M. h. m. sec.	Hence appar. noon; or ⊙'s cent. on Mirid. per clock. h. m. sec.	Observed Eclipses of ♃'s Satellites.	Observations with the Meridian Telescope. h. m. sec.	Hence appar. noon; ⊙'s cent. on Mirid. per clock. h. m. sec.
1769.		*June 28th.*			
7. 59. 11	4. 7. 45	12. 3. 29,4		⊙ W. limb, 12. 2. 21	12. 3. 29½
8. 0. 31	4. 6. 25			E. ditto, 12. 4. 38	
8. 1. 55	4. 5. 0				
8. 3. 15	- - -				
		June 29th.			
- - -	4. 7. 43	12. 3. 37.	Em. 1st Sat. having been hid by a cloud, at h. m. sec. 10. 25. 1	⊙ W. limb 12. 2. 29	12. 3. 37.
8. 0. 48	4. 6. 22			E. ditto, 12. 4. 45	*June 30th.* Therm. 85°.
8. 2. 11	4. 4. 59				
8. 3. 32	4. 3. 38				
		July 2d.			
8. 0. 24	4. 7. 28	12. 3. 59	Immersion. 3d Satellite. 11. 19. 36	⊙ W. limb 12. 2. 52	12. 4. 0
8. 1. 44	4. 6. 8			E. ditto, 12. 5. 8	Therm. 81°½
8. 3. 8	4. 4. 43				
8. 4. 29	- - -				
		July 3d.			
8. 0. 46	4. 7. 21	12. 4. 6		⊙ W. limb 12. 2.59	12. 4. 6½
8. 2. 7	4. 5. 58			E. ditto, 12. 5.15	Therm. 87°
8. 3. 31	4. 4. 37				
8. 4. 51	4. 3. 16				
		July 4.			
8. 1. 9	4. 7. 13	12. 4. 14		⊙ W. limb 12. 3. 11	12. 5. 14½
8. 2. 30	4. 5. 52			E. ditto, 12. 5. 23	Therm. 87°
8. 3. 53	4. 4. 31				
8. 5. 14	4. 3. 10				
		July 5th.			
8. 5. 30	4. 2. 57	12. 4. 19,3		⊙ W. limb 12 3. 11	12. 4. 19½
				+ passed semidi. 1. 8. 5	Ther. at 3 P.M. 94°½
		July 8th.			
8. 1. 36	4. 7. 41	12. 4. 42½		⊙ W. limb 12. 3. 36	12. 4. 44
8. 2. 56	4. 6. 20			E. ditto, 12. 5. 52	Therm. 83°½
8. 4. 19	4. 4. 57				

TABLE *of the Eclipses of Jupiter's 1st Satellite, observed at* Norriton, *from February* 16*th to June* 13*th; compared with the* calculated *times of the same Eclipses, for Greenwich, in order to fix the Longitude of the Observatory. The Immersions were observed with* Mr. Rittenhouse's *Refractor, and the Emersions with the Gregorian Reflector.*

1st. Sat. *Immersions.* 1769. Apparent time at *Norriton.*					Calculated apparent time of the same at *Greenwich.*					Longitude of *Norriton* W. from *Greenwich*; thence deduced.		
	D.	h.	m.	sec.		D.	h.	m.	sec.	h.	m.	sec.
Feb.	16	14.	21.	10	*Feb.*	16	19.	22.	29	5.	1.	19
	23	16.	15.	1		23	21.	16.	35	5.	1.	34
April,	3	14.	49.	25	*April*	3	19.	51.	24	5.	1.	59
	10	16.	46.	0		10	21.	47.	14	5.	1.	14
	12	11.	14.	37		12	16.	16.	13	5.	1.	36
May	5	11.	29.	27	*May*	5	16.	31.	20	5.	1.	53
	Emersions.					Emersions.						
	21	11.	55.	13		21	16.	56.	49	5.	1.	36
June	6	10.	11.	32	*June*	6	15.	12.	59	5.	1.	27
	13	12.	5.	1		13	17.	6.	31	5.	1.	30

Difference of Longitude for a mean of the above 9 Eclipses which we must fix for the Longitude of our Observatory, for the present. 5. 1. 34,22

But

But ſhould the obſerved * times of thoſe eclipſes, come out different at Greenwich from their calculated times in the nautical almanac, for the preſent year, a correction of the difference of longitude muſt be made accordingly.

OBSERVATIONS *for fixing the* Latitude *of* Norriton Obſervatory, *with an Aſtronomical-Quadrant of two and an half feet radius; made by* Siſſon.

This Quadrant was ſent up by Mr. *Lukens*, and erected in the meridian of the Obſervatory, *May* 20th, by Mr. *Rittenhouſe*, who took the following obſervations with it, *viz.*

Zenith diſtances of ſtars, for diſcovering whether there might be any error in the inſtruments.

With the face of the Quadrant weſtwards.

Higheſt ſtar in left leg of Bootes	*May*	31	20°.	36′.	6″
	June	4	20.	36.	0
		5	20.	36.	0
Arcturus	*May*	31	19.	46.	18
	June	1	19.	46.	14
		2	19.	46.	20
		5	19.	46.	22
Bright ſtar in the Crown	*June*	1	12.	39.	36
		5	12.	39.	27

With the face eaſtwards.

Higheſt ſtar in the left leg of Bootes	*June*	6	20°.	35′.	55″
		7	20.	35.	54
		8	20.	36.	0
Arcturus	*June*	6	19.	46.	5
		7	19.	46.	8
		8	19.	46.	13
		10	19.	46.	11
Bright ſtar in the Crown	*June*	6	12.	39.	34
		10	12.	39.	18

From a mean of the above 18 obſervations, the error of the quadrant is 3,″5 to be *ſubſtracted* from the Zenith diſtance when the face is weſtwards and *added* when it is eaſtwards.

OBSERVATIONS

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* Since drawing up the above, the Revd. Mr. Maſkelyne, Aſtronomer Royal, agreeable to my requeſt, hath been pleaſed to communicate the following liſt of eclipſes of Jupiter's 1ſt Satellite as obſerved at the Royal Obſervatory, from April to June, both incluſive, viz.

1769.	Apparent time.	Immerſions of 1ſt Sat. at Greenwich.
D.	h. m. ſec.	
March 29	12. 25. 7	with 2 f. Reflect. made by *Short*; Apert. 4,5 inches diameter.
April 12	16. 16. 8	with 2 f. Reflect. made by *Bird*; Apert. 3,8 inches diameter.
28	14. 35. 17	with *Short*'s 2 f. Reflector.
	Emerſions.	
May 16	9. 32. 15	with *Short*'s 2 f. Reflector.
	9. 31. 35	with 6 f. Newtonian Reflector; Aperture 9 inches diameter.
June 8	9. 40. 56	with 6 f. ditto.
15	11. 35. 33	with *Short*'s 2 f. Reflector.
July 1	9. 50. 24	with ditto.

Mr. Maſkelyne writes that the 6 f. reflector ſhews an immerſion later and an emerſion ſooner than Short's 2 f. Reflector by about 20″; and that the difference of the 2 f. reflectors, owing to the difference of their appertures, may be about 5″.

There are only three of the above eclipſes obſerved at Greenwich, (viz. the 3 immerſions) that could have been ſeen here, and but one of them happens to be among thoſe actually obſerved, viz.

April 12*th.* 16h. 16′. 8″ at *Greenwich.*
11. 14. 37 at *Norriton.*

Hence 5. 1. 31 Difference of longitude.

'Till we have an opportunity, the enſuing ſpring, to obſerve more eclipſes of Jupiter's Satellites, we would rather depend on the difference of longitude deduced from the two foregoing correſponding obſervations, than on the *mean* deduced from the calculated times; which, however, puts us only 3″ more weſt. The immerſion of April 12th was taken at *Greenwich*, with *Bird*'s teleſcope of 3, 8 inches aperture, and the ſame immerſion at *Norriton* with a refractor that, in all trials, as near as can be judged, gives the ſame ſecond with the Gregorian reflector of 4, 4 inches aperture; ſo that 2″ or 3″ might be added to the time of the immerſion at Greenwich to agree with our teleſcope, which would make 5h. 1′ 33″ or 34″ diff. long. the ſame as got from the *mean* of the calculated times.

The eclipſes of 2d and 3d ſatellite are not ſet down, as they are not ſo much to be depended on, as thoſe of the 1ſt.

OBSERVATIONS *of the Zenith Distance of the Sun's upper and lower Limb; and the latitude of the Observatory deduced from each separately*

☉'s upper limb à Zenith.		Hence Lat.	☉'s lower limb à Zenith.		Hence Lat.
May 25.	18°. 48'. 45'	40°. 10'. 17''	*June* 8.	17°. 29'. 33''	40°. 9.' 48''
26.	18. 38 18	40. 10. 10	9.	17. 24. 35	40. 9. 47
27.	18. 28. 21	40. 10. 10	10.	17. 20. 5	40. 9. 49
June 1.	17. 43. 47	cloudy, and doubtful.	11.	17. 15. 59	40. 9. 52
2.	17. 36. 16	40. 10. 2	14.	17. 6. 9	40. 9. 58
4.	17. 21. 51	40. 9. 52			
doubtful. 6.	17. 8. 53	40. 9. 34			
7.	17. 3. 21	40. 9. 47			
12.	16. 41. 10	40. 10. 14			
13.	16. 37. 45	40. 10 8			

Mean of the above 9 observations of ☉'s upper limb is	40°. 10'. 1''. 33'''	Mean of the 5 observations of the lower limb,	40°. 9'. 50''. 48'''
Do. from the 5 observations of lower limb,	40. 9. 50. 48		
Mean of both,	40°. 9.' 56'' 10'''	for the lat. of *Norriton* Observatory.	
And	39. 56. 54	lat. of *Philadelphia* Observatory.	

The difference of the above observations is greater than might be wished. All that can be offered to excuse them is the want of better instruments; though Mr. *Rittenhouse* thinks the differences chiefly arose from the action of the sun on the wooden frame which supported the quadrant. For he always observed that when the shutter in the roof was opened, the plummet-wire would, in a minute or two, leave the point, though it had stood over it quietly all the forenoon. Yet, notwithstanding those differences, *a Mean*, from so many, may be supposed very near the truth; since, if we leave out that of June 6th, which differs most from the others, the mean of the rest will be but 2'' greater than it is set down above.

So far I have given Mr. *Rittenhouse*'s observations, previous, and subsequent to the *Transit*, for ascertaining the going of his timepiece and fixing the latitude and longitude of the observatory, from February 15th to July 8th; by which it will appear what laudable diligence he hath used in these material articles. He hath taken many more observations since; but those given above, are judged fully sufficient to shew that both the latitude and longitude of the observatory may be* depended on, and also the times given on the day of the transit. It

* As the mensuration of the ground between the *Observatories* of Philadelphia and Norriton, will give the same difference both of longitude and latitude, which was got by the different astronomical observations at each place, they may be therefore taken as a confirmation of each others.

It hath been mentioned before, that it was on Thurſday afternoon, June 1ſt, that Mr. Lukens and myſelf arrived at *Norriton* with a deſign to continue with Mr. Rittenhouſe 'till the tranſit ſhould be over. The proſpect before us was very diſcouraging. That day, and ſeveral preceding, had been generally overcaſt with clouds, and frequent heavy rains; a thing not very common for ſo long a period at that ſeaſon of the year in this part of America. But, by one of thoſe ſudden tranſitions, which we often experience here, on Thurſday evening, the weather became perfectly clear, and continued the day following, as well as the day of the *Tranſit*, in ſuch a ſtate of ſerenity, ſplendor of ſunſhine, and purity of atmoſphere, that not the leaſt appearance of a cloud was to be ſeen.

June 2d, and the forenoon of June 3d, were ſpent in making the neceſſary preparations, ſuch as examining and marking the foci of our ſeveral teleſcopes, particularly the reflector, with and without the micrometer. The reflector was alſo placed on a polar axis, and ſuch ſupports contrived for reſting the ends of the refractors, as might give them a motion as nearly parallel to the equator as ſuch haſty preparations would admit. Several diameters of the Sun were taken, and the micrometer examined by ſuch other methods as the ſhortneſs of the time would allow.

The Sun was ſo intenſely bright on the Day of the Tranſit, that inſtead of uſing the coloured glaſſes ſent from *England* with the Reflector, I put on a deeply-ſmoaked glaſs prepared by Mr. *Lukens*, which gave a much more beautiful, natural and well-defined appearance of the Sun's Diſk. The ſmoaked glaſs was faſtened on the Eye Tube with a little bees-wax, and there was no occaſion to change it during the whole day, as there was not the leaſt cloud, or intermiſſion of the Sun's ſplendor.

Mr. *Rittenhouſe*, in his previous projection (ſee p. 4) had made the firſt external contact to be, *June* 3d, $2^h. 11'$ for lat. 40° N. and long. 5^h. W. of *Greenwich*; on a ſuppoſition of the Sun's horizontal parallax being 8″. He happened

happened to be very near the truth. For at $2^h. 10' 33''$ *mean* time, the 1ſt external *contact* was at *Norriton*, lat. 40°. 9'. 56" N. and long. $5^h. 1'. 31''$ weſt. Other calculations made it generally from 6' to 8' later for the latitude and longitude.

Though this calulation was not given, to be entirely depended on, yet it was ſufficient to make us keep what, in the ſea phraſe, would be called a *good look-out;* and therefore, at one *o'clock*, we took off the Micrometer, which had been fitted to the Reflector with a power of 95, and adjuſted it to diſtinct viſion, with the * ſame power to obſerve the *Contacts*. And during the hour that was to intervene from *one* to *two*, we reſolved to keep an alternate watch through the *Reflector*, on that half of the *Sun*'s limb, where *Venus* was certainly expected to touch; while the others, not thus employed, were fixing what more remained to be done, as follows, viz.

Firſt, That each of us might the better exerciſe our own judgment, without being influenced, or thrown into any agitation by the others, it was agreed to tranſact every thing by ſignals, and that one ſhould not know what another was doing. The Situation of the Teleſcopes, the two Refractors being at ſome diſtance *without* the Obſervatory, and the Reflector *within*, favoured this deſign.

Secondly, Two perſons, Mr. *Sellers*, one of our Commitee, and Mr. *Archibald M'Clean*, both well accuſtomed to matters of this kind, were placed at one window of the Obſervatory, to count the clock and take the ſignal from Mr. *Lukens*. Two of Mr. *Rittenhouſe*'s family, whom he hath often employed to count the clock for him in his obſervations were placed at another window to take his ſignal.

* As the two *Refracting Teleſcopes*, uſed by my aſſociates, took into their field but a ſmall part of the Sun's limb, and were difficult to manage on account of their length and the Sun's great altitude, it was thought beſt that I ſhould not uſe the greateſt power of the *Reflector*; that, having a larger field, I might be able to give notice to them, if the CONTACT ſhould happen at any great diſtance from that part of the Sun's limb where it was expected, and which might not be within their field. But if it ſhould happen near that part, we were to tranſact every thing by ſignals given to the counters at the clock, without the leaſt notice to each other. It was alſo thought beſt that there ſhould be ſome difference in our magnifying powers; and I am well pleaſed that I did not uſe a larger with the Reflector, as the viſion, with the power I uſed, was exquiſitely diſtinct and accurate.

ſignal. My Teleſcope was placed cloſe by the clock, and I was to count its beats, and ſet down my own time.

Theſe Preliminaries being ſettled, we prepared at two o'clock to ſit down to our reſpective Teleſcopes; or (I ſhould rather ſay) lie down to the *Refractors*, on account of the Sun's great height.

As there was a large concourſe of the inhabitants of the county, and many from the city, we were apprehenſive that our ſcheme for ſilence might be defeated, by ſome of them ſpeaking, when they ſhould ſee any of the ſignals for the Contacts; and therefore we found it neceſſary to tell them that the ſucceſs of our obſervation would depend on their keeping a profound ſilence 'till the *Contacts* were over. And to do them juſtice, during the 12′ that enſued, ther could not have been a more ſolemn pauſe of ſilence and expectation, if each individual had been waiting for the ſentence that was to give him life or death. So regular and quiet was the whole, that, far from hearing a whiſper, or word ſpoken, I did not even hear the feet of the counters, who paſſed behind me from the windows to the clock; and was ſuprised when I turned from my Teleſcope to the clock, to find them all there before me, counting up their ſeconds to an even number; as I imagined, from the deep ſilence, that my aſſociates had yet ſeen nothing of *Venus*.

As the Contacts are among the moſt eſſential articles relative to this phænomenon, it is material, before we ſet down the *times*, to give a particular account of the manner in which each obſerver judged of them, and the circumſtances attending them.

Mr. RITTENHOUSE's Account of the Contacts.

" At $2^h. 11'. 39''$ per clock, the Revd. Mr. *Barton* of *Lancaſter*, who aſſiſted me at the Teleſcope, on receiving my ſignal, as had been agreed, inſtantaneouſly communicated it to the counters at the window, by waving a handkerchief; who walking ſoftly to the clock, counting ſeconds

as

as they went along, noted down their times ſeparately, agreeing to the *ſame ſecond*. And three ſeconds ſooner than this, to the beſt of my judgment, was the time when the leaſt impreſſion made by *Venus* on the Sun's limb, could be ſeen by my teleſcope.

"When the planet had advanced about one third of its diameter on the Sun, as I was ſteadily viewing its progreſs, my ſight was ſuddenly attracted by a beam of light, which broke through on that ſide of *Venus* yet off the Sun. Its figure was that of a *broad-baſed pyramid;* ſituated at about 40 or 45 degrees on the limb of *Venus*, from a line paſſing through her center and the Sun's, and to the left hand of that line as ſeen through my teleſcope, which inverted. About the ſame time, the Sun's light began to ſpread round *Venus* on each ſide, from the points where their limbs interſected each other." See a repreſentation of both theſe phænomena, plate 3. fig. 1.

"As *Venus* advanced, the point of the pyramid ſtill grew lower, its circular baſe wider, until it met the light which crept round from the points of interſection of the two limbs; ſo that when half the planet appeared on the Sun, the other half yet off the Sun was entirely ſurrounded by a ſemicircular light, beſt defined on the ſide next to the body of *Venus*, which continually grew brighter, till the time of the internal contact." See plate 3. fig. 2.

"Imagination cannot form any thing more beautifully ſerene and quiet, than was the air during the whole time; nor did I ever ſee the Sun's limb more perfectly defined, or more free from any tremulous motion; to which his great altitude undoubtedly contributed much.

"When the *internal contact* (as it is called) drew nigh, I foreſaw that it would be very difficult to fix the time with any certainty, on account of the great breadth and brightneſs of the light which ſurrounded that part of *Venus* yet off the Sun. After ſome conſideration, I reſolved to judge as well as I could of the co-incidence of the limbs; and accordingly gave the ſignal for the *internal contact*

 at

at 2^h. 28′ 45″ by the clock (when the appearance of *Venus* and the border of light where as in fig. 3. plate 3.) and immediately began to count ſeconds, which any one who has been accuſtomed to it, may do for a minute or two, pretty near the truth. In this manner I counted no leſs than 1′ 32″ * before the effect of the atmoſphere of *Venus* on the Sun's limb wholly diſappeared; leaving that part of the limb as well defined as the reſt. From this I concluded that I had given the ſignal for the *internal contact* too ſoon; and the times given by the other obſervers at *Norriton* confirm me in this opinion."

Mr. LUKENS's Account of the Contacts.

"The teleſcope I uſed, being a refractor of 42 feet, giving but a ſmall field, and ſomething difficult to manage, by reaſon of the Sun's great altitude; I was obliged to move † often, and apprehend that I did not diſcover the firſt impreſſion of the planet on the Sun, which my teleſcope would have ſhewn. For, after one of thoſe movements, on bringing the glaſs to bear again on that part of the Sun's limb where Venus was expected, I ſaw a large tremulous ſhadow, already ſome what advanced, and ſeeming to preſs ſtill inwards on the Sun's limb. Having contemplated this for a few ſeconds, and perceiving the appearance grow more dark, and make a better defined impreſſion on the limb, I gave the ſignal to the perſons who counted time for me, which they noted down ſeparately at 2^h. 12′ 3″ by the clock. I ſuppoſe my teleſcope might have ſhewn the impreſſion on the Sun's limb at leaſt 15″ ſooner.

"When Venus was near one half of her diameter advanced on the Sun, I ſaw diſtinctly a border of light encompaſſing that part of her which was yet off the Sun. This was ſo bright that it rendered that part of Venus viſible and pretty well defined, although not yet entered on the

* Mr. Rittenhouſe thinks that a perſon who had ſeen the Sun nearer the horizon, and could not ſo well diſtinguiſh between the body of Venus, and this ſurrounding atmoſphere, would have been near 1′ later than him in pronouncing the contact; and that the other 32″ elapſed before the Sun's limb (through the large refractor he uſed) appeared totally reſtored to its former ſplendor.

† The obſervers with the refractors were obliged to lie on the ground, with their heads bolſtered up by the perſons that aſſiſted them.

the Sun. But towards the *internal contact*, the circular border of light feemed to grow more dufky towards the points where the luminous fegments of the Sun's limb were ready to clofe round the planet. This dufkinefs did not feem to part wholly from the Sun's limb, at the time I apprehended the body of Venus to be wholly entered on the Sun, and when I gave the fignal for the internal contact, which was noted by both the perfons who counted for me at 2^h. 28′. 58″ by the clock. And I judge at leaft from 16″ to 18″ more, before I faw the Sun's limb clear of this dufky fhadow."

Dr. SMITH's Account of the Contacts.

"The power kept on the *Gregorian reflector*, for obferving the *contacts*, as hath been already obferved, was the fame which we had been ufing, and were again to ufe, with the *micrometer*, magnifying 95 times. I had therefore a large field, taking in about half the Sun's difk; and the inftrument was fo firmly fupported, with its axis in a polar direction, that it could not be fhaken by any motion on the earthen floor of the obfervatory, and required only an eafy movement of one part of the rack-work to manage it. With thefe advantages, any part of the Sun's limb could be readily kept in the middle of the field, without neglecting, every 4″ or 5″, to caft my eye on all other parts of the limb on both fides, where there was any poffibility of the contact to happen.

"Within half a minute of the time calculated for the 1ft contact by Mr. Rittenhoufe, I fpoke to the counters at the windows to be very attentive to thofe who were to give them the fignals from the telefcopes out of doors; and turning my eye clofely to the part of the Sun's limb where Venus was expected, I had viewed it ftedfaftly for feveral feconds, without having occafion to change my field, when I was fuddenly furprized with fomething ftriking into it, like a watery pointed fhadow, appearing to give a tremulous motion to all that part of the limb, although the telefcope ftood quite firm, and not the leaft difturbance or undulation were perceptible about any other part.

"The

"The idea I had formed of the *contact* was---That Venus would inſtantaneouſly make a well defined black and ſmall impreſſion or dent on the Sun. But this appearance was ſo different, the diſturbance on the limb ſo ill defined, undulatory, pointed, wateriſh, and occupying a larger ſpace than I expected, that I was held in a ſuſpenſe of 5″ or 6″ to examine whether it might not be ſome ſkirt of a watery flying cloud.

"Perceiving this ſhadow (atmoſphere, or whatever elſe it was) to preſs ſtill forward on the limb, with the ſame tremulous pointed appearance, the longeſt points towards the middle, I began to count the beats of the clock for either 15″ or 16″, when a well-defined black dent, apparently occupying a leſs ſpace on the Sun's limb, became diſtinctly viſible. I then quitted the teleſcope and turning to the clock, noted the time it then ſhewed, which was 2^h. 12′ 5″.

"About 22″ ſooner than this (viz. the 16″ I counted, and the 5″ or 6″ in which I remained in doubt at the beginning) was the firſt viſible impreſſion on the limb which my teleſcope would ſhew; and I alſo marked that time down: viz. 2^h. 11′ 40″ to 43″. If this firſt impreſſion is to be taken for the *external contact*, I think it may be judged of almoſt to a *ſingle ſecond*, by perſons having equally good eyes and teleſcopes; which cannot be done, as I apprehend, to *ſeveral ſeconds*, either with reſpect to the *internal contact*, or even with reſpect to the moment of the firſt diſtinct black dent, commonly marked for the *external contact*. In both theſe, ſome differences may well happen among the beſt obſervers, from their different manner of judging, in reſpect to a circumſtance of ſuch exquiſite nicety.

"Whether a teleſcope of larger powers than what I made uſe of, might not have ſooner ſhewn this firſt ſhadowy impreſſion (that preceded the diſtinct black contact) I will not take upon me to determine; though, from the time given by Mr. *Rittenhouſe*, I think it would. But this I can

I can be ſure of, that I ſaw the firſt ſtroke of it perceptible through my teleſcope, having that part of the Sun's limb in full and ſteady view; and I might have noted the time to a ſingle ſecond, if I had expected it in that way.

" As to the *internal contact*, the thread or creſcent of light, coming round from both ſides of the Sun's limb, did not cloſe inſtantaneouſly about the dark body of the planet, but with an uncertainty of ſeveral ſeconds; the points of the threads darting backwards and forwards into each other, in a quivering manner, for ſome ſpace of time, before they finally adhered. The inſtant of this *adheſion* I determined to wait for, with all the attention in my power, and to note it down for the *internal contact;* which I did, at $2^h. 29' 5''$ by the clock; a few ſeconds later than Mr. *Lukens*, who judged in the ſame way. And even then, though the points of the thread of light ſeemed to cloſe, yet the light itſelf did not appear perfect on that part of the limb till about $12''$ afterwards; and I apprehend that a perſon who had waited for the perfection of this ſmall thread of light, would have given the contact that number of ſeconds later than I did, although I was later than the others.

" After the 1ſt contact, having quitted the teleſcope, to note down my time, the gentleman who counted for us, and ſeveral others now in the obſervatory, were impatient to ſee Venus before ſhe had wholly entered on the Sun; an indulgence not to be denied them, as the reflector was moſt convenient for them. For this reaſon I did not ſit down to it again till within $5'$ or $6'$ of the internal contact, and conſequently ſaw none of thoſe curious appearances, on that part of the planet off the Sun, mentioned by my aſſociates. But their account may be fully depended on, as both of them are well accuſtomed to celeſtial obſervations, and are accurate in judgment as well as ſight. The ſmall differences in the times of our *contacts*, it is preſumed, may be eaſily reconciled, from the different powers of our teleſcopes, and other circumſtances mentioned in the manner of judging. At any rate, we have ſet them down faithfully.

" As

"As to the firſt diſturbance in the Sun's limb, it may be worthy of conſideration, whether it was really from the interpoſition of the limb of *Venus*, or of her atmoſphere. One cannot eaſily imagine it to be the former, without ſuppoſing her limb and body much more ragged and uneven, than they appear when ſeen on the Sun. An atmoſphere is a much more probable ſuppoſition, not only from the faint and wateriſh colour at firſt, but the undulatory motion above mentioned, which might ariſe from the growing denſity of the atmoſphere, puſhing forward on the Sun, and varying the *refraction* of his rays, as they paſs in ſucceſſion through it.

"If ſuch an atmoſphere be granted, it will probably account for the tremulous motion, in the thread of light creeping round Venus at the *internal contact;* which may be thus prevented from cloſing and adhering quietly, till this atmoſphere (or at leaſt its denſeſt part) has entered wholly on the Sun, and conſequently the co-incidence of the limbs be paſt. For, though the atmoſphere of Venus (as far as we could poſſibly judge) be not viſible on the Sun; yet that part of it which is ſurrounding, or juſt entering his limb, may be viſible; having, if I may ſo expreſs it, a darker ground behind it.

"But theſe are only haſty conjectures, ſubmitted to others; although, if they have any foundation, it would make ſome difference in the time eſtimated between the *contacts*. And therefore, thoſe aſtronomers who may happen to be in the world at *another tranſit*, will perhaps think it beſt to fix on ſome general mode of pronouncing with reſpect to the *contacts;* either by neglecting this atmoſphere altogether; or taking their time from the appearance and diſappearance of its effects on the Sun's limb. In either caſe, it is preſumed the times of different obſervers having nearly the ſame altitude of the Sun, and equal advantages of weather and inſtruments, would not differ ſo much as has been the caſe hitherto, even among eminent aſtronomers at the ſome place."

General

General TABLE *of the* CONTACTS *of the Limbs of the* SUN *and* VENUS, *as observed at Norriton, June 3d,* 1769. *Reduced to apparent Time.*

N B. June 3d, (by the preceding tables of the work) the Sun's center was on the meridian at 11h. 58′. 49″ by the clock; and June 4th, at 11h. 59′. 2″, and therefore gained at the rate of 13″ in 24 hours. Hence, at noon June 3d, the clock being 1′. 11″ slow of apparent time, she was only 1′. 9″. 48‴ slow at the external contact, and 1′. 9″. 40‴ slow at the internal contact. But to avoid fractions, we say, 1′. 10″ slow at both contacts. Whence——

The apparent time of the Contacts, by different Observers, was——

External Contact, by Dr. SMITH.	External Contact, by Mr. LUKENS.	External Contact, by Mr. RITTENHOUSE.
First visible impression on ⊙'s limb, in form of a tremulous pointed shadow, at h. m. sec. 2. 12. 50 to 53 A well-defined black dent in ⊙'s limb, at 2. 13. 15	Mr. Lukens changing his field. A small dent in ⊙'s limb, at h. m. sec. 2. 13. 13	First impression on ⊙'s limb, at h. m. sec. 2. 12. 49
Internal Contact.	**Internal Contact.**	**Internal Contact.**
A thread of light, closing round the dark body of ♀ with a tremulous motion, at h. m. sec. 2. 30. 15 The luminous thread become clear and quiet in 12″ more, viz. at 2. 30. 27	Thread of light beginning to close round ♀ at h. m. sec. 2. 30. 8 Thread of light seemed, complete, at 2. 30. 24	Appearance as in plate 3, fig. 3, and judged by him for the Contact, at h. m. sec. 2. 29. 55

When Venus was fully entered on the Sun's limb, and we had compared the different papers on which our contacts were written down, and entered them in our book, we prepared for the micrometer and other observations.

Those of the micrometer reduced to apparent time, are as follow, viz.

No. of Observations.	Apparent time. June 3d, 1769.	Micrometer measures of least distance of nearest limbs of ⊙ and ♀	Value of micromet. measures; or least dist. of limbs, in min. and sec. of ⊙'s diameter.	Parallaxes of ♀ from ⊙ adjusted to the times of the micrometer measures, in order to the projection; by Mr. Rittenhouse.		
				In the Vertical.	In Path of ♀	Perpendi. to Path.
	H.M.Sec.	Inches. 20ths. 500ths.	M. Sec.	Seconds.	Seconds.	Seconds.
1	3. 7. 19	0. 4. 0,5	1. 45,4	14,54	13,67	4,94
2	3. 11. 39	0. 4. 12	1. 57,6	14,74	13,88	4,96
3	3. 17. 42	0. 5. 2	2. 13,5	15,09	14,24	5,01
4	3. 32. 3	0. 6. 14	2. 52,7	15,77	14,92	5,13
5	3. 40. 4	0. 7. 4	3. 8,6	16,17	15,32	5,23
6	4. 35. 5	0. 10. 21,5	4. 46,67	18,45	17,45	6,01
7	4. 57. 9	0. 11. 19	5. 10,75	19,02	17,95	6,32
8	5. 7. 49	0. 11. 22,75	5. 14,5	19,5	18,36	6,63
9	5. 21. 40	0. 11. 23,5	5. 15,3	19,88	18,64	6,98
10	5. 31. 46	0. 11. 21,5	5. 13,17	20,12	18,8	7,23
11	5. 42. 38	0. 11. 17,5	5. 8,93	20,36	18,95	7,48
12	5. 51. 10	0. 11. 13,5	5. 4,7	20,52	19,06	7,67
13	6. 22. 14	0. 10. 5,5	4. 29,7	21,00	19,21	8,57
14	6. 31. 5	0. 9. 20	4. 18,58	21,12	19,22	8,82
15	6. 41. 24	0. 9. 0	3. 57,38	21,22	19,15	9,14
16	6. 48. 12	0. 8. 13	3. 44,66	21,26	19,12	9,31
17	6. 53. 30	0. 8. 1,5	3. 32,47	21,28	19,04	9,49
18	6. 56. 22	0. 7. 23	3. 28,76	21,29	19,02	9,56

Distance

No. of Observ.	Distance of the limbs of ☉ and ♀ in Chords parallel to the Equator.			Parallaxes to the times of the micrometer measures.		
	H.M.Sec.	In. 20ths. 500ths.	M. Sec.	Seconds.	Seconds.	Seconds.
1	3. 58. 53	0. 17. 14,3 E. limb	7. 44,57	17,0	16,1	5,40
2	4. 27. 18	1. 3. 6 E. limb	10. 14,74	18,16	17,18	5,86
3	6. 4. 27	2. 0. 20 E. limb	18. 0,08	20,75	19,16	8,06
4	6. 9. 28	0. 15. 6.5 W. limb	6. 43, 7	20,81	19,2	8,2

Diameters of ☉ June 3, 1769.

Time per clock *A. M.* h. m. sec.	Micrometer measures. In. 20ths. 500ths.	Value. m. sec.
8. 35. 0	3. 11. 13	31. 34,16
8. 40. 0	3. 11. 16	31. 37,34
8. 45. 0	3. 11. 13	31. 34,16
P. M.		
12. 35. 0	3. 11. 13	31. 34,16
12. 40. 0	3. 11. 12	31. 33,1
Mean of the above 5 horizontal diameters of ☉ - - -		31. 34,58
Or leaving out the 2d which differs most from the rest, and was judged to be taken too large; the mean of the other 4 is - - -		31. 33,89

Diameters of ♀ taken on ☉ June 3d, 1769.

Time per clock. h. m. sec.	Micrometer measures. In. 20ths. 500ths.	Value. Sec.
3. 0. 0	0. 2. 4,6	56,75
3. 2. 0	0. 2. 5,0	57,18
3. 4. 0	0. 2. 5,25	57,44
4. 15. 0	0. 2. 4,7	56,91
5. 55. 0	0. 2. 4,7	56,91
5. 58. 0	0. 2. 5,33	57,53
Mean of the above 6 for diameter of ♀ - - - -		57,12

Which gives ☉'s semidiameter 15′. 46,″ 94; that is, *one second* and ⅓ of a second larger than the diameter given in the nautical almanack for the transit day. Yet, Venus's diameter, though taken with the utmost care by the same micrometer and at the same focus (as the Sun's) comes out about one second less than it was expected, being 57″,12; or about 1-33 of ☉'s diameter.

The vertical diameter of ☉ on the same day was 31′. 31″,8 at 4h. 40. *P. M.*

Of the micrometer measures, the 2d, 5th, and 18th distance of the nearest limbs of the *Sun* and *Venus*; the 1st in a chord parallel to the equator, the 1st and 6th of the diameters of *Venus*; and the 1st and 4th of the diameters of the *Sun*, were taken by Mr. Rittenhouse. The 3d and 16th distance of the nearest limbs, the 3d diameter of *Venus* and the 2d of the *Sun*, were taken by Mr. Lukens. All the other micrometer measures were taken by myself, while Mr. Rittenhouse applied himself to take the appulses of the limbs of the *Sun* and center of *Venus* to the cross hairs of his equal altitude instrument, Mr. Lukens writing down the observations and their exact time.

The micrometer measures were all separately reduced to their value in minutes and seconds by Mr. Rittenhouse, and by myself, making the proper allowance for the error of adjustment of the instrument. Many more micrometer measures might have been taken; but had we made the intervals

intervals between them much ſhorter than 8 or 10 minutes, they would have been of little uſe in the projection, and would have crouded it too much. Nor could we have beſtowed the ſame care in ſetting the inſtrument, reading off the vernier, &c. if a much larger number had been taken.

In order to judge of the error of the micrometer (if any) Jupiter's diameter was not only taken with it both ways, viz. to the right and to the left, but Mr. Rittenhouſe likewiſe took a *mean* to the right of 10 diameters of a white painted circle about 330 yards diſtant, and alſo a *mean* of as many to the left. This work was performed early in the morning before ſun-riſe; when the air was free from all tremulous motion; and the reſult gave an error of adjuſtment of 1″, 12 to be ſubſtracted from all the micrometer meaſures.

It was once intended ſtill further to confirm the work of the following delineation, by applying the obſervations of the appulſes of the limbs of the *Sun* and center of *Venus*, mentioned to have been taken above. But the lines neceſſary for this, would have confuſed the figure; and the micrometer obſervations being found ſo exact, any further uſe of the others, than to try how well they would agree, was thought to be needleſs, eſpecially as the fractions of ſeconds in them could not be eſtimated, ſo as to come up to the accuracy of the micrometer. For this reaſon, they are not ſet down.

Delineation of the Tranſit of Venus *over the* Sun, *according to the foregoing Obſervations, with the principles of the work.* *By Mr.* RITTENHOUSE.

"THE Sun's horizontal parallax is aſſumed 8″,65 at his mean diſtance from the earth; from which, and the obſerved leaſt diſtance of the centers of the Sun and Venus, the chord of the tranſit line was laid down. The Sun's ſemidiameter and that of Venus are taken as by the above obſervations. One point in the tranſit line was then fixed by the firſt micrometer diſtance of the limbs at $3^h. 7' 19''$ apparent

apparent time. This line was then divided carefully into hours and minutes, fuppofing Venus to move 240,″36 over the Sun's Difk in an hour, according to a calculation I had formerly made from Halley's tables. The place of Venus's center in the tranfit line, was then marked to the times of each of the obfervations; and from thence the apparent place of her center found, by fetting off the quantity of her parallax from the Sun in its proper direction. About each of the centers fo found, a circle is defcribed with the radius 28′,56. the obferved femidiameter of Venus. Blank lines were next drawn through the Sun's center and the apparent place of the center of Venus; and on thefe the black lines were drawn from the Sun's limb precifely of fuch length as we found they ought to be by the micrometer; fo that it may be feen at once how far they correfpond with each other, by obferving how much they exceed or fall fhort of reaching the limb of Venus.

Out of the 18 micrometer obfervations, there is fo exact a correfpondence among 14 of them, that I am well convinced they may be depended upon. Two of the others, as will appear by the figure, reach about a *fecond* over the limb of *Venus;* and the other two are fcarce a *fecond* fhort of it. Such fmall differences might eafily have happened for the leaft inaccuracy in reading off the time, or the divifions of the vernier, or from their not being exactly taken in the direction of the neareft diftance of the limbs; that is in a line joining the center of the *Sun* and *Venus*.

The meafures intended to be taken in chords parallel to the equator, are likewife exceeding near the truth, if it be confidered in fetting the micrometer to that direction, we had only the truth of the polar axis to depend on, which was conftructed haftily to anfwer the purpofe, of the day. Three of thefe meafures agree well with each other, and with all the other micrometer obfervations, on fuppofing the chord in which they were taken inclined half a degree to the plane of the equator. The 4th is ftill more nearly parallel, but diverging fomething the other way. Thefe chords

chords are delineated in the projection, and ſerve to confirm the other work.

All the parallaxes of Venus from the Sun were taken from a projection on a large ſcale of half an inch to a ſecond, and then reduced to the ſcale of this delineation. After calculation ſome of thoſe parallaxes, and finding that thoſe got by the projection came as near thoſe got by calculation, as it was poſſible to lay them down from the ſcale; any further nicety was not thought neceſſary.

The angle of Venus,s viſible way with the Ecliptic I find to be } $8^{\circ}.\ 28'.\ 27''$

The angle of the ecliptic with a parallel of declination at 3^{h}. P.M } $7^{\circ}.\ 5'.\ 13''$

Decreaſing $53''$ per hour.

Latitude of the Obſervatory (as above) $40^{\circ}.\ 9'.\ 56''$

Hence the parallaxes were fitted to each of the micrometer obſervations, as laid down above. If a computation be made from the firſt micrometer obſervation of the diſtance of the limbs, we ſhall find the time of the leaſt diſtance of the centers of the Sun and Venus as ſeen from the Earth's center to have been - - - $5^{h}.\ 26'\ 16''$

If a like computation be made from the 16th obſervation it will be found } 5. 26. 21

By comparing ſome other obſervations with theſe I conclude the time of leaſt diſtance of the centers to have been $5^{h}.\ 26'.\ 20''$.

Then ſay, as radius to the tangent of the angle of *Venus*'s viſible way with the ecliptic; ſo is the leaſt diſtance of the centers, to that portion of the path, intercepted between the place of *Venus* at the time of the leaſt diſtance of the centers, and her place at the time of ecliptic conjunction; that is---

$$\text{Rad} : \text{T}.\ 8^{\circ}.\ 28'.\ 27'' :: 610'' : 90'',88.$$

But $90'',88$ reduced to time is - - $0^{h}.\ 22'.\ 41''$

Time of leaſt diſtance of centers is - 5. 26. 20

Difference of which is the time of ecliptic conjunction } $5^{h}.\ 3'.\ 39''$

Again

Again Rad : sec. 8°. 28′ 27″ : : 610″:616″,73; the geocentric latitude of *Venus* at the time of ecliptic conjunction.

From the logarithm of *Venus* geocent. lat. 2.7900974
Substract the diff. of the logarithms of *Venus*'s distance from the earth, and from the sun, } 0.4002370
Remains the log. of the heliocentric lat. 2.3898604=4′.5″,39

Then say, as the tangent of the inclination of the orb of *Venus*, is to radius, so is the tangent of her heliocentric latitude to the sine of her distance from the node in the ecliptic; that is——

T. 3°. 23′. 20″ : Rad : : T. 4′. 5″,39 : Sine 1°. 9′. 4″ the distance from the node.

The *Sun*'s place by Halley's tables at the time of ecliptic conjunction was	2ˢ.	13°.	26′.	32″
Distance of the node from the Sun,	0.	1.	9.	4
The sum is the place of *Venus*'s ascending node,	2.	14.	35.	36
But, by Halley's tables, the place of *Venus* to the above time is only	8.	13.	26.	22

That is *ten seconds* too slow.

Thus gentlemen you have a faithful account of our whole work, which we could have wished to have reduced to less compass. Had our latitude and longitude been previously fixed, as they had been at Philadelphia by able mathematicians, a great part of our work might have been saved. But we thought it necessary (as hath been before hinted) to shew that such pains were taken in these material articles that they may be depended on. And as we were happily favoured at the transit, with advantages of weather, and other circumstances, which cannot have happened to the generality of observers in many parts of the world, it was thought we should be more readily excused, by men of science, for the insertion of things that might be superfluous, than the omission of the least article material,

rial, in the account of the phœnomenon, that will never be obſerved again, by any of the preſent generation of men.

I am,

Gentlemen, with great reſpect,

Your moſt obedient humble ſervant,

Philadelphia July 19th, 1769.

WILLIAM SMITH.

P. S. As it is hoped that not only this province in general, but likewiſe the ſociety who ſet on foot, and the honourable Houſe of Aſſembly, who ſo liberally encouraged, the deſign for obſerving the tranſit here, may derive ſome credit from the laudable ſpirit ſhewn on that occaſion, I ſhall add an extract of a letter from the Revd. Mr. Maſkelyne, the Aſtronomer Royal, to ſhew how well our labours have been received at home.

SIR, GREENWICH, *Auguſt* 2, 1769.

"I THANK you for the account of the Pennſylvania obſervations (of the tranſit) which ſeem *excellent* and *complete*, and do honour to the gentlemen who made them, and thoſe who promoted the undertaking; among whom I reckon yourſelf in the firſt place.

"As ſoon as I can ſettle the longitude of their places of obſervations, with reſpect to this place, I hope to be able, from comparing them with my own, and other European obſervations, which I have already received, to find the Sun's parallax, nearer than we could depend on it from the *tranſit* in 1761. "I do

The reader is deſired to make the following correction of the equal altitudes of April 11th and 14th, as that part of the work was printed off before the miſtake was diſcovered.

April 11th.	*A. M.*	*P. M.*	Hence appar. noon; per clock.
	h. m. ſec.	h. m. ſec.	h. m. ſec
	8. 30. 32	3. 30. 43.	
	8. 33. 28	3. 27. 47.	
	8. 34. 53	3. 26. 22.	12. 0. 25.

April 14th.	*A. M.*	*P. M.*	Appar. noon; per clock.
	h. m. ſec.	h. m. ſec.	h. m. ſec.
	8. 25. 42	3. 33. 56	
	- - - - -	3. 31. 1	
	8. 30. 2	3. 29. 37	11. 59. 37

which gives 1″ to be ſubtracted from, inſtead of being added to, the obſerved time of the immerſion of 1ſt ſatellite, April 12th, and makes it 11h. 14′. 37″ (as it ſtands corrected in the table of eclipſes of the ſatellites) inſtead of 11h. 14′. 39″, as it would be deduced from the altitudes printed above for April 11th, compared with thoſe of April 14th.

The emerſion of 2d ſatellite, per clock, June 7th, is alſo to be read, 8h. 43′. 29″, inſtead of 8h. 23′. 42″.

" I do not yet know whether the obſervations made by Meſſrs. Maſon and Dixon in Pennſylvania will ſuffice to ſettle the longitude of Philadelphia, to the exactneſs here requiſite. I wiſh, therefore to receive the obſervations of the eclipſes of Jupiter's ſatellites, made there in the ſpring of this year, of which Dr. *Smith* makes mention. Thoſe which have been made here, I have ſet down on the *next page, and requeſt you will be pleaſed to ſend them to him, with my beſt compliments and congratulations on his and his fellow obſervers ſucceſsful labours. I wiſh alſo to have an account of the difference of latitude and longitude between the *Philadelphia obſervatory*, and the two other *obſervatories* at *Norriton* and the *Capes of Delaware;* and alſo how much the *State Houſe* ſquare differs from the ſouthermoſt point of the city of Philadelphia, to which Meſſrs. Maſon and Dixon have referred their obſervations.

" When you receive any further account of the Pennſylvania obſervations, promiſed by Dr. Smith, or any other American obſervations, I ſhall be obliged to you for a ſight of them.

" I beg you will accept of the encloſed account of my obſervations of the tranſit, and of the eclipſe of the Sun, June 3d. You will perceive that ſeveral phœnomena noted at *Norriton* agreed with thoſe obſerved here; but they have further obſerved a curious circumſtance at the firſt entrance of Venus, which the low altitude of the Sun did not permit me to obſerve here; as, on the other hand, ſome phœnomena were noted here, which they have not taken notice of.

" In a few days I will do myſelf the pleaſure to leave ſome of my pamphlets with you, which I beg you would ſend to the Pennſylvania obſervers, when you have an opportunity. I am, S I R,

Your very humble Servant

NEVIL MASKELYNE."

To the hon. Thomas Penn, *Eſq.*

The

* They are inſerted above at the bottom of page 20.

The above letter was occaſioned by a ſhort account I had ſent to Mr. Penn four days after the tranſit, informing him of the ſucceſs of our obſervations, the times of the contacts, and a few other circumſtances attending them; which he communicated to Mr. Maſkelyne. Since that, Mr. Maſkelyne has received full ſatisfaction on all the points mentioned in his letter, as complete copies of our different obſervations have been tranſmitted to Dr. Franklin, to communicate to him, and ſuch other aſtronomers as he may think proper among his correſpondents in Europe. The particular circumſtances which I mentioned relative to the firſt entrance of Venus, was the duſky tremulous ſhadow or atmoſphere that ſeemed to precede her body, and the light that ſurrounded that part of her limb not entered on the Sun, which was alſo obſerved by the gentleman at Philadelphia, and by Mr. Biddle at the Capes. Which of theſe, or whether both, may be the curious circumſtance, or circumſtances, obſerved here, which Mr. Maſkelyne ſays the low altitude of the Sun did not permit him to obſerve, we cannot tell; as his account of the Greenwich obſervations has not yet come to hand. W. S.

An Account of the Obſervations *on the* Tranſit of Venus *over the* Sun, *on the 3d of June*, 1769, *by the* Committee *appointed to obſerve it at* Philadelphia; *drawn up, and preſented to the* American Philoſophical Society, *held at Philadelphia, for promoting uſeful Knowledge*,

By JOHN EWING.

GENTLEMEN,

IT doubtleſs muſt appear ſtrange to many, that the parallax of the Sun, which is ſo important and fundamental an article in aſtronomy, has not been ſettled by aſtronomers long ago, as ſo many things in that uſeful ſcience depend upon it. But this ſurpriſe is leſſened by conſidering, that the ſmallneſs of the parallactic angle has eluded their moſt careful reſearches in all ages, as it is but about 8 or 9 ſeconds

9 feconds of a minute; fo that the fubtenfe of it, were it much larger than it is, muft be invifible to the naked eye at the diftance of 6 inches, and it is hardly poffible to diftinguifh 10 feconds by inftruments, let them be ever fo fkilfully made. Many methods have been devifed by aftronomers, which fhew the ingenuity of the inventors; but the difadvantage of them all was, that they depended upon obfervations to be made with a precifion, which no inftruments hitherto conftructed could poffibly accomplifh. The tranfits of Venus alone afford an opportunity of determining this problem with fufficient certainty, and thefe, from the ftrict laws of her motion, happen fo feldom, that there cannot be more of them than two in one century, and in fome centuries none at all. Three only have been obferved fince the creation, and the firft of them by two perfons only. The peculiar advantage of this phœnomenon for determining the parallax of the Sun with a precifion which is not to be expected from any other method, confifts in its being deduced from the abfolute time that elapfes between the inftants of the contacts with the Sun's limb, as feen from different parts of the earth; or from the difference of total durations as noted by diftant obfervers, properly ftationed for that purpofe. A fecond of time being eafily diftinguifhed by a well regulated clock, if the aforefaid abfolute difference of time be carefully noted, in places where it will amount to 24 minutes, it will give the parallax, fmall as it is, within the hundreth part of a fecond of a degree, and confequently the diftance of the Sun and planets within the feven hundredth part of the whole. In fome tranfits this difference of time will be greater, and in others lefs, in certain places on the earth, which renders thofe that happen on the northern part of the Sun's difc, in general, more favourable to our purpofe, than thofe that happen on the fouthern hemifphere. Hence it is, that although much was done in this matter by the fedulity and care of aftronomers at the tranfit in the year 1761, when Venus paffed fouth of the Sun's center, yet our

our expectations could not be fully anſwered by the obſervations that were then made; as it was eaſily foreſeen that much greater preciſion might be attained, from the advantageous circumſtances that would attend the tranſit in 1769. The great proficience, which the aſtronomers made in ſettling this fundamental element, beyond what was ever known before, has only raiſed their expectations and engaged their attention to improve every advantage, that can be derived from a careful obſervation of this tranſit. If they have not been diſappointed by unfavourable weather, we hope for the utmoſt certainty that can be gained in this matter, from the obſervations they have made, when they ſhall be compared together. But after all, we muſt ſit down with the diſagreeable aſſurance that the diſtance of the Sun cannot be determined by them, let them be made with ever ſo great accuracy, within many thouſand miles; which will not appear ſtrange, when we conſider that his diſtance is upwards of 94 millions of miles, and that an error of a ſingle ſecond in his parallax will give an uncertainty of 10 or 11 millions of miles in his diſtance.

This approximation, however, is ſo much greater than could be expected, from any other method, that has ever been propoſed, that it has deſervedly engaged the attention of every civilized nation in the world; and it muſt redound to the honor of our ſociety, that they have taken ſuch effectual care to have proper obſervatories erected, to furniſh them with the neceſſary inſtruments, and to appoint proper perſons, to uſe them on that occaſion.

As the credit of our obſervations, and the ſtreſs that will be laid upon them, in determining the parallax of the Sun, will greatly depend not only on the care and ſkill of the perſons that made them, but alſo on the goodneſs of the inſtruments, with which we were furniſhed; it has been judged proper to give the public the following account of our apparatus, and of the pains we have taken to have it in the beſt order.

As the Society were pleafed to appoint *Jofeph Shippen*, Efq. Dr. *Hugh Williamfon*, Mr. *Charles Thomfon*, Mr. *Thomas Prior*, and *myfelf*, as a committee to obferve the tranfit at the obfervatory, which they had erected in this city, we fpared neither time nor labour to have every thing neceffary for the obfervation in readinefs. We were provided with an excellent fector of 6 feet radius, made by the accurate Mr. Bird, and an equal altitude and tranfit inftrument, both belonging to the honourable Proprietaries of this province, which the Governor very generoufly lent to the fociety on this occafion. Our telefcopes were, a large reflector of 4 feet focus and 7 inches aperture, which magnified from 100 to 400 times with an excellent micrometer of Mr. Dollond's conftruction fitted to it, which the affembly of the province had ordered over at the requeft of the fociety; a refracting telefcope of 24 feet focus, belonging to Mifs Norris; two reflecting telefcopes of 18 inches focus, one the property of Mr. Hamilton, the late Governor of this province, and the other of Mr. Prior, together with another reflector of 12 inches focus. With thefe, and a good time-piece, we promifed ourfelves the pleafure of making accurate obfervations, if the weather fhould prove favourable. For this purpofe we met frequently before the day of the tranfit, to adjuft our inftruments, and to remove every local obftruction that might hinder our obfervations.

Some of us gave particular attention to the regulation of the time-piece, and therefore took the paffage of the Sun's limbs over the crofs hairs of the tranfit inftrument, both forenoon and afternoon for many days before and after the tranfit, and particularly on that day. As it had three horizontal hairs fixed in the focus, it afforded us fix fets of correfponding altitudes, which generally agreed in giving the time of apparent noon within 2 feconds of each other; fo that by comparing them together daily, and applying the proper equations for correfponding altitudes, on account of the Sun's change of declination between the forenoon

forenoon and afternoon obſervations, we were aſſured of the rate of our clock's going and the time of apparent noon to a ſingle ſecond. We did not think it neceſſary to burden our minutes, with the great number of obſervations of this kind, that we made. Let us ſuffice to ſay, that they were made with the utmoſt care, and that our time-piece was fixed to a large poſt ſunk into the ground four or five feet, ſecured from ſhaking by a brick wall at the bottom, and no ways communicating with the ſides of the building.

The long expected day of the tranſit came, ſo favourable to our wiſhes, that there was not the leaſt appearance of a cloud in the whole horizon from morning 'till night, and the ſky was uncommonly ſerene. The committee aſſembled in the morning at the obſervatory, examined the adjuſtment of their teleſcopes anew, and appointed two aſſiſtants to obſerve the clock, one to count the ſeconds with an audible voice, and the other to write down the minutes as they were compleated, to prevent a miſtake in that article.

Every obſerver being fixed at his teleſcope, at leaſt half an hour before the beginning of the tranſit; we obſerved the contacts of the limbs of Venus and the Sun at the times mentioned in the following accounts, as they were drawn up ſeparately by the obſervers themſelves, and are here inſerted in their own words.

Account of the CONTACTS, *by* JOSEPH SHIPPEN, ESQ.

"I obſerved this very uncommon and curious phœnomenon with a new reflecting teleſcope, made by Mr. George Adams, whoſe tube is two feet and half an inch long, its aperture 4,15 inches diameter, and its magnifying power about 90 times. After having well adjuſted its focal diſtance, the Sun's limb appeared ſo well defined, that the leaſt obſcuration of it might be clearly diſcerned by a good eye.

"In

"In order to difcover the firft external contact, as near the precife time of its happening as poffible, I kept conftantly in the field of the telefcope, but a fmall arch of the Sun's limb, and only that part of it, where it was expected the planet would enter; by which means I believe I faw the obfcuration on the limb of the Sun as near the exact time of its beginning as the power of the telefcope would admit of.

"The firft alteration which I perceived in the Sun's difk, was *a jagged like appearance* on a fmall arch of the limb; as if a fhadow had been caft on it with *an irregular notched edge*, which at every fecond, feemed to increafe with a kind of waving and tremulous motion. I firft perceived this change at 2^h. 13$'$. 47$''$ apparent time, though I was not then convinced that that appearance was, either the phœnomenon we looked for, or caufed by the planet's near approach to the Sun's limb; but imputed it rather to fome duft that might accidentally have fallen on the large mirror of the telefcope, as I expected the contact would have fhewn itfelf by one fmall arched *indent* on the Sun's limb. And it was not 'till after twelve feconds more had paffed, that I was certain the contact had happened; for then, viz. at 2^h. 13$'$. 59$''$ apparent time, I could plainly diftinguifh a fingle impreffion, or indent, in the Sun's limb; yet it was exceedingly fmall, and without any of the *jagged appearance* before mentioned.

"I cannot well account for thefe different appearances in fo fmall a fpace of time, but by fuppofing that the firft was occafioned by an atmofphere around the body of Venus, which might have obfcured in a fmall degree, part of the Sun's limb, a few feconds before the contact; and that after Venus herfelf had actually entered on the Sun's limb, the brilliancy of the folar rays might have fo far illuminated the atmofphere of Venus, as to caufe the obfcuration at firft perceived to difappear, and leave only the well defined form of the planet on the Sun's difk.

"On

"On confidering the matter in this view, I am inclined to think that the firft external contact did not really happen 'till at leaft three feconds after I firft perceived the jagged obfcuration on the Sun's limb; and then it would be at $2^h. 13'. 50''$ apparent time.

"But if aftronomers agree to fix the time of the firft contact at the beginning of that obfcuration, I think it is probable the contact may have happened two or three feconds before I difcerned that obfcuration: In which cafe, the contact may be faid to take place at $2^h. 13'. 44''$ apparent time.

"In determining on the manner in which I fhould judge of the *internal contact*, I confidered that after Venus fhould move on the Sun's difk with half her diameter, the horned points occafioned thereby in the Sun's limb would appear more acute, and approach nearer to each other as the planet proceeded till the points fhould actually unite. From this reflection I was induced to think, that the inftant of the clofing of thofe points ought to be fixed on as the precife time of the internal contact; becaufe Venus muft then have paffed the Sun's limb with her whole diameter, and both their circumferences, or limbs, might be faid to coincide.

"I therefore carefully obferved the progrefs of the planet, and faw very diftinctly, as fhe moved onwards, that the illuminated points of the Sun's limb became better defined; and when they approached fo near each other as to be within about 8 feconds of touching, which was at $2^h. 31'. 26''$ ap. time, I heard one of the obfervers call out, *contact*; but as his obfervation did not feem to agree with the manner which I had fixed for judging of the contact, I continued viewing with the clofeft attention, in order to fix the time of contact according to the idea I had formed of it; and at $2^h. 31' 34''$. ap. time I could fcarcely diftinguifh the illuminated points of the Sun's limb to be any longer feparate; for in two feconds more they appeared to be fo far clofed as to form a fingle thread of light on that part of the Sun's limb, which a few feconds before had been eclipfed.

I therefore

I therefore conclude that the *apparent* firſt internal contact of Venus happened at 2ʰ. 31′. 34″ ap. time. Yet it is not improbable that her *real* contact may have happened a few ſeconds ſooner, if it be certain that ſhe has an *atmoſphere*; becauſe *that* might have obſcured the Sun's limb a few ſeconds after Venus was entirely immerſed within the diſk; in the ſame manner as I judged with reſpect to the external contact, that the beginning of the obſcuration of the Sun's limb was occaſioned by the intervention of the atmoſphere of Venus a few ſeconds before her body actually came in contact with the Sun."

Account of the CONTACTS, *by Dr.* WILLIAMSON.

"I made uſe of a refracting teleſcope 24 feet long, which magnifies ninety times. The glaſſes were in very good order, and the air uncommonly ſerene, ſo that the Sun's limb appeared very diſtinct and well defined, whence I promiſed myſelf the pleaſure of fixing the external contact to a ſecond, but the event convinced me that I had promiſed too much. A duſky appearence once and again drew my attention to a particular part of the Sun's limb, but I could ſee no ſuch dark ſpot there as I thought Venus muſt produce, and it was not till 2ʰ. 11′. 31″ mean time, or 2ʰ. 13′. 46″ apparent time, that I determined to ſtop a watch which I had in my hand, to aſcertain the time of my obſervation, leaſt ſome accident ſhould prevent my hearing the aſſiſtant, who ſtood at 5 or 6 yards diſtance by the clock counting ſeconds. At that very time I was doubtful, whether the appearance on the limb of the Sun was certainly occaſioned by the interpoſition of the body of Venus; for though the darkneſs was of ſome extent along the Sun's limb, yet the impreſſion was not proportionably deep, ſuppoſing that it was made by a circle ſo ſmall as Venus compared with the diameter of the Sun, nor was the darkneſs equally perfect; yet the ſubſequent progreſs of the darkneſs ſoon convinced me that I had not been much too haſty in noting the time of the external contact.

"When

" When Venus had advanced with a little more than half her body on the Sun, her whole eaſtern limb appeared faintly illuminated: This light ſeemed to encreaſe as ſhe advanced farther on the Sun, till near the time of the internal contact. By this time I was convinced that Venus is ſurrounded by a denſe atmoſphere of a conſiderable height, which doubtleſs had prevented my fixing the external contact, with that accuracy I had expected, and had occaſioned that inequality in the darkneſs, which I had obſerved on the Sun's limb.

" In determining the internal contact, which I apprehend was done with great exactneſs, I attended to the inſtant, when there was a prefect coincidence of the limb of Venus with the limb of the Sun, as when two circles touch internally. This appeared at $2^h. 31'. 24''$ apparent time. I expected by the time the aſſiſtant had counted another ſecond, to have ſeen light diſtinctly round the eaſtern limb of Venus; not ſuch a radiance as had for 7 or 8 minutes rendered that part of the planet viſible; but a certain narrow portion of the Sun's limb which had a very diſtinguiſhable appearance from the light I have mentioned. The edge of the Sun did not appear ſo ſoon; nevertheleſs I fixed upon $2^h. 31'. 25''$ for the preciſe time of the internal contact, being certain, that no part of Venus was then off the Sun. One or two ſeconds more were counted before the Sun appeared diſtinctly without the limb of Venus. But then it was obvious that Venus did not then touch the Sun's limb in any part, ſo that the contact was certainly over."

Mr. Prior made his obſervations with his own reflecting teleſcope, whoſe magnifying power he does not certainly know, but ſuppoſes it to be at leaſt an hundred times. He gave the following account of his obſervation of the contacts, viz.

" The uncertainty where Venus would touch the Sun's limb made me take the following method. From 8 or 9 minutes paſt two o'clock I made it a rule to paſs my eye from the lower edge of the field of my teleſcope to the up-

per,

per, many times in a minute, and examine the limb of the Sun ſtrictly, in hopes of diſcovering the atmoſphere of Venus approach, ſo as to give an opportunity of taking the contacts of the limbs to a great certainty. In paſſing my eye along the limb of the Sun, I diſcovered a ſmall imperfection, which I thought muſt be the ſtroke of the atmoſphere, but in four ſeconds I diſcovered it to be the limb of Venus, the atmoſphere not being viſible on the Sun. The time therefore that I note for my external contact is, when I firſt diſcovered that imperfection on the Sun's limb, which was at $2^h. 13'. 42''$ apparent time. When the body of Venus was ſomething more than one third on the Sun, I ſaw her eaſtern atmoſphere very diſtinctly reflecting the light of the Sun ſo ſtrongly on the limb of Venus, as to ſhew it well defined; but as it came on the Sun, it was entirely loſt. The time, I note for my internal contact, was, when the thread of light was diſtinctly ſeen all round the body of Venus, which was at $2^h. 31'. 28''$ apparent time."

Mr. James Pearſon, having obſerved the external contact at $2^h. 13'. 50''$ apparent time, with a ſmall teleſcope, belonging to the honorable proprietaries of this province, whoſe magnifying power is about 60 times; Mr. Charles Thompſon obſerved the internal contact with the ſame teleſcope, of which he gave the following account, viz.

"At $2^h. 29'. 11''$ mean time, or $2^h. 31'. 26''$. apparent time, I ſaw ſome tremulous rays of light paſs from the upper or eaſtern limb of the Sun to the eye, acroſs, and ſo as juſt to touch the upper limb of Venus. Marking that down therefore as the time of contact, I counted four ſeconds, at which time I ſaw a continued thread of light, like a ſilver lace, but ſtill with a tremulous motion, round the eaſtern limb of Venus, whereby it appeared to me that the whole body of Venus was then within the diſk of the Sun. The tremulous appearance of the rays of light, I at firſt attributed to my teleſcope reſting againſt the ſide of the obervatory, but afterwards apprehended might be owing to their paſſing through the atmoſphere of Venus." The

The committee having defired me to ufe the large reflector mentioned above, I chofe that power which magnifies the diameters of objects 300 times; with which I obferved at $2^h. 13'. 48''$. apparent time, an obfcuration on the north-eaftern limb of the Sun, gradually advancing forwards with a tremulous motion, which, from its irregular and dufky appearance, I concluded was occafioned by the refraction on the Sun's rays through the atmofphere of Venus, which atmofphere foon afterwards became very obfervable to us all. From this I was led to conclude that the contact did not happen till about 15 or 16 feconds afterwards, when there was a large and evident impreffion made on the limb of the Sun; but as the precife moment of the external contact cannot be noted by an obferver, the body of Venus not yet being interpofed between the Sun's limb and the eye; this contact muft have happened about the time that her atmofphere made the abovementioned obfcuration, and therefore I am of opinion that the true time of the contact fhould be accounted at $2^h. 13'. 48''$, or it may be 3 or 4 feconds fooner, when nothing but the atmofphere of Venus, which preceded her body, appeared on the limb of the Sun. About the time that the center of Venus approached the Sun's difk, I faw the whole body of Venus, her eaftern edge being furrounded with a faint light which was doubtlefs occafioned by her atmofphere refracting the Sun's rays. At $2^h. 29'. 11''$ mean time, or $2^h. 31'. 26''$ apparent time, I faw the internal contact, when the whole body of Venus was introduced within the difk of the Sun, and the thread of light had compleatly furrounded her, although not as bright as it became in two feconds afterwards.

From what has been faid, it appears that the apparent times of the contacts may be reprefented at one view in the following table, as they were noted by the different obfervers.

	1ft Exeter. Contact. h. m. fec.	1ft Inter. Contact. h. m. fec.	Magnifying Powers.
Jofeph Shippen, Efq.	2. 13. 47 Ap. T.	2. 31. 34 Ap. T.	80 times.
Dr. Williamfon,	2. 13. 46	2. 31. 25 to 27	90 times.
Mr. Pearfon,	2. 13. 50	- - - - }	60 times.
Mr. Thompfon,	- - - -	2. 31. 26 to 30 }	
Mr. Prior,	2. 13. 42	2. 31. 28	100 times.
Myfelf,	2. 13. 48	2. 31. 26	300 times.
A well-defined black dent in ☉'s limb, at	2. 14. 3		

After the obſervation of the contacts, I applied myſelf to the micrometer to meaſure the diameters of the Sun and Venus, and the diſtance of their limbs at ſundry times during the tranſit. I had indeed frequently meaſured the equatorial diameter of the Sun before the day of the tranſit, and always found it to be 6 ſeconds leſs than what is given in the nautical almanac. The mean of 6 meaſures on that day is 31′. 31″.6, which differs but 0″,3 or three-tenths of a ſecond from what is given in the ſaid almanac leſſened as above. Therefore I have ſtated it at 31′. 31″.3 in the following reductions and calculations.

Six meaſures of the diameter of Venus on the Sun made it 58 ſeconds. I attempted to meaſure it both ways, with the beginning of the diviſions of the vernier advanced on the ſcale of the micrometer and the contrary, that the error of adjuſtment might have been thereby taken away. But the micrometer did not admit of it, the diameter of Venus being a ſmall matter too large for this operation. However I took ſome meaſures this way, but they gave the diameter no more than 55″.4, which appearing too ſmall were therefore rejected.

About 20 minutes after the contacts, I began to meaſure the neareſt diſtance of the limbs of Venus and the Sun, and continued untill the Sun was ſo low, that the meaſures could not be made with ſufficient accuracy any longer. Some of the meaſures appear to diſagree too much with the others, and therefore ſhould not be depended on; but I could not prevail upon myſelf to neglect the inſerting of them; leaſt the unuſual agreement among ſo great a number ſhould raiſe a ſuſpicion, in the minds of aſtronomers, that they had not been honeſtly tranſcribed from our minutes; eſpecially as there are enough, to anſwer all the purpoſes deſigned by them, which agree in giving the neareſt diſtance of the centers with ſufficient preciſion. Although theſe meaſures are ſet down in the following table with the parts of a ſecond, we would not therefore be ſuppoſed to affect an impoſſible accuracy in them; but they are ſuch as the micrometer has given them when properly reduced.

Mean

No. of Obſerv.	M. Time. 1769. *June 3d,*			Ap. Time.			Neareſt diſtance of the limbs of ☉ and ♀		Neareſt diſtance of their centers.		Par. of ♀ in the Vertical.	Par. of ♀ in her Path.	Par. of ♀ perpendic. to her path.
	h.	m.	sec.	h.	m.	sec.	m.	sec.	m.	sec.	sec.	sec.	sec.
1	2.	53.	43	2.	55.	59	1.	8,46	14.	8,19	13,95	13,20	4,56
2	3.	5.	51	3.	8.	7	1.	48,23	13.	57,42	14,60	13,9	4,64
3	3.	11.	32	3.	13.	48	2.	4,49	13.	12,16	14,92	14,20	4,68
4	3.	14.	17	3.	16.	33	2.	10,4	13.	6,25	15,05	14, 3	4,70
5	3.	22.	7	3.	24.	23	2.	24,77	12.	33 07	15,50	14,70	4,78
6	3.	25.	45	3.	28.	0	2.	33,25	12.	34,3	15,70	14,90	4,86
7	3.	27.	37	3.	29.	52	2.	38,46	12.	29,09	15,75	15,02	4,90
8	3.	44.	31	3.	46.	46	3.	18,86	11.	57,89	16,55	15,80	5,02
9	4.	2.	31	4.	4.	46	3.	53,64	11.	23,01	17,38	16,56	5,30
10	4.	3.	41	4.	5.	56	3.	55,6	11.	21,05	17,45	16,62	5,31
11	4.	8.	39	4.	10.	54	4.	8,54	11.	8,11	17,63	16,64	5,32
12	4.	10.	9	4.	12.	24	4.	13,85	11.	2,8	17,60	16,80	5,35
13	4.	14.	53	4.	17.	8	4.	15,81	11.	0,84	17,83	17,01	5,44
14	4.	22.	5	4.	24.	20	4.	22,10	10.	53,55	18,10	17,20	5,52
15	4.	25.	37	4.	27.	52	4.	30,36	10.	46,29	18,20	17,30	5,56
16	4.	29.	47	4.	32.	2	4.	35,92	10.	40,73	18,40	17,50	5,68
17	4.	41.	57	4.	44.	12	4.	50,14	10.	26,51	18,80	17,90	5,90
18	4.	44.	0	4.	46.	15	4.	51,96	10.	24,69	18,94	17,98	5,97
19	4.	51.	18	4.	53.	33	4.	58,62	10.	18,03	19,14	18,10	6,06
20	4.	52.	16	4.	54.	31	5.	1,23	10.	15,42	19,16	18,16	6,09
21	4.	53.	27	4.	55.	42	5.	1,23	10.	15,42	19,20	18,20	6,12
22	4.	54.	52	4.	57.	7	5.	3,18	10.	13,47	19,26	18,26	6,17
23	4.	56.	30	4.	58.	45	5.	5,14	10.	11,51	19,30	18,30	6,20
24	4.	58.	29	5.	0.	44	5.	6,44	10.	10,21	19,36	18,35	6,24
25	5.	1.	35	5.	3.	50	5.	5,14	10.	11,51	19,44	18,43	6,30
26	5.	9.	29	5.	11.	44	5.	5,79	10.	10,86	19,55	18,52	6,46
27	5.	11.	52	5.	14.	7	5.	9,05	10.	7,6	19,68	18,74	6,50
28	5.	18.	29	5.	20.	44	5.	12,96	10.	3,69	19,95	18,85	6,69
29	5.	20.	29	5.	22.	43	5.	14,26	10.	2,39	20,05	18,90	6,76
30	5.	24.	17	5.	26.	31	5.	14,26	10.	2,39	20,14	18,98	6,90
31	5.	25.	59	5.	28.	13	5.	9,7	10.	6,95	20,19	18,99	6,91
32	5.	28.	33	5.	30.	47	5.	8,4	10.	8,25	20,20	19,01	6,96
33	5.	33.	39	5.	35.	53	5.	5,14	10.	11,51	20,36	19,03	7,08
34	5.	35.	45	5.	37.	59	5.	1,88	10.	14,77	20,40	19,10	7,10
35	5.	43.	17	5.	45.	31	5.	2,53	10.	14,12	20,50	19,18	7,28
36	6.	1.	13	6.	3.	27	4.	50,79	10.	26,86	20,84	19,34	7,78
37	6.	2.	39	6.	4.	53	4.	49,49	10.	27,16	20,90	19,38	7,88
38	6.	8.	7	6.	10.	21	4.	44,27	10.	32,38	20,96	19,42	7,97
39	6.	10.	4	6.	12.	18	4.	43,52	10.	33,13	21,0	19,44	8,00
40	6.	18.	37	6.	20.	51	4.	30,58	10.	46,07	21,04	19,46	8,20
41	6.	21.	49	6.	24.	3	4.	24,06	10.	52,59	21,10	19,48	8,32
42	6.	26.	13	6.	28.	27	4.	15,81	11.	0,84	21,14	19,50	8,40
43	6.	32.	18	6.	34.	32	4.	1,46	11.	14,19	21,18	19,50	8,60
44	6.	33.	55	6.	36.	9	4.	3,42	11.	13,23	21,20	19,46	8,68
45	6.	37.	29	6.	39.	43	3.	58,2	11.	18,45	21,22	19,43	8,76
46	6.	38.	55	6.	41.	9	3.	54,29	11.	22,36	21,24	19,40	8,82
47	6.	41.	39	6.	43.	53	3.	49,73	11.	26,92	21,26	19,36	8,92
48	6.	43.	57	6.	46.	11	3.	44,94	11.	31,71	21,28	19,34	8,98
49	6.	46.	25	6.	48.	39	3.	42,98	11.	33,67	21,29	19,31	9,02
50	6.	48.	49	6.	51.	3	3.	36,46	11.	39,19	21,30	19,29	9,17
51	6.	53.	17	6.	55.	31	3.	28,64	11.	48,01	21,34	19,26	9,21
52	7.	2.	1	7.	4.	15	3.	9,08	12.	7,57	21,38	19,24	9,48
53	7.	4.	33	7.	6.	47	3.	4,52	12.	12,13	21,39	19,20	9,56
54	7.	9.	26	7.	11.	40	3.	5,82	12.	11,83	21,40	19,10	9,70

The

The foregoing neareſt diſtances of their centers are deduced from the meaſured diſtances of their limbs, taking their diameters as they are ſtated above: And the parallaxes are not computed, but meaſured from a projection of the diſk of the earth as ſeen from the Sun, the projection being 21 inches and an half in diameter.

The latitude of our oſervatory in Philadelphia is determined from the obſervations of Meſſrs. Maſon and Dixon with the above mentioned ſector. From a mean of thirty obſervations of the paſſage of ſome ſtars over the meridian, they found the latitude of the moſt ſouthern point of the city of Philadelphia to be $39°. 56'. 29'',2$. Our obſervatory is north of this point, 26,2 ſeconds, and therefore its latitude is $39°. 56' 55'',4$.

In order to determine the parallax of the Sun, from the foregoing obſervations, it is neceſſary that our longitude from ſome fixed meridian ſhould be aſcertained with the moſt rigorous preciſion. For this purpoſe we have obſerved various eclipſes of Jupiter's ſatellites, that they might be compared with the correſpondent obſervations made at Greenwich and elſewhere, when we are furniſhed with them.

Eclipſes of JUPITER's SATELLITES, obſerved at *Philadelphia*, with a two feet reflector.

		D.	h.	m.	ſec.			
1767.	*April*	3,	7.	11,	23	Em.	2*d*.	Ap. T.
	May	30,	10.	15,	32	Em.	1*ſt*.	
	June	13,	9.	18.	6	Em.	2*d*.	
1768.	*Mar.*	1,	9.	46.	49	Im.	1*ſt*.	
	April	9,	10.	37.	2	Em.	1*ſt*.	
		25,	8.	56.	50	Em.	1*ſt*.	
	May	12,	10.	33.	9	Em.	2*d*.	
1769.	*Feb.*	16,	14.	21.	51	Im.	1*ſt*.	
		20,	15.	42.	1	Im.	2*d*.	
		23,	16.	16.	21	Im.	1*ſt*.	
	Mar.	17,	12.	45.	21	Im.	2*d*.	
1769.	*April*	3,	14.	50.	48	Im.	1*ſt*.	Ap. T.
		11,	9.	49.	14	Im.	2*d*.	
		12,	11.	15.	49	Im.	1*ſt*.	
	May	5,	11.	30.	28	Im.	1*ſt*.	
With a four feet reflector.								
	June	7,	8.	44.	37	Em.	2*d*.	
		22,	8.	27.	35	Em.	1*ſt*.	
		29,	10.	21.	55	Em.	1*ſt*.	
	Aug.	23,	12.	15.	48	Em.	1*ſt*.	
	Sept.	11,	7.	44.	41	Em.	2*d*.	

Since the foregoing account has been drawn up, we have been furniſhed with ſome obſervations of the eclipſes of Jupiter's ſatellites, made by the revd. Mr. Maſkelyne, aſtronomer royal, at Greenwich. By comparing theſe with the like obſervations made at Philadelphia and Norriton, we are enabled to ſettle the longitudes of our obſervatories. But

But as there are but two or three of them correſpondent with ours, we muſt have recourſe to another method; which is firſt to compare them with the calculations in the nautical almanac, which were made for the meridian of Greenwich, that the error of the tables may be diſcovered by the mean of them; and then to compare ours with the ſame calculations, applying the errors of the tables to the longitude deduced from this compariſon. We may depend upon the reſult of this method with much more confidence, than upon any ſingle obſervation.

Here follow the Apparent Times of the Greenwich Obſervations compared with the calculations of the Nautical Almanac.

1769.	D.	h.	m.	ſec.	
Mar.	29,	12.	25.	7	Im. 1*ſt* obſ. at Green.
	29,	12.	24.	26	Do. p. calc. of N. Al.
				41	Error Weſt.
Apr.	11,	14.	50.	23	Im. 2*d* obſ. at Greenw.
	11,	14.	50.	4	Do. p. calc. of N. Al.
				19	Error Weſt.
	12,	16.	16.	13	Im. 1*ſt* obſ. at Greenw.
	12,	16,	16,	13	Do. p. calc. of N. Al.
				00	
June	8,	9.	41.	16	Em. 1*ſt* obſ. at Green.
	8,	9.	41.	26	Do. p. calc. of N. Al.
				10	Error Eaſt.
	15,	11.	35.	33	Em. 1*ſt* obſ. at Green.
	15,	11,	34.	55	Do. p. calc. of N. Al.
				38	Error Weſt.

1769.	D.	h.	m.	ſec.	
April	28,	14.	35.	17	Im. 1*ſt* obſ' at Green.
	28,	14.	36.	14	Do. p. calc. of N. Al.
				57	Error Eaſt.
May	6,	11.	51.	2	Im. 2*d* obſ. at Greenw.
	6,	11.	51.	45	Do. p. calc. of N. Al.
				43	Error Eaſt.
May	16,	9.	32.	15	Em. 1*ſt* obſ. at Greenw.
	16,	9.	31.	7	Do. p. calc. of N. Al.
			1.	8	Error Weſt.
July	1,	9.	50.	24	Em. 1*ſt* obſ. at Greenw.
	1,	9.	50.	37	Do. p. calc. of N. Al.
				13	Error Eaſt.

Now although the errors of the firſt ſatellite appear conſiderable, yet if we reject the obſervation of the 16th of May as being too near to the time of Jupiter's oppoſition with the Sun; the mean of thoſe, which give an eaſtern meridian correſponding with the calculations of the nautical almanac, exactly counterbalances the mean of thoſe which give a weſtern meridian correſponding with them. Therefore we have nothing to do but to reduce all our obſervations at Norriton and Philadelphia to the meridian of Philadelphia, and then compare them with the calculations in the nautical almanac.

The

The Norriton obſervations of the eclipſes of Jupiter's firſt Satellite are as follow.

	D.	h. m. ſec.			1769. D.	h. m. ſec.	
1769. *Feb.*	16,	14. 21. 10	Im. *1ſt.*	*May*	14,	10. 2. 14	Em. *1ſt doubtful.*
	23,	16, 15. 1	Im. *1ſt.*		21,	11. 55. 13	Em. *1ſt.*
April	3,	14, 49. 25	Im. *1ſt.*	*June*	6,	10. 11. 32	Em. *1ſt.*
	10,	16. 46. 0	Im. *1ſt.*		7,	8. 43. 44	Em. *2d.*
	12,	11. 14. 37	Im. *1ſt.*		13,	12. 5. 1	Em. *1ſt.*
May	5,	11. 29. 27	Im. *1ſt.*				

Now if we compare the correſpondent obſervations at Philadelphia and Norriton on the 16th of February, the 12th of April, the 5th of May, and the 7th of June 1769, the difference of our meridians will be found from the mean of them to be 57 ſeconds of time. This is farther confirmed by the obſervations we have made on the tranſit of Mercury over the Sun, on the 9th of November, 1769, which being compleated before theſe ſheets were printed off, we have judged proper to inſert.

Apparent Time.	h. m. ſec.	
The external contact was at	2. 36. 9	by the mean of 4 obſervations at Philadelphia,
And at	2. 35. 17	by the mean of 3 obſervations at Norriton.
The difference is	52	
The internal contact was at	2. 37. 34	by the mean of 4 obſervations at Philadelphia,
And at - - -	2. 36. 34	by the mean of 3 obſervations at Norriton.
The difference is	1. 0	

Therefore the mean of both theſe makes the difference of our meridians 56 ſeconds of time, which muſt certainly be more accurate than what is deduced from a few correſponding obſervations of the eclipſes of Jupiter's ſatellites; both becauſe they afford 24 compariſons, all nearly agreeing among themſelves, and becauſe theſe tranſits, in the judgment of moſt aſtronomers, afford the beſt opportunities of ſettling the longitude of places. Hence if we add 56 ſeconds to the time of the Norriton obſervations of the eclipſes of Jupiter's ſatellites, they will be reduced to the meridian of our obſervatory in Philadelphia, and may be uſed in fixing our longitude from Greenwich, in the following manner.

The

The calculated time per Nautical Almanac.	The observed Time at Philadelphia.	The Norriton obs. red. to the merid. of Phil.	The difference of merid. of Gr. and Philadel.
D. h. m. sec.	D. h. m. sec.	D. h. m. sec.	D. h. sec.
1767. *May* 30, 15. 16. 10 Em. *1st.*	30, 10. 15. 32	- - - - -	5, 0. 38
June 13, 14. 17. 37 Em. *2d.*	13, 9. 18. 6	- - - - -	4, 59. 31
1768. *Mar.* 1, 14. 48. 24 Im. *1st.*	1, 9. 46. 49	- - - . -	5, 1. 35
April 9, 15. 36. 34 Em. *1st.*	9, 10. 37. 2	- - - - -	4, 59. 32
25, 13. 57. 46 Em. *1st.*	25, 8. 56. 50	- - - - -	5, 0. 56
May 12. 15. 34. 11 Em. *2d.*	12, 10. 33 9	- - - - -	5, 1, .2
1769. *Feb.* 16. 19. 22. 29 Im. *1st.*	16, 14. 21. 51	- - - - -	5, 0, 38
16, 19. 22. 29 Im. *1st*	- - - -	16, 14. 22. 6	5, 0. 23
20, 20. 42. 55 Im. *2d.*	20, 15. 42. 1	- - - - -	5, 0. 54
23, 21. 16. 35 Im. *1st.*	23, 16. 16. 21	- - - - -	5, 0. 14
23, 21. 16. 35 Im. *1st.*	- - - -	23, 16. 15. 57	5. 0. 38
Mar. 17. 17. 46. 4 Im. *2d.*	17, 12. 45. 21	- - - - -	5. 0. 43
April 3, 19. 51. 24 Im. *1st.*	3, 14. 50. 48	- - - - -	5. 0. 36
3, 19. 51. 24 Im. *1st.*	- - - -	3, 14, 50. 21	5. 1. 3
10, 21, 47. 14 Im. *1st.*	- - - -	10, 16. 46. 56	5. 0. 18
11, 14. 50. 4 Im. *2d.*	11, 9, 49. 14	- - - - -	5, 0. 50
12, 16. 16. 13 Im. *1st.*	12, 11. 15. 49	- - - - -	5. 0. 24
12, 16. 16. 13 Im. *1st.*	- - - -	12. 11. 15. 33	5, 0 40
May 5, 16. 31. 20 Im. *1st.*	5, 11, 30. 28	- - - - -	5, 0. 52
5, 16. 31. 20 Im. *1st.*	- - - -	5, 11. 30. 23	5, 0. 57
21, 16. 56. 49 Em. *1st.*	- - - -	21, 11. 56. 9	5, 0. 40
June 6, 15. 12. 59 Em. *1st.*	- - - -	6, 10. 12. 28	5. 0. 31
7, 13. 45. 13 Em. *2d.*	7, 8. 44. 37	- - - - -	5, 0. 36
7, 13. 45. 13 Em. *2d.*	- - - -	7, 8. 44. 39	5. 0. 34
13, 17. 6. 31 Em. *1st.*	- - - -	13. 12. 5. 57	5. 0. 34
22, 13. 28. 30 Em. *1st.*	22, 8. 27. 35	- - - - -	5, 0. 55
29, 15. 22. 11 Em. *1st.*	29, 10, 21. 55	- - - - -	5. 0. 16
Aug. 23, 12. 15. 49 Em. *1st.*	23, 7. 15. 48	- - - - -	5. 0. 1
Sept. 11, 12. 45. 10 Em. *2d.*	11, 7. 44. 41	- - - - -	5, 0. 29

Now if we take the mean of all the 21 foregoing determinations of our longitude from Greenwich, by the eclipses of the first satellite, rejecting only those of March 1st, and April 9th, 1768, which differ most from the others, the result will be $5^h. 0'. 35''$ for the difference of our meridians. These ought evidently to be rejected, as they differ near twice as much, from the mean of the rest, as any other of the determinations do, yet the retaining of them will make no difference in the result. If the mean determination of the longitude be taken from the immersions alone, rejecting that of the 1st of March, 1768, it will be $5^h. 0'. 36''$, and if from the emersions alone, it will be $5^h. 0'. 34''$, when the observation of the 9th of April, 1768, is excluded. Therefore the mean of both, (which should always be preferred,) is $5^h. 0'. 35''$.

As a farther confirmation of this conclusion; if this difference of meridians be applied to the Greenwich obser-

vations

vations, of the firft fatellite, rejecting that of the 16th of May, to reduce them to the meridian of Philadelphia, and if they are then compared with the calculations in the nautical almanac; we fhall have the fame refult from them alfo.

The calculated time per Nautical Almanac.				Greenwich obfervations reduced to the meridian of Philadelphia.		Difference of meridian of Greenwich and Philadelphia.
1769.	D.	h. m. fec.		D.	h. m. fec.	h. m. fec.
Mar.	29,	12. 24. 26	Im. 1ft.	29,	7. 24. 32	4. 59. 54
April	12,	16. 16. 13	Im. 1ft.	12,	11. 15. 38	5. 0. 35
	28,	14. 36. 14	Im. 1ft.	28,	9. 34. 42	5. 1. 32
June	8,	9. 41. 26	Em. 1ft.	8,	4. 40. 41	5. 0. 45
	15,	11. 34. 55	Em. 1ft.	15,	6, 34. 58	4. 59. 57
July	1,	9. 50. 37	Em. 1ft.	1,	4. 49. 49	5. 0. 48
April	11,	14. 50. 4	Im. 2d.	11,	9. 49. 48	5. 0. 16
May	6,	11. 51. 45	Im. 2d.	6,	6. 50. 27	5. 1. 18

The mean of thefe determinations of the longitude, from the Greenwich obfervations of the firft fatellite, is $5^h. 0'. 35''$. But farther if we take the mean of all the determinations, derived from the eclipfes of the fecond fatellite, it will be found to be $5^h. 0'. 37''$. And laftly, if the mean of all the determinations from the eclipfes of both firft and fecond fatellite be chofen, the deduced longitude will be $5^h. 0'. 35''$. So that we may fafely conclude, that the difference of meridians between Philadelphia and Greenwich, is $5^h. 0'. 35''$; and that Norriton is $56''$ of time weft of Philadelphia, and its longitude is $5^h. 1'. 31''$. weft. With this determination we muft be contented until farther obfervations are made, by which it may be confirmed, or rendered liable to exception.

Thefe obfervations are fufficient to determine every thing relative to the theory of Venus, and the parallaxes of the Sun and planets, as may be feen by the annexed projection of the tranfit, and the following calculations. Although the parallax of the Sun may be obtained from the obferved neareft diftance of the centers of the Sun and Venus, yet this method cannot be fo much depended on, as the comparifon of the contacts of the limbs obferved in proper places, where the abfolute difference of time is confiderable. Neverthelefs, as the public feem very impatient

tient to know the reſult of what was done in this place, I have endeavoured to deduce it from our obſervations alone; and flatter myſelf, that in the concluſion it will be found pretty accurate; as it is nearly the ſame with what I had before found it to be, by an hundred and forty determinations of it, from the obſervations of aſtronomers on the tranſit of 1761; and alſo from another method, the invention of the celebrated Mr. Stuart, of Edinburgh; both which I have now annexed to the following calculations.

Having thus collected together all the elements neceſſary for the enſuing calculation, before I proceed to it, I muſt in juſtice to Dr. Williamſon and Mr. Prior, obſerve, that of the micrometer meaſures, the 2d, 3d, 19th, 20th, 21ſt, 22d, 23d, 24th, and 25th were made by Mr. Prior, and the 35th, 43d, 44th, and 54th by Dr. Williamſon, with the ſame adjuſtment of the focus, that I uſed in the others.

I have taken the trouble of making above fifty determinations of the middle of the tranſit, and find from a mean of them, that the neareſt approach of their centers was at $5^h.\ 21'.\ 27''$ mean time, or $5^h.\ 23'.\ 41'',7$ apparent time, which was haſtened by parallax $4'.\ 48''$ at Philadelphia; and therefore, that the central apparent time of the middle of the tranſit was $5^h.\ 28'.\ 29'',7$, according to our meridian.

By comparing together eighteen determinations of the neareſt diſtance of the center of the Sun and Venus, I find the mean of them to be $10'.\ 3'',58$, as ſeen in Philadelphia. But ſhe was then depreſſed $6'',91$ by parallax; and therefore, the geocent. neareſt diſtance of the centers was $10'.\ 10'',49 = 610'',49$. Therefore ſay,

As 72626 45 the diſtance of ♀ from the ☉ : 28879,55 her diſtance from ⊖ : : 610′,49 : heliocentric diſtance of their centers.

4. 861,0949
4. 460,5904
2. 785,6785

7. 246,2689
2. 385,1740=242″,7583=4′. 2″,7583 the heliocentric diſtance of their centers.

As S, 3°. 23.′ 20″ the incl. of ♀ orbit to the eclip. : R : : S, 4′. 2″,758 : Sine of ☉'s diſt. from the node of ♀.

8. 771,6803
10. - - -

7. 070,2506
8. 291.5703=1°. 8′. 20′,23 ☉ diſt. from the node of ♀.

 Now

Now ſuch is the peculiarity of the orbit of Venus and her horary motion at that time, that we may indifferently ſay,

As S, 1°. 8'. 20".23 : Rad : : S, 10'. 10",49 : S, of the angle of her viſible path with the ecliptic 8°. 33' 11",5.

Or as T, 4'. 2".7583 : T, 10'. 10",49 : : S, 3°. 23'. 20" : S, of the angle of her viſible path= 8°. 33'. 12",3.

Or laſtly, if it ſhould be deemed more eligible to deduce her horary motion from the foregoing meaſures, and from a compariſon of it with the horary motion of the Sun, to deduce the angle of her viſible path, it may be done in the following manner, and will be found to be nearly the ſame.

For let A B repreſent the horary motion of ☉=2'.392375 (ſee fig. 2. pl. 4.)

B A C=the inclination of the orbit of ♀ with the ecliptic=3°. 23'. 20".

A C=the horary motion of ♀=3'.952942, as it may be deduced from the ſaid meaſures.

Then the angle DBC will repreſent the viſible path of ♀ with the ecliptic, and may be found as follows:

Let 2'.392375=horary motion ☉
3.922942=horary motion ♀=237". 17652 whoſe Log. is 2. 375. 0716

As 6.345317=ſum of their horary motions - - - - - 0.802,4534
Is to 1.560567=difference of their horary motions - - - 0.193,2825
So is cot. of half of 3°. 23'. 20", or cot. 1°. 41'. 40" - - - 11.528,9451

To T, of half the diff. of the angles at B & C=83°. 8'. 27".2=10.919,7742
To which add half the ſum of do. - - 88. 18. 20

171. 26 47,2 and the ſupl: of this is 8° 33'. 12".8 =the angle of the viſible path of ♀

916,65=the difference of the ſemidiameters of ☉ and ♀
610,49=the geo. neareſt diſtance of their centers.

Sum, 1527,14=3. 183,8789
Diff. 306,16=2. 485,9484

2)5. 669,8273 the log. of the ſquare of half the tranſit line between the internal contacts.
2. 834,9136=the log. of half the tranſit line between int. cont.=683",776
237" 17652=2. 375,0716=the log. of ♀ hor. mot.

0. 459,8420=2h. 882982=2h. 52'. 58",7=the ſemidu. between the in. cont.

974,65=the ſum of the ſemidiameters of ☉ and ♀
610,49=the geo. neareſt diſtance of their centers.

Sum, 1585,14 3. 200,0677
Diff. 364,16 2. 561,2922

2)5. 761,3599
2. 880,6799=the log. of half the tran. line between the ext. co.=759",766
2. 375,0716=the log. of ♀ hor. mot.

0. 505,6083=3h. 20338=3h. 12'. 12",168=the ſemiduration between the external contacts.

As R : Sec. 8°. 33'. 11",5 :: 610",49 : geo. latitude of ♀
10. - - -
10. 004,8572
2. 785,6785

2. 790,5357=617",356=10'. 17",336=the geo. lat. of ♀

As 72626,45 : 28879,55 :: geocentric latitude : heliocentric latitude of ♀
4. 861,0949
4. 460,5904
2. 790,5357

7. 251,1261

2. 390,0312=245",4885=4'. 3",4885=the heliocentric latitude of ♀

610,49

610,49	
617,356	
1227,846	3. 089,1440
96,866	0. 836,7038
	3. 925,8478
	1. 962,9239
	2. 375,0716=the log. of hor. mot. of ♀

9. 587,8523=0h. 387126=23′. 13″,6536=the time between the middle and eclip. conjunction.

From the apparent time of the middle of the transit, viz. 5ʰ. 28′. 29″,7 deduct 23′. 13″,65 and the apparent time of the ecliptical conjunction will be 5ʰ. 5′. 16″,05, when the Sun's place given in the nautical almanac was 2ˢ. 13°. 27′.18″,7, making the difference of our meridian from Greenwich 5ʰ. 0′ 35″, as found above. To his place in the ecliptic add his distance from the node of Venus, found above, viz. 1°. 8′. 20″,23, and the sum gives the place of her ascending node, 2ˢ. 14°. 35′. 38″,9.

From the middle of the transit, as seen at the center of the earth, viz. 5ʰ. 28′. 29″,7, apparent time, deduct the semi-duration between the internal contacts, viz. 2ʰ. 52′. 58″,7 and there remains 2ʰ. 35′. 31″, the apparent time of the first internal contact, without parallax. This I observed at 2ʰ. 31′ 26″ apparent time; the difference between these is the total effect of parallax in longitude and latitude, which is 4′. 5″. But upon the supposition that the Sun's horizontal parallax, on the day of the transit, was 8″,5204, the total effect of parallax should have been 4′. 4″. Therefore say,

As 4′. 4″.=244″ : 4″. 5″=245″ : : 8″,5204 : 8″,555= the hor. par. of the Sun on June 3d, 1769. Then

As 100000=his mean dist. from the earth : 101506= his dist. on the day of the Transit, : : 8″,555 : 8″,6838 his horizontal parallax at his mean distance from the earth.

This is nearly the same, with what is deduced from the best of the observations made on the transit of 1761: And according to this parallax of the Sun, the mean distances of the planets from the Sun will be, as they are exhibited in in the following table, taking a mean ſemidiameter of the earth 3985 Engliſh miles.

36693417	Mercury's	Mean diſtance from the Sun, in Engliſh miles.
68564850	Venus's	
94790550	the Earth's	
144431400	Mars's	
493005300	Jupiter's	
904307200	Saturn's	

On account of the difficulty of aſcertaining the preciſe moment of the middle of the tranſit, from the menſurations of the neareſt diſtances of the limbs of the Sun and Venus, and the ſmall difference of time between the contacts happening, at the center of the earth, and at any particular place on its ſurface; aſtronomers have generally preferred the compariſon of two obſervations at proper places, where the effects of parallax will be contrary to each other, retarding the contacts at one place and accelerating them at the other, for the purpoſe of deducing the parallax and diſtance of the Sun from them. We have an opportunity of confirming the former concluſions, by comparing our obſervations with thoſe that have been made at the royal obſervatory at Greenwich, as they have lately come to hand. They differ indeed conſiderably among themſelves, probably owing to the various methods, which the obſervers took to judge of the contacts, the account of which is not yet arrived here; yet they give a mean parallax of the Sun nearly the ſame that we have deduced from our own obſervations at Philadelphia. I have therefore inſerted them in this account of the tranſit, as they ſerve to ſhew that we have not loſt our labour and expence on this occaſion. The method I have uſed is firſt to reduce the Greenwich obſervations of the contacts to the meridian of our obſervatory in Philadelphia, by deducting from them the difference of longitude converted into time; and then to calculate the effect of parallax for both places at the apparent times of the contacts, upon the ſuppoſition of the Sun's horizontal parallax

parallax being 8″,5204 on the day of the tranfit. From this, the Sun's horizontal parallax is found either greater or lefs, as the calculated effect of parallax is greater or lefs, than what is obferved.

The parallax of Venus in longitude at Greenwich, at the time of the firft external contact was 16″,9, which haftened the contact there 4′. 16″,5, and her parallax in latitude at the fame time was 12″,97, which depreffed her on the difk of the Sun, lengthened her vifible path, and accelerated the contact 2′. 34″,5, fo that the total effect of her parallax was to haften the contact 6′. 51″ of time. In like manner her parallax in longitude at the internal contact was 16″,6, which haftened it 4′. 12″ of time; and her parallax in latitude being 13″,42 at that time, for the fame reafon haftened the faid contact 2′. 40″; and therefore the total effect of parallax to accelerate the internal contact at Greenwich is 6′. 52″.

At Philadelphia her parallax in longitude being 10″,74 at the external contact, haftened it 2′. 43″; and her parallax in latitude being 4″,43, lengthened her vifible path on the Sun and haftened the contact 53″ of time; whence its total effect was 3′. 36″ of time. In like manner her parallax in longitude at the internal contact being 11″,95 haftened it 3′. 1″ of time, and her parallax in latitude being 4″,49 lengthened the tranfit line, and haftened the contact 1′. 3″; and therefore the total effect of her parallax at that time to haften the internal contact was 4′. 4″.

Now as the total effect of parallax both at Greenwich and at Philadelphia confpired to haften the contacts at both thefe places, with refpect to the center of the earth, their difference is the whole effect they have on abfolute time, viz. 3′. 15″ at the external contact, and 2′. 48″ at the internal contact.

The contacts were obferved at Greenwich at the apparent times mentioned in the following table, according to their meridian.

External

External Contact.			Internal Contact.			
h.	m.	sec.	h.	m.	sec.	
7.	10.	54	7.	28.	47	by Hitchins.
7.	11.	11	-	-	-	Hirst.
7.	10.	37	7.	29.	28	Dun.
7.	11.	19	7.	29.	20	Dollond.
7.	11.	30	7.	29.	20	Nairne.
7.	10.	58	7.	29.	23	Maskelyne.

These times are reduced to the meridian of Philadelphia, by substracting $5^h.0'.35''$ from them in the following manner.

	External Contact.			Internal Contact.			
	h.	m.	sec.	h.	m.	sec.	
	2.	10.	19	2.	28.	12	by Hitchins.
	2.	10.	36	-	-	-	Hirst.
	2.	10.	2	2.	28.	53	Dun.
	2.	10.	44	2.	28.	45	Dollond.
	2.	10.	55	2.	28.	45	Nairne.
	2.	10.	23	2.	28.	48	Maskelyne.
M. of all is,	2.	10.	30	2.	28.	40,6	

The mean of all the times of the external contacts at Philadelphia is $2^h. 13'. 46'',6$, and of the internal contacts 2h. $31'. 28''$, as appears by page 49, and the difference between these means is the observed effect of parallax.

h.	m.	sec.	h.	m.	sec.	
2.	13.	46,6	2.	31.	28	at Philadelphia.
2.	10.	30	2.	28.	40,6	at Greenwich.
	3.	16,6		2.	47,4	the observed effects of

parallax, at the external and internal contacts. Therefore say,

As $3'. 15''=195''$ the calculated effect of parallax at the external contact is to $3'. 16'',6=196'',6$: : So is the assumed horizontal parallax of the Sun on the day of the transit $8'',5204$: to his true parallax on that day. And in like manner, as $2'. 48''=168''$: $2'. 47'',4=167'',4$: : $8'',5204$: the Sun's parallax on that day.

2. 290,0346	2. 225,3093
2. 293,5835	2. 223,7555
0. 930,4600	0. 930,4600
3. 224,0435	3. 154,2155
0. 934,0089=8″,59031 ☉ hor. par.	0. 928,9062=8″,48997 ☉ hor. par.

8″,48997

2) 17″,08028

8″,54014 the mean hor. par. of ☉ on the day of the transit.

As 100000 : 101506 : : $8'',54014$: the Sun's horizontal parallax at his mean distance from the earth.

5. 000,0000
5. 006,4917
0. 931,4650

0. 937,9567=8″,66875 the Sun's hor. par. at his mean distance from the earth.

The

The parallax of the Sun being fixed by the mean of ſuch compariſons as theſe, it is an eaſy matter to aſcertain not only the diſtances of the bodies, which compoſe the ſolar ſyſtem, but alſo their real diameters; that of the earth being previouſly known from the actual menſuration of ſome degrees on it's ſurface. For

As the rectangle of the parallax of the Sun, and his diſtance from the earth, is to the real diameter of the earth; ſo is the rectangle of the parallax and diſtance of any other planet from the Sun, to its real diameter.

As to my delineation of the tranſit, I have taken the elements of the projection from our own obſervations on the 3d of June, 1769. Plate 4, fig. 2.

THE neareſt approach of the centers having been determined, from the mean of a great number of computations, and found to agree very nearly with the meaſures that were actually made at the middle of the tranſit, it was accordingly ſet off on the diameter of the Sun, and through this point a chord was drawn at right angles to the ſaid diameter for the central tranſit line. This was then divided carefully into hours and minutes, according to the horary motion of Venus, determined by the preceding calculation, in ſuch a manner, as that the exact moment of the middle of the tranſit, at the earth's center, ſhould fall on the point of interſection between the ſaid diameter of the Sun and tranſit line; this moment of time having been previouſly determined, by the mean of a ſufficient number of computations.

The parallaxes of Venus, in longitude and latitude, as ſeen from Philadelphia, having been alſo adapted to the apparent times of the micrometer meaſures, on the ſuppoſition of the Sun's horizontal parallax being 8″,5204 on the day of the tranſit, they were accordingly applied to the projection, by which the places of her center were determined for the ſaid times. Round theſe, ſmall circles were drawn, with the radius of 29 ſeconds, to repreſent the diſk of Venus

Venus on the face of the Sun; andlines were drawn between the limbs, in the direction of their centers, of ſuch a determined length, as the micrometer has given them. Many of the meaſures were taken from the fartheſt limb of the Sun, as well as from the neareſt, to both limbs of Venus, and theſe meaſures were afterwards reduced to the neareſt diſtance of the neareſt limbs, as they are exhibited in the preceding table, uſing the diameters of the Sun and Venus, as they are ſtated above.

As a confirmation of the foregoing concluſions, I have ſubjoined the obſervations of aſtronomers, in different places, of the contacts and durations of the tranſit of 1761, as they have ſent them to the Royal Society, together with the longitudes and latitudes of the places of obſervation, on which the following calculations depend.

OBSERVATIONS on the TRANSIT of VENUS over the SUN, June 6th, 1761, N. S. Apparent Time.

Nam. of places.	1ſt Ex. Con.	1ſt In. Cont.	2d In. Con.	2d Ex. Cont.	Duration.
	h. m. ſec.	h. m. ſec.	h. m. ſec.	h. m. ſec.	h. m. ſec.
Greenwich,	- -	- -	8. 19. 0	8. 37. 9	- -
Shirburn Caſtle,	- -	- -	8. 15. 12	8. 33. 17	- -
Saville Houſe,	- -	- -	8. 18. 22	- - - -	- -
Spittal Square,	- -	- -	8. 18. 41	- - - -	- -
Chelſea,	- -	- -	8. 18. 4	- - - -	- -
Leſkard,	- -	- -	8. 0. 21	- - - -	- -
Paris,	- -	- -	8. 28. 27	8. 46. 44	- -
Bolongna,	- -	- -	9. 4. 57	9. 23. 0 to 7	- -
Rome,	- -	- -	9. 9. 36	- - - -	- -
Drontheim,	- -	- -	9. 1. 49	- - - -	- -
Upſal,	3. 20. 45	3. 37. 43 to 56 3. 38. 5	9. 28. 6	9. 46. 13 to 30	5. 50 5 to 26
Stockholm,	3. 21. 37	3. 39. 23 to 29	9. 30. 10	- - - -	5. 50. 41 to 47
Hernoſand,	3. 20. 40	3. 38. 26 to 35	9. 28. 52	9. 46. 43	5. 50. 17 to 26
Calmar,	- -	3. 23. 1	9. 23. 40	- - - -	5. 50. 39
Abo,	- -	3. 35. 50	9. 45. 59	10. 4. 42	5. 50, 9
Tornea,	3. 45. 44 to 51	4. 4. 0	9. 54. 8 to 22	10. 12. 18 to 22	5. 50. 9 to 21
Cajaneburg,	- -	4. 19. 5	10. 8. 59	- - - -	5. 49 54
Tobolſki,	- -	7. 0. 21	12. 49. 20½	13. 7. 39½	5. 48. 50
Cape G. Hope,	- -	- -	9. 39. 50	- - - -	- -
Rodrigues,	- -	- -	12. 35. 47	12. 53. 18	- -
Calcutta,	- -	8. 20. 58	14. 11. 34	14. 37. 38	5. 50. 36
Madraſs,	7. 31. 10	7. 47. 55	13. 39. 38	13. 55. 44	5. 51. 43
Tranquebar,	- -	- -	- -	- - - -	5. 51. 33
Great Mount.	- -	- -	- -	- - - -	5. 51. 20

N. of

N. of Places	Latitude.	Longitude fr. Greenwich	N. of Places.	Latitude.	Longitude fr. Greenwich.
	° ′ ″	h. m. sec.		° ′ ″	h. m. sec.
Greenwich,	51. 28. 37 N.	0. 0, 0	Hernosand,	60. 38. 0 N	1. 11. 28 E.
Shirb. Castle,	51. 39. 22 N	0. 4. 1 W.	Calmar,	56. 40. 30 N.	1. 5. 39 E
Sav. House,	- -	0. 0. 31 W.	Abo,	60. 27. 0 N.	1. 28. 33 E
Spit. Square,	- -	0. 0. 16½ W.	Tornea,	65. 50, 50 N.	1. 36. 48 E.
Chelsea,	- -	0. 0. 40 W.	Cajaneburg,	64. 13. 30 N	1. 51. 50 E.
Leskard,	50. 26. 55 N	0. 18. 32 W.	Tobolski,	58. 12. 22 N.	4. 32. 52 E.
Paris,	48. 50. 14 N	0. 9. 16 E.	Cape G. Hope,	33. 55. 42 S.	1. 13. 35 E.
Bologna,	44. 29. 36 N	0. 45. 21. E.	Rodrigues,	19. 40. 40 S.	4. 12. 34 E.
Rome,	41. 53. 54 N	0. 49. 53 E.	Calcutta,	22. 30. 0 N.	5. 53. 44 E.
Drontheim,	63. 26. 10 N	0. 44. 3 E.	Madras,	13. 8. 0 N.	5. 20. 10 E.
Upsal,	59. 51. 50 N	1. 10. 26. E.	Tranquebar,	10. 56. 0 N.	5. 18. 8 E.
Stockholm,	59. 20. 30 N	1. 12. 26 E.	Great Mount,	- -	- -

The Parallax of the SUN, deduced from the 2d Internal Contact of the Limbs of the SUN and VENUS, in the Transit of 1761.

Cape of Good Hope & Leskard.

h. m. sec.		Parall. ′ ″
9. 39. 50	*Cape,*	6 8
1. 32. 7	Diff. Longitude.	
8. 7. 43		
8. 0. 21	*Leskard,*	1 4
7. 22		7 12

As 7.12 : 7.22 : : 8″,5
☉'s Par. 8″,69

Cape & Sherburne Castle.

h. m. sec.		Parall. ′ ″
9. 39. 50		6. 8
1. 17. 36	diff. longitude.	
8. 22. 14		
8. 15. 12	*Sherborne*	1. 12
7. 2		7. 20

Sun's Par. 8″,15

Cape & Chelsea.

h. m. sec.		Parall. ′ ″
9. 39. 50		6. 8
1. 14. 15		
8. 25. 34		
8. 18. 4	*Chelsea,*	1. 11
7. 30		7. 19

Sun's Par. 8″,73

Cape & Saville House.

9. 39. 50		6 8
1. 14. 5		
8. 25. 45		
8. 18. 22	*Saville,*	1. 11
7. 23		7. 19

Sun's Par. 8,57

Cape & Spittal Square.

9. 39. 50		6. 8
1. 13. 51		
8. 25. 59		
8. 18. 41	*Spit. Sq.*	1. 11
7. 18		7. 19

Sun's Par. 8,47

Cape & Greenwich.

9. 39. 50		6. 8
1. 13. 35		
8. 26. 15		
8. 19. 0	*Greenw.*	1. 11
7. 15		7. 19

Sun's Par. 8,42

Cape & Paris.

9. 39. 50	6 8
1. 4. 19	
8. 35. 31	
8. 28. 27	0 54
7. 4	7 2

Sun's Par. 8,54

Cape & Drontheim.

9. 39. 50	6. 8
0. 29. 32	
9. 10. 18	
9. 1. 49	2. 38
8. 29	8. 46

Sun's Par. 8,23

Cape & Bologna.

8. 39. 50	6 8
0. 28. 14	
9. 11. 36	
9. 4. 57	0. 29
6. 39	6. 37

Sun's Par. 8,54

Cape & Rome.

9. 39. 50	6. 8
0. 23. 42	
9. 16. 8	
9. 9. 36	0. 13
6. 32	6 21

Sun's Par. 8,74

Cape & Calmar.

9. 39. 50	6. 8
0. 7. 56	
9. 31. 54	
9. 23. 40	1. 59
8. 14	8. 7

Sun's Par. 8,62

Cape & Upsal.

9. 39. 50	6 8
0. 3. 9	
9. 36. 41	
9. 28. 6	2. 21
8. 35	8. 29

Sun's Par. 8,60

Cape & Hernosand.

9. 39. 50	6. 8
0. 2. 7	
9. 37. 43	
9. 28. 52	2. 26
8. 51	8. 34

Sun's Par. 8,78

Cape & Stockholm.

9. 39. 50	6. 8
0. 1. 9	
9 38. 41	
9. 30. 10	2. 18
8. 31	8. 26

Sun's Par. 8,58

Cape & Abo.

9. 39. 50	6 8
+0. 14. 58	
9. 54. 48	
9. 45. 59	2. 38
8. 49	8. 38

Sun's Par. 8,68

Cape & Tornea.

9. 39. 50	6. 8
+0. 3. 13	
0. 3. 3	
9. 54. 8	3. 5
8. 55	9. 13

Sun's Par. 8,22

Cape & Cajaneburg.

9. 39. 50	6. 8
+0. 38. 15	
10. 1[illegible]. 5	
10. 8. 59	2 59
9. 6	9. 7

Sun's Par. 8,49

Cape & Tobolski.

9. 39. 50	6 8
3. 19. 17	
12. 59. 07	
12. 49. 20	3. 35
9. 47	9. 43

Sun's Par 8,64

Cape & Madrass.

h. m. sec.	Parall. ′ ″
9. 39. 50	6. 8
4. 6. 35	
13. 46. 25	
13. 39. 38	0. 36
6. 47	6. 44

Sun's Par 8″,74

Rodrigues & Leskard.

12. 35. 47	3. 7
4. 31. 6	
8. 4. 41	
8. 0. 21	1. 4
4. 20	4. 11

Sun's Par. 8,80

Rodrigues & Saville house.

12. 35. 47	3. 7
4. 13. 4	
8. 22. 43	
8. 18. 22	1. 11
4. 21	4. 18

Sun's Par. 8,60

Rodrigues & Paris.

12. 35. 47	3. 7
4. 3. 18	
8. 32. 29	
8. 28. 27	0. 54
4. 2	4. 1

Sun's Par. 8,53

Rodrigues & Rome.

12. 35. 47	3. 7
3. 22. 41	
9. 13. 6	
9. 9. 36	0. 13
3. 30	3. 20

Sun's Par. 8,92

Rodrigues & Hernosand.

12. 35. 47	3. 7
3. 1. 6	
9. 34. 41	
9. 28. 52	2. 26
5. 49	5. 33

Sun's Par. 8,90

Rodrigues & Tornea.

12. 35. 47	3. 7
2. 35. 46	
10. 0. 1	
9. 54. 8	3. 5
5. 53	6. 12

Sun's Par. 8,07

Rodrigues & Calcutta.

12. 35. 47	3. 7
1. 41. 10	
14. 16. 57	
14. 11. 34	2. 14
5. 23	5. 21

Sun's Par. 8,55

Cape & Calcutta.

h. m. sec.	Parall. ′ ″
9. 39. 50	6. 8
4. 40. 9	
14. 19. 59	
14. 11. 34	2. 14
8. 25	8. 22

Sun's Par. 8″,55

Rodrigues & Sherburn castle.

12. 35. 47	3. 7
4. 16. 35	
8. 19. 12	
8. 15. 12	1. 12
4. 0	4. 19

Sun's Par. 8,00

Rodrigues & Spittal square.

12. 35. 47	3. 7
4. 12. 50	
8. 22. 57	
8. 18. 41	1. 11
4. 16	4. 18

Sun's Par. 8,44

Rodrigues & Drontheim.

12. 35. 47	3. 7
3. 28. 31	
9. 7. 16	
9. 1. 45	2. 38
5. 27	5. 45

Sun's Par. 8,05

Rodrigues & Calmar.

12. 35. 47	3. 7
3. 6. 55	
9. 28. 52	
9. 23. 40	1. 59
5. 12	5. 6

Sun's Par. 8,67

Rodrigues & Stockholm.

12. 35. 47	3. 7
3. 0. 8	
9. 35. 39	
9. 30. 10	2. 18
5. 29	5. 25

Sun's Par. 8,51

Rodrigues & Cajaneburg.

12. 35. 47	3. 7
2. 20. 44	
10. 15. 3	
10. 8. 59	2. 59
6. 4	6. 6

Sun's Par. 8,45

Rodrigues & Madrass.

12. 35. 47	3. 7
1. 7. 36	
13. 43. 23	
13. 39. 38	0. 36
3. 45	3. 43

Sun's Par. 8,58

Cape & Rodrigues.

h. m. sec.	Parall. ′ ″
9. 39. 50	6. 8
2. 58. 59	
12. 38. 49	
12. 35. 47	3. 7
3. 2	3. 1

Sun's Par. 8″,54

Rodrigues & Chelsea.

12. 35. 47	3. 7
4. 13. 14	
8. 22. 33	
8. 18. 4	1. 11
4. 29	4. 18

Sun's Par. 8,86

Rodrigues & Greenwich.

12. 35. 47	3. 7
4. 12. 34	
8. 23. 13	
8. 19. 0	1. 11
4. 13	4. 18

Sun's Par. 8,33

Rodrigues & Bologna.

12. 35. 47	3. 7
3. 27. 13	
9. 8. 34	
9. 4. 57	0. 29
3. 37	3. 36

Sun's Par. 8,54

Rodrigues & Upsal.

12. 35. 47	3. 7
3. 2. 8	
9. 33. 39	
9. 28. 6	2. 21
5. 33	5. 28

Sun's Par. 8,62

Rodrigues & Abo.

12. 35. 47	3. 7
2. 44. 1	
9. 51. 46	
9. 45. 59	2. 30
5. 47	5. 37

Sun's Par. 8,75

Rodrigues & Tobolski.

12. 35. 47	3. 7
+0. 20. 18	
12. 56. 5	
12. 49. 20	3. 35
6. 45	6. 42

Sun's Par. 8,56

Tobolski & Leskard.

12. 49. 20	3. 35
4. 51. 24	
7. 57. 56	
8. 0. 21	1. 4
2. 25	2. 31

Sun's Par. 8,16

Tobolski

Tobolſki & Chelſea.

h. m. ſec.	Parall. ′ ″
12. 49. 20	3. 35
4. 33. 32	
8. 15. 48	
8. 18. 4	1. 11
2. 16	2. 24

Sun's Par. 8″,02

Tobolſki & Saville houſe.

h. m. ſec.	Parall. ′ ″
12. 49. 20	3. 35
4. 33. 22	
8. 15. 58	
8. 18. 22	1. 12
2. 34	2. 24

Sun's Par. 8″,99

Tobolſki & Spittal Square.

h. m. ſec.	Parall. ′ ″
12. 49. 20	5. 35
4. 33. 9	
8. 16. 11	
8. 18. 41	1. 11
2. 30	2. 24

Sun's Par. 8″,85

Tobolſki & Greenwich.

12. 49. 20	3. 35
4. 32. 52	
8. 16. 28	
8. 19. 0	1. 11
2. 32	2. 24

Sun's Par. 8.97

Tobolſki & Paris.

12. 49. 20	3. 35
4. 23. 36	
8. 25. 44	
8. 28. 27	0. 54
2. 43	2. 41

Sun's Par. 8,60

Tobolſki & Bologna.

12. 49. 20	3. 35
3. 47. 31	
9. 1. 49	
9. 4. 57	0. 29
3. 8	3. 6

Sun's Par. 8,59

Tobolſki & Rome.

12. 49. 20	3 35
3. 42. 59	
9. 6. 21	
9. 9. 36	0 13
3. 15	3. 22

Sun's Par. 8,20

Tobolſki & Calmar.

12 49. 20	3. 35
3. 27. 13	
9. 22. 7	
9. 23. 40	1. 59
1. 33	1. 36

Sun's Par. 8,23

Tobolſki & Upſal.

12. 49. 20	3. 35
3. 22. 26	
9. 26. 54	
9. 28. 6	2. 21
1. 12	1. 14

Sun's Par. 8,27

Tobolſki & Stockholm.

12. 49. 20	3. 35
3. 20. 26	
9. 28. 54	
9. 30. 10	2. 18
1. 16	1. 17

Sun's Par. 8,39

Tobolſki & Calcutta.

12. 49. 20	3. 35
1. 20. 52	
14. 10. 12	
14. 11. 34	2. 14
1. 22	1. 21

Sun's Par. 8,61

Tobolſki & Madraſs.

12. 49. 20	3. 35
0. 47. 18	
13. 36. 38	
13. 39. 38	0. 36
3. 0	2. 59

Sun's Par. 8‘55

Cajaneburg & Saville houſe.

10. 8. 59	2. 59
1. 52. 20	
8. 16. 39	
8. 18. 22	1. 11
1. 43	1. 48

Sun's Par. 8″.11

Cajenburg & Spittal ſquare.

10. 8. 59	2. 59
1. 52. 7	
8. 16. 52	
8. 18. 41	1. 11
1. 49	1. 48

Sun's Par. 8,58

Cajaneburg & Greenwich.

10. 8. 59	2. 59
1. 51. 50	
8. 17. 9	
8. 19. 0	1. 11
1. 51	1. 48

Sun's Par. 8,74

Cajaneburg & Paris.

10. 8. 59	2. 59
1. 42. 34	
8. 26. 25	
8. 28. 27	0. 54
2. 2	2. 5

Sun's Par. 8,30

Cajaneburg & Rome.

10. 8. 59	2. 59
1. 2. 7	
9. 6. 52	
9. 9. 36	0. 13
2. 44	2. 46

Sun's Par. 8,33

Cajaneburg & Bologna.

10. 8. 59	2. 59
1. 6. 29	
9. 2. 30	
9. 4. 57	0. 29
2. 27	2. 30

Sun's Par. 8,22.

Cajaneburg & Madraſs.

10. 8. 59	2. 59
3. 28. 20	
13. 37. 19	
13. 39. 38	0. 36
2. 19	2. 23

Sun's Par. 8.27

Stockholm & Spittal ſquare.

9. 30. 10	2 18
1. 12. 43	
8. 17. 37	
1. 18. 41	1. 11
1. 4	1. 7

Sun's Par. 8,12

Stockholm & Greenwich.

9. 30. 10	2. 18
1. 12. 20	
8. 17. 50	
8. 19. 0	1 11
1. 10	1. 7

Sun's Par. 8,88

Stockholm & Paris.

9. 30. 10	2 18
1. 3. 10	
8. 27. 0	
8. 28. 27	0. 54
1. 27	1. 24

Sun's Par. 8,80

Stockholm & Bologna.

9. 30. 10	2. 18
0. 27. 5	
9. 3. 5	
9. 4. 57	0. 29
1. 52	1. 49

Sun's Par. 8.73

Stockholm & Rome.

9. 30. 10	2. 18
0. 22. 33	
9. 7. 37	
9. 9. 36	0. 13
1. 59	2. 5

Sun's Par. 8,09

Stockholm & Madras.

h. m. ſec.	Parall. ′ ″
9. 30. 10	2 18
4. 7. 44	
13. 37. 54	
13. 39. 38	0. 36
1. 44	1. 42
Sun's Par. 8″,67	

Upſal & Leſkard.

h. m. ſec.	Parall ′ ″
9. 28. 6	2. 21
1. 28. 58	
7. 59. 8	
8. 0. 21	1. 4
1. 13	1. 17
Sun's Par. 8″,06	

Upſal & Saville Houſe.

h. m. ſec.	Parall. ′ ″
9. 28. 6	2. 21
1. 10. 56	
8. 17. 10	
8. 18. 22	1. 11
1. 12	1. 10
Sun's Par. 8″,74	

Upſal & Paris.

9. 28. 6	2. 21
1. 1. 10	
8. 26. 56	
8. 28. 27	0. 54
1. 31	1. 27
Sun's Par. 8,89	

Upſal & Bologna.

9. 28 6	2. 21
0. 25. 5	
9. 3. 1	
9. 4. 57	0. 29
1. 56	1. 52
Sun's Par. 8,0	

Upſal & Rome.

9. 28. 6	2. 21
0. 20. 33	
9. 7. 33	
9. 9. 26	0. 13
2. 3	2. 8
Sun's Par. 8,17	

Upſal & Madras.

9. 28. 6	2. 21
4. 9. 44	
13. 37. 50	
13. 39. 38	0. 36
1. 48	1. 45
Sun's Par. 8,74.	

Calcutta and Saville Houſe.

14. 11. 34	2. 14
5. 54. 14	
8. 17. 20	
8. 18. 22	1. 11
1. 2	1. 3
Sun's Par. 8,37	

Calcutta & Paris.

14. 11. 34	2. 14
5. 44. 28	
8. 27. 6	
8. 28. 27	0. 54
1. 21	1. 20
Sun's Par. 8,61	

Calcutta & Bologna.

14. 11. 34	2. 14
5. 8. 23	
9. 3. 11	
9. 4. 57	0. 29
1. 46	1 45
Sun's Par. 8,58	

Calcutta & Madras.

14. 11. 34	2. 14
0. 33. 34	
13. 38. 0	
13. 39. 38	0. 36
1. 38	1. 38
Sun's Par. 8,50	

Abo & Leſkard.

9. 45. 59	2. 30
1. 47. 5	
7. 58. 54	
8. 0. 21	1. 4
1. 27	1. 26
Sun's Par. 8,60	

Abo & Rome.

9. 45. 59	2. 30
0. 38. 40	
9. 7. 19	
9. 9. 36	0. 13
2. 17	2. 17
Sun's Par. 8,50	

Hernoſand & Rome.

9. 28. 52	2. 26
0. 21. 35	
9. 7. 17	
9. 9. 36	0. 13
2. 19	2. 13
Sun's Par. 8,88.	

Calmar & Madras.

9. 23. 40	1. 59
4. 14. 31	
13. 38. 11	
13. 39. 38	0. 36
1. 27	1. 23
Sun's Par. 8,91	

Sherburne & Tornea.

8. 15. 12	1. 12
1. 40. 49	
9. 56. 1	
9. 54. 8	3. 5
1. 53	1 53
Sun's Par. 8,50	

Greenwich & Paris.

8. 19. 0	1. 11
0. 9. 16	
8. 28.16	
8. 28. 27	0. 54
17	17
Sun's Par. 8,50	

Greenwich & Leſkard.

8. 19. 0	1. 11
0. 18. 32	
8. 0. 28	
8. 0. 21	1. 4
7	7
Sun's Par. 8,50	

The parallax of the Sun may alſo be deduced from the total duration of the tranſit, as obſerved in different places, in the following manner.

Tranquebar & Calmar.

h. m. ſec.	Parall. ′ ″
5. 51. 33	6. 24
5. 50. 39	7. 21
54	57
Sun's Par. 8″,05	

Tranquebar & Upſal.

h. m. ſec.	Parrall. ′ ″
5. 51. 33	6. 24
5. 50. 26	7. 33
1. 7	1. 9
Sun's Par. 8″,25	

Tranquebar & Abo.

h. m. ſec.	Parall. ′ ″
5. 51. 33	6 24
5. 50. 9	7. 46
1. 24	1. 22
Sun's Par. 8″.71	

Tranquebar

Tranquebar & *Cajaneburg.*	Parall.	
h. m. ſec.	′	″
5. 51. 33	6.	24
5. 49. 54	8.	5
1. 39	1.	41
Sun's Par. 8″,33		

Tranquebar & *Toboljki.*	Parall.	
h. m. ſec.	′	″
5. 51. 33	6.	24
5. 48. 50	9.	3
2. 43	2.	39
Sun's Par. 8″,67		

Madras & *Stockholm.*	Parall.	
	′	″
5. 51. 43	6.	33
5. 50. 42	7.	34
1. 1	1.	1
Sun's Par. 8″,50		

Madras & *Tornea.*		
5. 51. 43	6.	33
5. 50. 9	8.	7
1. 34	1.	34
Sun's Par. 8,50		

Great Mount & *Abo.*		
5. 51. 20	6.	33
5. 50. 9	7.	46
1. 11	1.	13
Sun's Par. 8,26		

Great Mount & *Tobolſki.*		
5. 51. 20	6.	33
5. 48. 50	9.	3
2. 30	2.	30
Sun's Par. 8,50		

Cajaneburg & *Upſal.*		
5. 49. 54	8.	5
5. 50. 26	7.	33
32		32
Sun's Par. 8,50		

Cajaneburg & *Calmar.*		
5. 49. 54	8.	5
5. 50. 39	7.	21
9. 45		44
Sun's Par. 8,70		

Tobolſki & *Abo.*		
5. 48. 50	9.	3
5. 50. 9	7.	46
1. 19	1.	17
Sun's Par. 8,72		

The parallax of the Sun may alſo be determined, by comparing the times of the internal contacts, as obſerved in various places, with the time of their happening as obſerved at the center of the earth. For this purpoſe the following elements are uſed, as they were calculated by Mr. *Short*, from the meaſures made at the tranſit in 1761, viz. the diameter of the Sun 31′. 31″, the diameter of Venus 59″, her horary motion 3′, 59″,8, the angle of her path 8′. 30″.10, the neareſt diſtance of their centers 9′. 32″, and the difference of their horizontal parallaxes 21″,35. Hence the apparent time of the 1ſt and 2d internal contacts was 2^{h}. 22′. 3″, and 8^{h}. 20′. 4″, reckoned by the meridian of Greenwich, without parallax, and the central duration was 5^{h}. 58′. 1″.

Central Time & *Upſal.*	Parall.	
h. m. ſec.	′	″
2. 22. 3	0.	0
1. 10. 26		
3. 32. 29		
3. 37. 56	5.	12
5. 27		
Sun's Par. 8″,91		

Central Time & *Upſal.*	Parall.	
	′	″
2. 22. 3	0.	0
1. 10. 26		
3. 32. 29		
3. 37. 43	5.	12
5. 14		
Sun's Par. 8″,55		

Central Time & *[illegible]*	Parall.	
	′	″
2. 22. 3	0.	0
1. 11. 28		
3. 33. 31		
3. 38. 35	5.	10
5. 4		
Sun's Par. 8″,33		

Central Time & *Hernoſand.*		
2. 22. 3	0.	0
1. 11. 28		
3. 33. 31		
3. 38. 26	5.	10
4. 55		
Sun's Par. 8,09		

Central time & *Cajaneburg.*		
2. 22. 3	0.	0.
1. 51. 50		
4. 13. 53		
4. 19. 5	5.	6
5. 12		
Sun's Par. 8,66		

Central Time & *Stockholm.*		
2. 22. 3	0.	0
1. 12. 26		
3. 34. 29		
3. 39. 29	5.	16
5. 0		
Sun's Par. 8,07		

Central Time & *Abo.*	Parall. ′ ″
2. 22. 3	0. 0
1. 28. 33	
3. 50. 36	
3. 55. 50	5. 16
5. 14	
Sun's Par. 8,44	

Central Time & *Tornea.*	Parall. ′ ″
2. 22. 3	0. 0
1. 36. 48	
3. 58. 51	
4. 4. 0	5. 2
5. 9	
Sun's Par. 8,69	

Central Time & *Calmar.*	Parall. ′ ″
2. 22. 3	0. 0
1. 5. 39	
3. 28. 42	
3. 33. 5	5. 22
5. 23	
Sun's Par. 8,52	

Central Time & *Tobolski.*	Parall.
2. 22. 3	0. 0
4. 32. 52	
6. 54. 55	
7. 0. 28	5. 28
5. 33	
Sun's Par. 8,63	

Central Time & *Madras.*	Parall.
2. 22. 3	0. 0
5. 20. 10	
7. 42. 13	
7. 47. 55	5. 57
5. 42	
Sun's Par. 8,14	

Central Time & *Calcutta.*	Parall.
2. 22. 3	0. 0
5. 53. 44	
8. 15. 47	
8. 20. 58	5. 16
5. 11	
Sun's Par. 8,36	

The Sun's parallax deduced from the obferved and calculated times of the 2d internal contact.

Central Time & *Spittal Square.*	Parall. ′ ″
8. 20. 4	0. 0
0. 0. 17	
8. 19. 48	
8. 18. 41	1. 11
1. 7	
Sun's Par. 8,01	

Central Time & *Saville House.* h. m. fec.	Parall. ′ ″
8. 20. 4	0. 0
0. 0. 30	
8. 19. 34	
8. 18. 22	1. 11
1. 12	
Sun's Par. 8,62	

Central Time & *Paris.* h. m. fec.	Parall. ′ ″
8. 20. 4	0. 0
0. 9. 16	
8. 29. 20	
8. 28. 27	0. 54
53	
Sun's Par. 8,34	

Central Time & *Bologna.*	Parall.
8. 20. 4	0. 0
0. 45. 21	
9. 5. 25	
9. 4. 57	0. 29
28	
Sun's Par. 8,21	

Central Time & *Cape.*	Parall.
8. 20. 4	0. 0
1. 13. 35	
9. 33. 39	
9. 39. 50	6. 8
6. 11	
Sun's Par- 8,58	

Central Time & *Upfal.*	Parall.
8. 20. 4	0. 0
1. 10. 26	
9. 30. 30	
9. 28. 9	2. 21
2. 21	
Sun's Par. 8,50	

Central Time & *Upfal.*	Parall.
8. 20. 4	0. 0
1. 10. 26	
9. 30. 30	
9. 28. 7	2. 21
2. 23	
Sun's Par. 8,62	

Central Time & *Upfal.*	Parall.
8. 20. 4	0. 0
1. 10. 26	
9. 30. 30.	
9. 28. 3	2. 21
2. 27	
Sun's Par. 8,86	

Central Time & *Stockholm.*	Parall.
8. 20. 4	0. 0
1. 12. 26	
9. 32. 30	
9. 30. 11	2. 18
2. 19	
Sun's Par. 8,56	

Central Time & *Stockholm.*	Parall.
8. 20. 4	0. 0
1. 12. 26	
9. 32. 30	
9. 30. 8	2. 18
2. 22	
Sun's Par. 8,75	

Central Time & *Abo.*	Parall.
8. 20. 4	0. 0
1. 28. 33	
9. 48. 37	
9. 45. 59	2. 30
2. 38	
Sun's Par. 8,95	

Central Time & *Cajaneburg.*	Parall.
8. 20. 4	0. 0
1. 51. 50	
10. 11. 54	
10. 8. 50	2. 59
2. 55	
Sun's Par. 8,31	

Central Time & *Tobolski.*	Parall.
8. 20. 4	0. 0
4. 32. 52	
12. 52. 56	
12. 49. 20	3. 35
3. 36	
Sun's Par. 8,54	

Central Time & *Calmar.*	Parall.
8. 20. 4	0. 0
1. 5. 39	
9. 25. 43	
9. 23. 40	1. 59
2. 3	
Sun's Par. 8,78	

Central Time & *Rodrigues.*	Parall.
8. 20. 4	0. 0
4. 12. 34	
12. 32. 38	
12. 35. 47	3. 7
3. 9	
Sun's Par. 8,59	

Central Time & *Calcutta.*	Parall.
8. 20. 4	0. 0
5. 53. 44	
14. 13. 48	
14. 11. 34	2. 14
2. 14	
Sun's Par. 8,50	

The

The Sun's parallax is alſo found, by comparing the total duration between the internal contacts, as it was obſerved in different places, with the duration at the center of the earth, viz. 5ʰ. 58′. 1″.

Cent. Duration & at *Upſal.*	Parall.
h. m. ſec.	′ ″
5. 58. 1	0. 0
5. 50. 7	7. 33
7. 54	
Sun's Par. 8,89	

Cent. Duration & at *Calmar.*	
5. 58, 1	0. 0
5. 49. 54	8. 5.
8. 7	
Sun's Par. 8,53	

Cent. Dur. & at *Stockholm.*	
5. 58. 1	0 0
5. 50. 45	7. 34
7. 16	
Sun's Par. 8,16	

Cent. Duration & at *Upſal.*	
5. 58. 1	0. 0
5. 50. 2	
7. 59	7. 33
Sun's Par. 8,98	

Cent. Dur. & at *Hernoſand.*	
5. 58. 1	0. 0
5. 50. 26	7. 36
7. 35	
Sun's Par. 8,48	

Cent. Dur. & at *Stockholm.*	
5. 58. 1.	0. 0
5. 50. 42	7. 34
7. 19	
Sun's Par. 8,22	

Cent. Dur. & at *Upſal.*	Parall.
h. m. ſec.	′ ″
5. 58. 1	0. 0
5. 50. 26	7. 33
7. 35	
Sun's Par. 8,54	

Cent. Dur. & at *Hernoſand.*	
5. 58. 1	0. 0
5. 50. 17	7. 36
7. 44	
Sun's Par. 8,65	

Cent. Duration & at *Abo.*	
5. 58. 1	0. 0
5. 50. 9	7. 46
7. 52	
Sun's Par. 8,61	

Cent. Durat. & at *Cajaneburg.*	
5. 58. 1	0. 0
5. 49, 54	8. 5
8. 7	
Sun's Par. 8,53	

Cent. Duration & at *Madras.*	
5. 58. 1	0. 0
5. 51. 43	6. 33
6. 18	
Sun's Par. 8,17	

Cent. Duration & at *Tornea.*	Parall.
h. m. ſec.	′ ″
5. 58. 1	0. 0
5. 50. 15	8. 7
7. 46	
Sun's Par. 8,13	

Cent. Duration & at *Tobolſki.*	
5. 58. 1	0. 0
5. 48. 50	9. 3
9. 11	
Sun's Par. 8,63	

Cent. Duration & at *Calcutta.*	
5. 58. 1	0. 0
5. 50. 36	7. 30
7. 25	
Sun's Par. 8,40	

Cent. Dur. & at *Tranquebar.*	
5. 58. 1	0. 0.
5. 51. 33	6. 24
6. 28	
Sun's Par. 8,59	

Cent. Dur. & at *Great Mount.*	
5. 58. 1	0. 0
5. 51. 20	6. 33
6. 41	
Sun's Par. 8,67	

The mean of all the preceding determinations of the Sun's parallax is 8″52 on the day of the tranſit, in June, 1761, which gives 8″65 for his horizontal parallax at his mean diſtance from the earth.

Mr. Stuart of Edinburgh, whom I mentioned before, deduces the parallax and diſtances of the bodies that compoſe the ſolar ſyſtem, from the Newtonian theory of gravitation, and the periodical times of the Sun and Moon. As he proceeds upon the ſuppoſition that the diſtance of the Sun from the earth is very great, it would therefore ſeem, that the concluſion ſhould be accurate, in proportion to the greatneſs of that diſtance. His method depends

pends upon a ſeries of propoſitions, with long and difficult demonſtrations; ſo that the rules of calculation are not very obvious, without a conſiderable knowledge of geometry, in general, and a particular acquaintance with his very uſeful and ingenious treatiſe. I was deſirous of ſeeing what agreement there was between the reſult of his method of calculation, and the obſervations made on the tranſit of Venus; and therefore amuſed myſelf in a leiſure hour with the compariſon. As it may be agreeable to ſome, who have not time to read over the book, and to others, whoſe acquaintance with the mathematics will not admit of it, to have the practical rules of computation deduced from his propoſitions; I ſhall annex them to the foregoing calculations, together with the determination of the Sun's parallax and diſtance derived from them.

A Calculation of the horizontal Parallax and diſtance of the Sun, according to Mr. Stuart's method from the principles of gravitation.

D

Let P=the periodical time of the earth round the Sun=365. 256417824
p=the periodical time of the Moon round the earth= 27. 32162036
a=her revolution from apogee to apogee in time, 27. 554535
m=her mean diſt. from the earth, in ſemidi. of the earth= 60. 24
t=the tangent of the Sun's horizontal Parallax, at his mean diſtance.
S=the diſtance of the Sun from the earth.

Then according to Mr. Stuart's method, $$\frac{P^2}{p^2}\times\frac{a^{\frac{2}{3}}-p^{\frac{2}{3}}}{5a^{\frac{2}{3}}-3p^{\frac{2}{3}}}=\frac{2-\sqrt{1-9m^2t^2}}{1-9m^2t^2+\sqrt{1-9m^2t^2}}$$

Now if $$\frac{p^2}{P^2}\times\frac{5a^{\frac{2}{3}}-3p^{\frac{2}{3}}}{a^{\frac{2}{3}}-p^{\frac{2}{3}}}=c;\text{ then } S=\frac{3m\times\overline{2+1.5c}}{2\sqrt{\overline{1-.5c}\times\overline{1+2c}}}\text{ nearly}$$

And $$S=\frac{3m\times\overline{3+c}}{2\sqrt{\overline{1-.5c}\times\overline{2+1.5c}}}$$ Nearly. S is greater than the firſt, and leſs than the leaſt in theſe theorems.

But the parallax and diſtance of the Sun, may be found nearly, in a ſhorter method, by the following rules, derived from the foregoing; by ſaying,

1. As the cube root of the ſquare of the Moon's periodic revolution round the Earth, viz. $\overline{27,32162036}^{\frac{2}{3}}$
Is to the cube root of the ſquare of her revolution from apogee to apogee, viz. $\overline{27,554535}^{\frac{2}{3}}$
So is 1 to a fourth number, which call A=1.0056748164.

2. As 5 A—3 : A 1 : : 1 : a fourth number, which call B.=.002797833=the mean diſturbing force of the Sun; the ☽'s force=1.

3. As the rectangle of B and the ſquare of the periodic time of the Earth round the Sun, viz. $B\times\overline{365,2564}^2$
Is to the ſquare of the periodic time of the moon round the Earth, viz. $\overline{27,32162036}^2$
So is 1, to a fourth number, which call C=1,999840899.

4. As $\overline{C-1}^2$: 12 : : C : to a fourth number; to which add 1, and from the ſquare root of that ſum ſubtract 1, and multiply the remainder by the half of C—1, or 0,4999204495, and call that product D=1,9999715505.

5. Subtract

5. Subtract D from 2, multiply the remainder by D, and call the ſquare root of the product E.=.007543089.

6. As three times the Moon's mean diſtance from the Earth, in ſemidiameters of the Earth is to E, ſo is R, to the tang. of the Sun's horary parallax, at his mean diſtance,=8″,65.

7. As E : 3 : : the Moon's mean diſtance in miles: the Sun's mean diſtance in miles= 94,982,600.

In determining the parallax of the Sun, from the obſervation made in our obſervatory on the 3d of June, 1769, I have only made uſe of the time of the internal contact, as I noted it on that day, together with ſome of my own micrometer obſervations, without attending to thoſe of the other gentlemen who obſerved with me. But as the Society has a right to expect a full account of the reſult of the other obſervations, which were made on that occaſion; and as ſuch account may tend to corroborate the foregoing calculations, I have, with Dr. Williamſon's permiſſion, ſubjoined a calculation of his, founded entirely on his own obſervation, which being very ſhort, I have inſerted entire in his own words, except what refers to the manner in which he judged of the contacts, &c. which I have tranſcribed in another place, (ſee page 46.) From this, which is very ſimilar to the obſervations made by the other gentlemen on that committee, the Society will perceive, that our obſervations muſt have been made with conſiderable accuracy, as the reſult of the calculation is nearly the ſame.

DR. WILLIAMSON's *Determination of the* PARALLAX *of the* SUN, *from his Obſervation of the* TRANSIT *of* VENUS, *at Philadelphia, June 3d*, 1769.

"WITH a refracting teleſcope, 24 feet long, which magnified near 100 times, I obſerved,

The external contact at	$2^h. 11'. 31''$	Mean Time.
Internal do. at	2. 29. 10	

"With a micrometer of Dollond's conſtruction, fitted to a Gregorian reflector, which magnified 100 times, I meaſured the diſtance of Venus from the limb of the Sun; alſo the diameters of the Sun and Venus, as follows:

Mean

Mean Time.				Nearest Distance of the Center of ☉ and ♀.		Nearest Distance of the Limbs of ☉ and ♀.	
	h.	m.	sec.	m.	sec.	m.	sec.
At	5.	43.	17	10.	14,12	5.	2,53
	6.	32.	18	11.	14,19	4.	1,46
	6.	33.	55	11.	13,23	4.	3,42
	7.	9.	26	12.	11,83	3.	5,82

"I measured the diam. of Venus on the Sun, and found it to be 55″,42. I also frequently measured the diam. of the Sun, on the day of observation, and the next day, and found it to be 31′. 31″,30.

"From these data, I shall attempt to deduce the Sun's par. except that I shall make no use of the measure at 6^h. 32′. 18″, which I suspected was not accurate at the instant it was made, wherefore I immediately made another measure, viz. at 6^h. 33′. 55″.

"The nearest dist. of the limb of the Sun from that of Venus at 5^h. 43′. 17″ } mean time compared together,
And at 6 33. 53 }
give the apparent nearest dist. of their centers 10′. 3″,7, or 603″,7, and the parallax of Venus was at that time south 6″,91 nearly. Therefore, the geocent. nearest dist. of their centers was 610″,61. Then,

"As 72626,3 the relative nearest dist. of Venus from the Sun,

"Is to 28894,9 her dist. from the earth.

"So is 610″,61 the geocent. nearest dist. of the cent. of the Sun and Venus,

"To 242″,936=4′. 2″,936, the heliocent. dist. of their centers at the nearest approach.

"As Sine 3°. 23′. 20″ the given inclin. of Venus's orbit to the ecliptic: Is to Radius,

"So is S, 242″,936, the heliocent. dist. of the cent. of the Sun from Venus, at the middle of the transit,

"To the Sine of 410″,5=1°. 8′. 25″, the Sun's disk, from the node of Venus at the ecliptical conjunction.

"As S, of 1°. 8′. 25″, the Sun's dist. from the node of Venus,

"Is to 10′. 10″,61, the geocent. nearest dist. of their centers

"So

"So is Rad: to the S, of 8°. 32′. 57″,6, the angle of Venus's viſible path with the ecliptic.

"From 8°. 32′. 57″6, the angle of Venus's viſible path,

"Subt. 3. 23. 20, the inclination of Venus's orbit with the eclipt. and the remainder is 5°. 9′. 37″,6. Then

"As S, 5°. 9′. 37″,6 the diff. of the angle of Venus's viſible path and the inclin. of her orbit, &c.

"Is to S, 8°. 32′. 57″,6 the angle of Venus's viſible path with the eclipt.

"So is 2′,392375 the given hor. motion of the Sun.

"To 3′,95412 the hor. motion of Venus.

"As Rad. Is to T, 8°. 32′. 57″,6 the angle of Venus's viſible path.

"So is S, 1°. 8′. 25″ the Sun's diſt. from the node of Venus.

"To T, 10′. 17″,2 Venus's geocent. latitude.

"As 72626,3 the relative diſt. of Venus from the Sun,

"Is to 28894,9 her diſtance from the earth.

"So is 617″,2 her geocent. latitude.

"To 245″,56 her heliocent. latitude.

"From 15′. 45″,65 the ſemid. of the Sun,

"Take 27″,71 the ſemid. of Venus, and the difference is 15′. 17″,94., the diſt. of the center of the Sun from the center of Venus at the inter. contact. But the geocent. neareſt diſt. of their centers was found 610″,61. From theſe (b. Euc. 1. 47) the length of half the tranſit line between the int. contacts is found to be 685′,397 which divided by the hor. motion of Venus gives the ſemiduration of the tranſit between the two internal contacts 2h. 53′. 20″,2.

"In the ſame manner, from the geocent. lat. of Venus, and the neareſt diſt. of her center from the center of the Sun, we find the time of Venus paſſing from the eclipt. conjunction to the middle of the tranſit 22′. 44″,9. Then from 5h. 28′ 47″, which I find to be the central time of the middle of the tranſit, deduct 22′. 44″,9, and the remainder, viz. 5h. 6′. 2″,1, will be the apparent time of the ecliptical

ecliptical conjunction when the Sun's place was $2^s. 13^°. 27'. 20'',5$, as calculated by the astronomer royal, on the supposition that our observatory is west of Greenwich $5^h. 0'. 35''$.——To the Sun's place in the eclipt. add his dist. from the node of Venus $1^°. 8'. 25''$. The sum is $2^s. 14^°. 35'. 45'',5$, the place of Venus's ascending node.

" From the micrometer measures above given, it appears that the center of Venus was at her nearest approach to the center of the Sun at $5^h. 21'. 44''$ mean time, or $5^h. 23', 59''$ appar. time. But on account of the parallax of Venus, the appar. time at the center of the Earth was $4'. 48''$ later, which brings it to $5^h. 28'. 47''$ as I have mentioned. From this deduct the semidurat. $2^h. 53'. 20$, and the remainder $2^h. 35'. 27''$ is the time of the internal contact at the center of the earth. This contact I observed as above, at $2^h. 29'. 10''$ mean time, or $2^h. 31'. 25''$ apparent time. This difference, therefore, viz. $4'. 2''$, is the observed effects of Venus's parallax both in latitude and longitude.

" But on the supposition that the Sun's horizontal parallax, at her mean dist. from the earth was $8'',05$, as Mr. Short has stated it at the former transit, then his horizontal parallax, on the 3d of June, the day of the transit, would have been $8'',5204$, in which case the total effect of her parallax, to hasten the internal contact at Philadelphia, should be $4'. 1''$. Therefore,

" As $4'. 1''$ is to $4'. ''2$, so is $8'',5204$ to $8'',556$, the Sun's horizontal parallax on the day of the transit, according to the foregoing observations.

" Hence we have $8'',685$, the Sun's horizontal parallax at his mean distance from the earth. Then say,

" As the Tang. of the Sun's horizontal parallax: is to the semidiameter of the earth,

" So is Rad. to the distance of the earth from the Sun, viz. 94791100 English miles, taking the earth's mean semidiameter at 3985.4 miles.

An

An Account of the Tranſit of MERCURY *over the* SUN, *on* November 9*th*, 1769. *N. S.*

IN the judgment of moſt aſtronomers, the tranſits of Mercury and Venus over the Sun afford the beſt opportunities, for ſettling the longitudes of places on the earth, even preferable to that derived from the eclipſes of Jupiter's ſatellites, when the parallax of the Sun is previouſly known. Thoſe of Mercury happen frequently, and although they are of but little importance in determining the parallax of the Sun and the dimenſions of the ſolar ſyſtem, by reaſon of his great diſtance from the earth, and the difference of their parallaxes being leſs than that of the Sun; yet they have been carefully obſerved, for the purpoſe of ſettling his theory, and the longitudes of the places of obſervation. The ſociety therefore ſenſible of the importance of this phœnomenon, both to the perfection of aſtronomy in general, and particularly for completing the purpoſes deſigned to be anſwered by the obſervation of the tranſit of Venus, have appointed the ſame committee, with the addition of two other gentlemen, to obſerve the tranſit of Mercury on the 9th of November, 1769, in Philadelphia, that had been before appointed to obſerve that of Venus.

Having ſtill the ſame inſtruments in our obſervatory, which we uſed on the former occaſion, together with a new time-piece made by Mr. Duffield of this city, with an ingenious contrivance of his, in the conſtruction of the pendulum, to remedy the irregularities ariſing from heat and cold; we paid the utmoſt attention to the going of the clock both before and after the tranſit. From comparing a ſufficient number of correſponding altitudes of the Sun's limbs, we found that our clock was too ſlow for mean time 1′. 20″ and the equation of time being 15′. 49″,6 or to avoid fractions 15′. 50″; 17′. 10″ were added to the times of all our obſervations, as they were written down in the obſervatory, to reduce them to apparent time. In this

L manner

manner we obtained the time of the ſubſequent obſervations. Dr. Williamſon, Mr. Shippen and myſelf uſed the ſame teleſcopes, we had uſed before in obſerving the tranſit of Venus; excepting that on this occaſion I choſe that power of the teleſcope which magnifies the diameters of objects an hundred times. Mr. Evans uſed the reflecting teleſcope formerly uſed by Mr. Biddle at the Capes.

On the day of the tranſit, we aſſembled together at the obſervatory, adjuſted our teleſcopes to diſtinct viſion, appointed an aſſiſtant to count the clock with an audible voice, and agreed that no other perſon ſhould ſpeak, nor move from his teleſcope, until both contacts were over; but write down his own obſervation ſeparately by himſelf, that it might be compared with the others. The ſky being very ſerene, and the limb of the Sun well defined in our teleſcopes, we obſerved the contacts, as they are exhibited in the following table,

Obſervers.	External Cont.	Int. Cont.	Par. in Vert.	Par. p. to his P.	Par. in his Path.
	h. m. ſec	h. m. ſec.	″	″	″
Dr. Williamſon,	2. 36. 5 Ap.T.	2. 37. 30	3,74	3,44	1,48 at the External Contact.
Mr. Shippen,	2. 36. 12	2. 37. 40			
Mr. Evans,	2. 36. 9	2. 37. 38	3,745	3,44	1,49 at the Internal Contact.
Myſelf.	2. 36. 9	2. 37. 30			

I happened to have that part of the limb of the Sun, on which Mercury entered, in the middle of the field of my teleſcope, with my eye intent upon it; ſo that I am certain, that there was not the leaſt impreſſion on the Sun's limb, perceptible by my teleſcope, a ſingle ſecond of time before I diſcovered it. So that I am not ſurprized that Dr. Halley, who had obſerved a tranſit of Mercury in the Iſland of St. Helena, concluding that, that of Venus would be equally inſtantaneous, expected, that the contact of her limb with the Sun might be determined to a ſingle ſecond of time. The atmoſphere of Venus renders it quite otherwiſe, and produces an uncertainty of 5 or 6 ſeconds of time, in judging of the contacts; whereas no ſuch thing was perceptible in Mercury. The firſt appearance of Mercury, on the Sun's limb, was a ſteady ſmall ſpeck,

ſpeck, black, well-defined, and not larger in my teleſcope than the dot of a pen. But that of Venus was tremulous, obſcure, and ill-defined, growing gradually darker as ſhe advanced on the Sun. If Mercury has an atmoſphere, it muſt be ſo rare and low, that his diſtance from us renders it abſolutely imperceptible with the teleſcopes that we uſed. At the internal contact, the creſcent of light round the body of Mercury cloſed inſtantaneouſly, ſo that it might be judged of with more preciſion than that of Venus; his atmoſphere giving us no diſturbance in this caſe. We could not have a fairer opportunity, for aſcertaining the truth of theſe concluſions; as our teleſcopes were in good order, and well adjuſted, and the ſky was remarkably clear and ſerene, on both of theſe days. On the firſt of them, not a cloud appeared from morning till evening, and on the latter, none till about four o'clock, when the Sun was very low; and both the tranſits began between two and three o'clock, in the afternoon.

About three o'clock, I applied myſelf to the micrometer, to meaſure the diameters of the Sun and Mercury, and the neareſt diſtance of their limbs; while Dr. *Williamſon* read off the diviſions of the micrometer, and a third perſon wrote them down, with the times of making them. Theſe meaſures make the diameter of the Sun on the 9th of November 1769, 32′. 20″,2 or his ſemidiameter 970″,1 ſeconds, and the ſemidiameter of Mercury 4″,238. The meaſures of the leaſt diſtances of their limbs reduced to minutes and ſeconds of a degree, with the parallaxes of Mercury adapted to the apparent times of the obſervations, as they are determined from a very large projection of two inches to a ſecond of his hor. parallax, are ſet down in the following table.

Apparent

Apparent Time. h. m. fec.	Neareft diftance of limbs of ☉ & ☿	Parrallax of ☿ in the vert.	Par. per. to his path.	Parallax in his path.
2. 59. 40	1'.54",1	3,"81	3",4	1",725
3. 1. 0	2. 0,62	3,81	3,396	1,73
3. 2. 35	2. 8,284	3,82	3,393	1,745
3. 4. 30	2. 20,832	3,825	3,39	1,765
3. 6. 10	2. 26,048	3,826	3,386	1,78
3. 10. 33	2. 48,216	3,835	3,38	1,83
3. 12. 6	2. 57,244	3,841	3,379	1,84
3. 12. 56	3. 2,56	3,844	3,376	1,85
3. 15. 4	3. 13,744	3,850	3,375	1,865
3. 18. 4	3. 26,032	3,856	3,369	1,87
3. 19. 18	3. 30,596	3,86	3,366	1,888
3. 21. 30	3. 41,68	3,864	3,363	1,915
3. 24. 0	3. 51,684	3,875	3,36	1,95
3. 30. 0	4. 20,8	3,895	3,34	2,0
3. 33. 30	4. 35,144	3,90	3,338	2,02
3. 36. 40	4. 51,444	3,905	3,334	2,04
3. 37. 40 } 3. 39. 25 }	5. 2,202	3,915	3,33	2,065
3. 41. 10 } 3. 42. 50 }	5. 21,406	3,930	3,325	2,09
3. 46. 58	5. 37,184	3,935	3,32	2,145
3. 55. 32	6. 8,48	3,96	3,30	2,2
3. 59. 10	6. 26,084	3,97	3,29	2,24
4. 28. 50	7. 54,756	4,0	3,22	2,42
4. 47. 50	8. 35,18	4,02	3,15	2,51

N. B. In the above table, the meafure at $2^{h.}\ 37'.\ 40''$ was taken between the neareft limb of the Sun and the interior limb of Mercury neareft to the Sun's center, and is $5'.\ 2''202$, the fame with the diftance of their neareft limbs at $3^{h.}\ 39'.\ 25''$: So alfo the diftance between the neareft limb of the Sun, and the interior limb of Mercury, at $3^{h.}\ 41'.\ 10''$, was the fame with the diftance of their neareft limbs at $3^{h.}\ 42'.\ 50''$, viz. $5'.\ 21'',406$. The fame is to be faid of the laft meafure, which was taken from the neareft limb of the Sun to the limb of Mercury neareft to the Sun's center.

If a computation be made from the above meafures, the apparent neareft diftance of their centers will be found to be $451'',914$. But Mercury was then depreffed by parallax $3'',11$; fo that the geocentric neareft approach of their centers was $455'',024$, which happened at $5^{h.}\ 1'.\ 15''$ apparent time, when his par. in the vert. was $4'',042$, and in his path $2'',53$, and perpend. to his path $3'',11$.

The horary motion of Mercury as feen from the Earth is alfo determined from the above meafures to be

5'

5′. 56″,941=5″,94856, which is nearly the ſame with what is given by Dr. Halley's tables of Mercury. On the day of the tranſit, he moves, by them, at the rate of 15″,334 per hour. The Sun's horary motion on that day is ſtated in the nautical almanac at 2″,516, and their difference, viz. 12′,818 is his horary motion from the Sun, as ſeen at that diſtance. Then ſay,

As the diſtance of ☿ from ⊖, is to his diſtance from ☉, So is this horary motion to his horary motion from ☉, as ſeen from ⊖.

4. 830,2920=log. of 67653.8
4. 495,3305=log. of 31284.6
1. 107,8203=log. 12.818

5. 603,1508

0. 772,8588=5′. 92733=5′. 55″,6398 ☿ hor. mot. from ☉, as ſeen from ⊖.
15. 334=horary motion ☿.
2. 516=horary motion ☉.

As 17. 850=1. 251,6382=the ſum of horary motions ☉ and ☿.

Is to 12. 818=1. 107,8203=their difference.
So is cot. 3°. 29′. 40″=11. 214,2067= } the log. cot. of half the incl. of ☿'s orbit with the ecliptic=½ 6°. 59′. 20″.
12. 322,0270

To Log. Tang. 11. 070,3888=85°. 8′. 22″.
86. 30. 20=½ ſup. of 6°. 59′. 20″.

Sum=171. 38. 42
The ſupplement whereof is 8. 21. 18=the angle of ☿'s viſible path with the ecliptic.

As Rad : Sec. 8°. 21′. 18″ : : geo. neareſt diſt. : the geo. lat. of ☿.
10. 000,0000
10. 004,6342
2. 658,0343=455″,024=geo. neareſt diſtance.

2. 662,6685=459″,905=geo. lat. of ☿=7′. 39″,905

As diſt. of ☿ from ☉ : his diſt. from ⊖ : : geo. lat. : his heliocent. latitude.
4. 495,3305
4. 830,2920
2. 662,6685

7. 492,9605

2. 997,6300=994″,558 the hel. lat. of ☿=16′. 34″,558

As T, 6°. 59′. 20″ : R : : T, 16′. 34″,558 : Sine of ☉'s diſt. from the node of ☿.
9. 088,4133
10. - - -
7. 683,0140

8. 594,6007=2°. 15′. 12″,2=☉'s diſt. from the node of ☿.

459,905=geocent. lat. ☿.
455,024=geocent. neareſt diſt. of ☉ and ☿.
Sum=914,929=2. 961,3873
Diff.= 4,881=0. 688,5088

2)3. 649,8961

1. 824,94805

1. 824,94805=66″,8264= } the length of part of the transit line between
2. 551,0104 ☿ hor. motion in seconds. } the middle of the transit and the eclipt. conjunction.

—1. 273,9376=0h. 187205=0h. 11′. 16″,458=the time between the middle and ecliptical conjunction.

974,338=the sum of the semidiameters of ☉ and ☿.
455,024=the geo. nearest dist. of their centers.

Sum=1429,362=3. 155,1422
Diff.= 519,314=2. 715,4300

2)5. 870,5722

2. 935,2861=861″,561 } half the length of the transit line from the external contact.
2. 551,0104=the horary motion of ☿ on ☉, as seen from ⊖.

0. 384,2757=2h. 422567=2h. 422567=2h. 25′. 21″,24 the semiduration from the external contact.

965,862 the diff. of the semidiameters of ☉ and ☿.
455,024 the geo. nearest distance of their centers.

Sum=1420,886=3. 152,5691
Diff.=510,738=2. 708,2833

2) 5. 860,8524

2. 930,4262= } 851,974=the length of half the transit line from the internal contact.
2. 551,0104=hor. mot. of ☿.

0. 379,4158=2h. 39561=2h. 23′. 44″,196

Now to 2h. 36′. 19″ the time of the external contact,
Add 2. 25. 21 the semidur. between the external contacts.

The Sum,	5. 1. 30	is the time of the nearest approach of their centers.
To this add,	11. 16,5	the time from the middle to the ecl. conjunction.
The sum,	5. 12. 46,5	is the apparent time of the ecl. conjunction at Philadelphia.
To this add,	5. 0. 35	the diff. of meridians between Greenwich and Philadelphia.
The sum,	10. 13. 21,6	is the time of the ecl. conjunction at Greenwich, when the

Sun's place, according to the Nautical Almanac, is 7s. 17° 50′. 41″, and that of Mercury is 1s. 17°. 50′. 41″, by Dr. Halley's tables. From this subtract 2°. 15′. 12″, the Sun's distance from the node of Mercury, and the remainder 1s. 15°. 35′. 29″, is the place of his node at that time.

The PROJECTION *of the* TRANSIT *of* MERCURY, *Pl.* V.

THE following projection of the transit of Mercury over the Sun, on the 9th of November, 1769, was made from the foregoing measures and calculations, on the supposition that the Sun's horizontal parallax, at his mean distance is 8″,65, and therefore, 8″,7437 on the day of the transit. In this case, the horizontal parallax of Mercury, at his mean distance, will be 14″,1132, and on the day of the transit 12″7856, and therefore his horizontal parallax from the Sun on that day is 4″,0419, being the difference of their parallaxes.

The delineation was made in the same manner as that of the transit of Venus. The elements for it were collected from

from the preceding calculation, and the parallaxes of Mercury were meaſured upon a very large projection, for that purpoſe, adapted to the apparent times of the micrometer meaſures, and applied to the projection. By theſe, the apparent places of Mercury were determined, as ſeen at Philadelphia; and ſmall circles were drawn round them, with the radius 4″,238, to repreſent his diſk on the face of the Sun. From the limbs of the Sun and Mercury, lines were drawn in the direction of their centers, of the preciſe length exhibited in the foregoing table of meaſures.

Upon the whole, I have given a full and faithful account of our obſervations of the tranſits of Venus and Mercury, in the foregoing ſheets; and if they ſhould be found, in the concluſion, to contribute any thing to the advancement of aſtronomical knowledge, it muſt reflect an honor on our new obſervatory, and give pleaſure to all the lovers of ſcience, as well as to,

Gentlemen,

Your moſt obedient

And very humble ſervant,

Philadelphia, July 19th, 1769. JOHN EWING.

An Account of the Tranſit of Venus, *over the* Sun'*s Diſk, as obſerved near* Cape Henlopen, *on Delaware Bay, June* 3d, 1769. *By* Owen Biddle, Joel Bailey, *and Drawn up By* Owen Biddle.

AGREEABLE to the appointment of the *American Philoſophical Society*, to obſerve the *tranſit of Venus* at the light-houſe, near Cape-Henlopen, I ſet out by water from Philadelphia, accompanied by Joel Bailey, and Richard Thomas, the latter of whom had offered to accompany us at his own expence, and proved very ſerviceable in the aſſiſtance he gave us.

On the 26th of the 5th month (May) we arrived at *Lewes-Town*, and immediately endeavoured to gain ſuch information

tion as might enable us to determinethe beſt place for our obſervations; and, on mature deliberation, we fixed on a place about one quater of a mile S. W. of the town of *Lewes*, where a convenient houſe was to be had, in a retired ſituation, and having an open view of the ſky.

We found on our firſt landing on the beach, that neither the *Light-Houſe*, nor any place near the ſea-ſhore, would be ſuitable for our obſervations; as it would be difficult to keep our inſtruments ſteady, or defend either the glaſſes of the teleſcopes, or the eyes of the obſervers, from receiving injury by the ſand which is wafted about by the wind.

Having choſen our place, we fixt up our inſtruments on the 27th of the month,and had ſome good correſponding altitudes of the Sun that day by which we ſet our clock, and took ſome equal altitudes of fixt ſtars in the evening. The four following days continued cloudy, with frequent rains. But that we might not be idle in the mean time, and have it in our power to aſcertain our latitude and longitude, in caſe we ſhould be diſappointed of celeſtial obſervations for that purpoſe; Joel Bailey and Richard Thomas, went to take the courſes and diſtances from our obſervatory, to the provincial weſt line, which was run from Fenwick's Iſland to the *middle point* of the peninſula; ſo that our *obſervatory* might thereby be connected with Meſſrs. Maſon and Dixon's meridian line.

The 1ſt of the 6th month (June) my aſſociates returned from this ſervice; and by their care and ſkill, I make no doubt, they performed it with the neceſſary preciſion.

We had concluded that it would be a more expeditious way to take the courſes, &c. from our obſervatory to the weſt line, rather along the neareſt public road than to run in one direct courſe through the woods; as by this laſt method, both the expence and delay of opening a viſta, would have been neceſſary.

As the fixing the latitude and longitude of our obſervatory muſt depend chiefly on this part of the work, I ſhall here inſert the field notes, before I proceed to draw the concluſions

conclusions from them. And I think it the more necessary to be particular in this request, that I may comply with the desire of the astronomer royal, expressed in his note to Dr. Franklin, as follows, viz.

Greenwich, December 11, 1769.

" *Mr. Maskelyne presents his compliments to Dr. Franklin and shall be obliged to him, when he writes to Philadelphia, for enquiring of Mr. Owen Biddle, what is the bearing and what the absolute distance of Lewestown from the stone on Fenwick's Isle in English miles; or else what is the difference of latitude and departure in English miles? He may also, if he pleases acquaint Mr. Biddle, that the latitude of the* Middle Point *between Fenwick's Isle and Chesapeak Bay, as found by Messrs. Mason and Dixon, is* 38°. 27'. 34"; *and the length of a degree of latitude, as measured by them, is* 68,896 *statute miles.*

" *Mr. Maskelyne would also recommend it to Dr.* Smith, *and the other* Norriton-observers, *to settle the bearing and distance in English miles between Norriton and the southermost point of the city of Philadelphia, or else the State House square; as this will still further confirm the situation of the Norriton-observatory, by connecting it with Messrs. Mason and Dixon's* meridian line.

" *Mr. Maskelyne hopes, the* Pennsylvania-observers *will be so kind as to send us their observations of the* Transit of Mercury, *which happened November 9th, if they were fortunate enough to see it; and any other observations, they have made, which have not yet been sent here, tending to establish the difference of longitudes.*"

The

The COURSES and DISTANCES from the Observatory near Lewestown, to the Provincial West Line, between Fenwick's Isle and Chesapeak-Bay, are as follows:

Courses. ° ′	Distance in Perches.	Courses. ° ′	Distance in Perches.	Courses. ° ′	Distance in Perches.
S. 43. 5 W.	495	S. 27. 15 W.	171	S. 10. 0 W.	56
S. 7. 30 E.	51	S. 43. 0 W.	23	S. 14. 0 E.	111
S. 45. 27 W.	446	S. 64. 0 W.	58	S. 23. 0 E.	54
S. 74. 0 W.	70	S. 50. 0 W.	26	S. 75. 0 E.	25
S. 68. 15 W.	44	S. 20. 40 W.	78	S. 64. 0 E.	65
S. 45. 0 W.	31	S. 30. 0 W.	41	S. 29. 0 E.	22
S. 35. 30 W.	52	S. 39. 0 E.	74	S. 13. 10 E.	81
S. 28. 0 W.	32	S. 44. 0 W.	52	S. 39. 0 E.	61
S. 82. 15 W.	56	S. 21. 30 W.	} 69,67	S. 9. 0 W.	24
N. 76. 0 W.	38	Across In-		S. 6. 0 E.	36
S. 42. 5 W.	102	dian Ri-		S. 25. 0 W.	84
S. 27. 0 W.	57	ver.		S. 21. 30 E.	40
S. 64. 0 W.	33	S. 65. 0 W.	131	S. 40. 0 E.	57
S. 44. 0 W.	46	S. 64. 0 W.	78	S. 18. 0 E.	26
S. 2. 0 W.	45	S. 79. 0 W.	76	S. 12. 0 E.	78
S. 10. 0 W.	138	N. 80. 0 W.	52	S. 40. 0 W.	96
S. 30. 30 W.	216	S. 85. 30 W.	42	S. 10. 50 W.	86
S. 28. 40 W.	76	N. 76. 0 W.	63	S. 13. 0 E.	56
S. 25. 0 W.	104	S. 86. 0 W.	70	S. 28. 0 W.	70
South. - -	55	S. 65. 0 W.	66	S. 16. 10 E.	48
S. 8. 0 W.	96	S. 24. 0 W.	50	S. 6. 0 E.	26
S. 19. 5 W.	56	S. 18. 45 W.	73	S. 8. 0 W.	59
S. 26. 0 W.	80	S. 12. 0 E.	24	S. 22. 0 E.	46
S. 27. 30 W.	159	S. 6. 0 E.	48	S. 2. 0 W.	20
S. 8. 0 W.	270	S. 11. 0 E.	174	S. 42. 0 E.	42
S. 29. 0 W.	58	S. 6. 0 E.	73	S. 22. 0 E.	30
S. 11. 20 E.	164	S. 10. 0 W.	38	S. 48. 0 W.	46
S. 25. 0 E.	44	S. 11. 0 E.	112	S. 14. 0 E.	21
S. 28. 30 E.	58	S. 6. 0 E.	35	S. 18. 0 E.	48
S. 40. 30 E.	200	S. 19. 0 W.	16	S. 12. 30 E.	52
S. 30. 5 E.	45	S. 13. 0 W.	22	S. 42. 0 E.	49
S. 40. 5 E.	76	S. 29. 0 W.	46	S. 40. 0 E.	44
S. 58. 0 E.	44	S. 50. 0 E.	145	S. 14. 0 E.	110
S. 10. 0 W.	58	S. 61. 0 E.	48	South - -	31
S. 18. 0 E.	42	S. 10. 0 E.	36	S. 40. 0 E.	26
S. 12. 0 E.	84	S. 21. 30 W.	110	S. 14. 0 E.	22
S. 14. 0 E.	178	S. 10. 0 W.	56	S. 22. 0 W.	27
S. 10. 0 E.	44	S. 8. 30 E.	55	Here the line from Fenwick's Isle to the Middle Point was interfected at 9 miles 86 perches, from the stone in Fenwick's Isle.	
S. 5. 30 E.	56	S. 27. 30 E.	34		
S. 21. 0 E.	60	S. 12. 0 E.	38		
S. 41. 0 W.	62	S. 10. 0 W.	30		
S. 21. 0 W.	40	S. 28. 0 W.	30		
S. 5. 0 W.	18	S. 38. 0 W.	75		

The needle, with which these courses were taken, being compared with our meridian line, and alfo with the Prov. W. line, was found to have 3°. 55′. *variation* W. which was allowed for in reducing the work.

Hence, from the above work, we get the obfervatory near Lewestown,

Weft of the Stone on Fenwick's Ifle	1895,5 perches,	=5 miles	295,5 perches.
Eaft of the middle point, - -	9286,3 perches,	=29 miles	6,3 perches.
North of the middle Point, - -	7007,5 perches,	=19 miles	4,3 perches.
The latitude of the middle point is - - -	38°. 27′. 34″		
The fum is the latitude of the obfervatory	38. 46. 38,3		

Thus

Thus the latitude of the obſervatory was fixed, and ſo would its longitude have been fixed by the above work alſo, if we had known either the longitude of the middle point, or of the ſtone on Fenwick's Iſle. But this not appearing from any part of the work of Meſſrs. Maſon and Dixon, left among their public papers in this province, the American Philoſophical Society ordered us in the 5th Month, (May,) 1770, to take the courſes and diſtances from New-Caſtle Court-Houſe, to the obſervatory in the State-Houſe ſquare, by which means the middle point, and conſequently our obſervatory at Lewes might be connected with the Philadelphia and Norriton obſervatories, and ſo the longitude of the two latter being known, the longitude of the former would be known alſo. Our work is as follows.

Courses. Begun at the center of Newcaſtle Court-Houſe.		Diſtance in perches.
N. 39°.	0' W.	3,52
N. 32.	40 E.	40
N. 42.	00 E.	50
N. 6.	50 E.	80
N. 1.	50 W.	153
N. 19.	0 E.	729
N. 16.	30 E.	328
N. 12.	30 E.	66
N. 7.	0 E.	192
N. 42.	0 E.	56
N. 19.	0 W.	50,22
North.	- -	89
N. 2.	0 W.	181
N. 7.	0 E.	56
N. 35.	0 E.	20
N. 59.	55 E.	944
N. 41.	50 E.	87
N. 51.	30 E.	276
N. 49.	0 E.	48

Courſes.		Perches.
N. 43.	30 E.	258
N. 45.	15 E.	168
N. 52.	30 E.	98
N. 60.	20 E.	232
N. 78.	20 E.	225
N. 62.	5 E.	132
N. 69.	0 E.	188
N. 71.	0 E.	135
N. 43.	0 E.	105
N. 58.	0 E.	112
N. 67.	45 E.	123
N. 49.	0 E.	105
N. 74.	0 E.	140
N. 64.	0 E.	76
N. 59.	0 E.	132
N. 73.	15 E.	148
N. 58.	30 E.	93
N. 26.	30 W.	32
N. 56.	30 E.	136
N. 5.	0 E.	124
N. 35.	25 E.	126
N. 61.	0 E.	280
N. 62.	15 E.	320

Courſes.		Perches.
N. 69.	0 E.	189
N. 57.	0 E.	116
N. 37.	40 E.	438
N. 58.	0 E.	406
N. 47.	35 E.	120
N. 11.	40 E.	66
N. 55.	15 E.	42
S. 73.	20 E.	38
N. 83.	30 E.	37
S. 70.	40 E.	162
N. 73.	30 E.	45
N. 50.	30 E.	790
S. 88.	15 E.	100
S. 71.	50 E.	189
S. 87.	0 E.	104
N. 55.	0 E.	432
S. 77.	40 E.	325,8
South.	- -	18

To the center of the obſervatory in the State-Houſe Square.

N. B. The variation of the needle by which theſe courſes were taken was 3°. 15' Weſt, which was allowed for in reducing the work

Thus by the above work we get—	Perches.
New-Caſtle court-houſe weſt of Philadelphia obſervatory	7011,5
Middle point of Peninſula weſt of New-Caſtle court-houſe	2212,2
Their ſum gives the middle point weſt of Philadelphia obſervatory	9223,7
But (p. 86.) the middle point is weſt of the Lewes obſervatory	9286,3
Their difference gives the Lewes obſervatory eaſt of the Philadelphia obſervatory	62,6

This difference of ſixty-two perches does not give quite a ſecond of time difference of longitude. And

And as, both by the Philadelphia and Norriton obfervations, the longitude of the Philadelphia obfervatory, weft of Greenwich, is - - -	5h. 0'. 35"
The longitude of Lewis obfervatory Weft of Greenwich is in time	5. 0. 34
Or, in degrees and parts of the equator the longitude of Lewis obfervatory weft of Greenwich is - - - -	75°. 8.' 30"
And its latitude as above - - - - -	38. 46. 38,3 North.

For the advantage of navigation, we alfo took the courfes and diftances from our obfervatory to the Provincial light-houfe near the Cape; and on reducing the work, we find the light-houfe north of our obfervatory 182,83 perches,=29",8; and eaft of the fame 944 perches=3'. 16",8. —Whence

The latitude of the light-houfe, is - -	38°. 47'. 8",1 North.
And its longitude, weft of Greenwich - -	75. 5. 13,2

I now proceed to give an account of the remainder of our obfervations. The 2d of the month we had feveral good correfponding altitudes of the Sun for fetting our time-piece.

The 3d being the tranfit-day, was as fine in every refpect for our obfervation, as we could defire; the air calm, and not a cloud in view. We had a feries of good correfponding altitudes of the Sun, taken in feafon, not to interrupt the obfervation of the tranfit.

About 12 o'clock we directed our telefcopes to the Sun, determined to keep it conftantly in the field, till the contacts fhould be paft; and in the mean time we fet our boys (whom we had tutored for that purpofe) to count the feconds by the clock, each boy counting one minute alternately, leaft they fhould be wearied, and not perform it with fufficient exactnefs. During the whole a perfon was ftanding by to overlook them, calling out each minute as it elapfed, and noting it down.

We had agreed with each other to attend to our telefcopes one minute by turns, until about 7 or 8 minutes before the expected time, leaft by too fteady attention, we fhould impair our fight, and difable ourfelves from difcerning the contact clearly. I had left my telefcope the minute preceding the contact, intending to apply myfelf fteadily to it before the minute was fully elapfed; and not to quit it again until the contact occurred. When the 48th fecond was called, I applied myfelf to the telefcope, and by the time three feconds more were elapfed, I perceived on that part of the Sun's limb, where I had expected the

the contact to take place, a ſmall impreſſion, which proved to be the limb of Venus in contact with the Sun. All the limb of the Sun which appeared at that time in the field of the teleſcope had a ſmall undulatory motion, which I apprehended was occaſioned by the aſcent of denſe vapours at this place (being near the ſea). On the firſt appearance of Venus, it was like one of theſe ſmall waves on the limb of the Sun, enlarged in ſo ſmall a proportion, that I remained doubtful for ſeveral ſeconds, whether it was any thing beſides. It continued making a deeper impreſſion with that tremulous motion for about 10 ſeconds, when the tremor diſappeared where Venus was in contact, and the indenture became truly circular with an even termination.

My abſence from my teleſcope, juſt before the contact occurred, deprived me of the opportunity of judging whether there was any appearance of an atmoſphere preceding the weſtern limb of Venus as it came in contact; but when Venus had entered near one half her diameter on the diſk of the Sun, my companion and I both ſaw a luminous creſcent, which enlightened that part of Venus's circumference which was off the Sun, ſo that the whole of her circumference was viſible; but it did not continue ſo, until the firſt internal contact took place.

At the time of the internal contact, agreeable to what was noted by ſome of the obſervers at the tranſit 1761; "the eaſtern limb of Venus ſeemed to be united to the limb of the Sun by a black protuberance or ligament, which was not broke by the entrance of the thread of light," until 4 ſeconds after the regular circumference of Venus ſeemed to coincide with the Sun's.

For this obſervation I uſed a reflecting teleſcope, magnifying about 150 times, which was in exceeding good order at the time, and defined the limb of the Sun, and ſpots on its diſk, very nicely. I had applied a polar axis to it, and had altered the rack work, by which I could keep the ſame part of the limb in the field with eaſe.

My

My companion Joel Bailey was not ſo well provided with a teleſcope. He had one of *Dollond*'s double object lens refracting glaſſes of about four and an half feet length. This, with a ball and ſocket, was fixed to a poſt, which made it very convenient for obſervation. Thus furniſhed we found the contacts take place as follows.

Joel Bailey's external contact was loſt by an accident, but ſeen by him after it had taken place, at	$2^h. 14'. 30''$ ap. t.
The internal contact, by do.	2. 32. 8
External contact, as ſeen by Owen Biddle, - - -	2. 14. 8
The internal contact by do.	2. 32. 8

Theſe obſervations are reduced to appar. time. And it muſt be noted, that the time of the internal contact, as given by Owen Biddle, is 4 ſeconds before the thread of light had broke the dark ligament by which Venus's limb was united to the limb of the Sun, that being the time he eſtimated the two limbs to be in contact. Alſo, that as the external contact occurred ſpeedily after he went to his teleſcope, he will not preſume to aſſert that he has the time to a ſingle ſecond, yet he conceives he has given the exact time of that contact, as he is not ſenſible of any error therein.

The foregoing being an exact diary of our tranſactions, we ſubmit the ſame to the ſociety, and hope for their approbation. OWEN BIDDLE.

P. S. Since the foregoing was drawn up, I received from Dr. Smith the following note; which gives me pleaſure to find ſo little difference between the reſult of Charles Maſon and Jeremiah Dixon's meaſurement and our own.

DEAR SIR,

SINCE you finiſhed your meaſurement from Newcaſtle Court-Houſe to the Philadelphia obſervatory in the State-Houſe Square, the 58th volume of Philoſophical Tranſactions has come to hand, containing the whole work of Meſſrs. Maſon and Dixon in meaſuring a *degree of latitude*; and it is with great pleaſure I find, that the longitude of the middle point of the peninſula (and conſequently of your obſervatory at Lewes) in reſpect to Philadelphia, will come out almoſt entirely the ſame from their work as from yours, although obtained by different routs*.

LONGITUDE

* The reſult by Mr. Biddle's rout is got, by going from the State-Houſe obſervatory to Newcaſtle Court-Houſe, agreeable to his meaſurement; thence by the 12 m. radius and tangent line to the middle point. The reſult by Meſſrs. Maſon and Dixon's work is got, by beginning at the ſouth point of the city of Philadelphia, (or the place of their obſervatory,) on the north ſide of Cedar-ſtreet, between Front-ſtreect and Delaware; thence to their obſervatory in the Forks of Brandywine, which is 31 miles Weſt, and 10″,5 South of the ſouthermoſt point of the city; thence by the other lines of latitude and departure, wherewith they connect the obſervatory in the Forks of Brandywine, with the middle point of the Peninſula. See their work in the volume of Tranſactions, quoted above.

LONGITUDE *of the Middle Point, and of the Lewes Obfervatory Weft of the Philadelphia Obfervatory, agreeable to the lines of Meffrs.* Mafon *and* Dixon.

	mil. ch. lin.
Obfervatory in the Forks of Brandywine Weft of the South point of the city of Philadelphia,	31. 00. 00
Middle point of the Peninfula Eaft of obfervatory in the Forks,	2. 5. 49
The diff. gives the middle point of Peninfula W. of S. point of Philadelphia,	28. 74. 51
But S. point of Philadelphia is E. of obfervatory in State-Houfe Square,	0. 28. 75
The diff. gives the *middle point* of Peninfula Weft of State-Houfe obfervatory,	28. 45. 76
But by your work the middle point is W. of the Lewes obf. 9286,3 perches,=	29. 1. 57
The difference gives Lewes obfervatory Eaft of the State-Houfe obfervatory, from Mafon and Dixon's lines,	0. 35. 81
But by your meafure to Newcaftle the Lewes obfervatory was Eaft of the State-Houfe obfervatory 62,6 perches,=	0. 15. 65
So that Mafon and Dixon's lines give your obfervatory more Eaft than your own work, only	0. 20. 16

Thus, by their work, we get your obfervatory not quite 2″, and by your own not quite 1″ Eaft of the obfervatory in the State-Houfe Square. Wherefore 1″ being taken as a mean, and applied to 5h. 0′. 35″ the longitude of the State-Houfe obfervatory Weft of Greenwich; the longitude of the Lewes obfervatory may be well depended on as ftated from your own work, to be in time Weft of Greenwich, 5h. 0′. 34″.

N. B. As Britifh mariners generally take their departure from the Land's end of England, as by Mr. Bradley's obfervations of the late tranfit of Venus, the longitude of the Lizard Point is now determined to be 5°. 15′ W. of Greenwich, if that be fubtracted from 75°. 5′. 13″,2, it will give the longitude of the Provincial Light-Houfe near the Capes W. of Lizard Point, 69°. 50′. 13′,2

If you think the above can be of any ufe, you may add it to the end of your account. I think there is no miftake in bringing out the different refults; but if I can find leifure I will re-examine the work before the fheet is ftruck off. I am, with great regard, your's, &c.

Philad. July 23, 1770. WILLIAM SMITH.

To Mr. Owen Biddle.

An Abftract of Mr. BENJAMIN WEST'*s Account of the tranfit of Venus, as obferved at* Providence, *in New-England, June 3d,* 1769.

AS it appears by fome letters of the aftronomer royal, which have been communicated to this Society, that moft of the Northern obfervers, both in Ruffia and Sweden, were greatly difappointed, by the unfavourable ftate of the weather, in their noble and public fpirited endeavours to obferve the late tranfit; the American obfervations have become of the greater importance, in order to a comparifon with thofe of Greenwich, and therefore the Society think it very material to preferve in their tranfactions, fuch of the obfervations made on this continent as they have been favoured with. The account of the Providence obfervations, drawn up by Mr. West, *was tranfmitted by Mr.* Joseph Brown, *and being laid before the Society by Dr.* Smith; *the following abftract thereof was ordered to be publifhed at a meeting, May 18th,* 1770.

WHEN

"WHEN it became more generally known that there would be a tranſit of Venus in 1769, and the advantages which were like to accrue to aſtronomy, and conſequently to navigation and chronology, from proper obſervations of it, Mr. JOSEPH BROWN*, a very reſpectable merchant of Providence, being very deſirous, if poſſible, to obtain an obſervation of it, was pleaſed to adviſe with me, concerning an apparatus ſuitable for ſuch an obſervation, and to know if we ſhould be able to obſerve the tranſit with the neceſſary preciſion for anſwering the important deſign? My anſwer gave him ſo much ſatisfaction in the matter, that he immediately ſent his orders to his correſpondent in London, to procure the inſtruments. His orders were accordingly executed with fidelity and diſpatch; and the inſtruments arrived in Providence about one month before the tranſit. Our apparatus was made by Meſſieurs Watkins and Smith, London; it conſiſted of a three feet reflecting teleſcope, with horizontal and vertical wires for taking differences of altitude and azimuths, adjuſted with ſpirit-levels at right angles, and a divided arch for taking altitudes; a curious helioſcope, together with a micrometer of a new and elegant conſtruction, with rack motions, and fitted to the teleſcope. Beſides the before mentioned inſtruments, we had a ſextant belonging to the government, made in Newport, by Mr. Benjamin King, under the direction of Joſeph Harriſon, Eſq. now collector of his Majeſty's Cuſtoms for the port of Boſton; its limb was divided to five miles, and by a vernier index to five ſeconds †. We had two good clocks, one of which was made in Providence, by Mr. Edward Spalding."

"We

* Reading Mr. Winthrop's account of the tranſit in 1761, was what firſt occaſioned Mr. BROWN to ſend for a teleſcope, fitted in the manner Mr. Winthrop there deſcribes; afterwards, taking notice of the application of the American Philoſophical Society to the Aſſembly of Pennſylvania, for an apparatus for obſerving the tranſit of Venus, he found the orders he had ſent were incomplete: He then adviſed with the author, as mentioned above, and thereupon ordered a micrometer to be added.——Mr. Brown's expence, in this laudable undertaking, was little leſs than one hundred pounds ſterliug, beſides near a month's time of himſelf and ſervants, in making the neceſſary previous experiments and preparations.

† And here we muſt not forget the Hon. Abraham Redwood, Eſq. of Newport, who, in order that Newport and Providence might both be ſupplied with a ſextant, for this ſingular occaſion, ordered one made at his own coſt, for the uſe of the Revd. Dr. Stiles. I am ſenſible Mr. Redwood, for ſo public ſpirited an action, will receive the thanks of every well-wiſher to ſcience.

"We had nothing to learn refpecting the apparatus, excepting our new catadioptric micrometer, which, I have lately learned, is of Dollond's conftruction; not having any author by us, from which we could get the ufe of that curious inftrument, we were obliged to have recourfe to experiments. When the micrometer was fixed upon the telefcope, it was found by trial, that objects could not be feen with the fame focal diftance as when it was off, and we were obliged to fcrew up the fmall fpeculum nearer to the eye; for which there is an optical reafon. From whence it was concluded, that objects fhould always be obferved in the moft diftinct point of view, the fame with the micrometer on, as when it was off. The next thing to be done was to find the apparent diameter of an object (or the angle fubtended at the eye by two objects) by this inftrument. In order to this, we ftretched a cord, as ftraight as poffible, one thoufand feet in length; which was meafured feveral times over, in order to avoid miftake. At the end of the cord was fet two circular objects, made of white paper, in a line perpendicular to the cord, and exactly ten feet apart; ftanding at the other end of the cord, and by opening the micrometer, we could bring the two images into an exact coincidence, or could make one of the images appear like two, and by bringing their limbs into contact, the diftance of their centers was fhewn on the fcale, to the five hundredth part of an inch. Now from the rules of trigonometry, the angular diftance of the two objects was $34'.22'',58$; from thence it was known, how many inches and parts of an inch were anfwerable to that angle. Thefe experiments were repeated every fair day (for no other was fuitable for thefe obfervations) till we could many times going find the diameter of a body to a fecond of a degree. From thefe obfervations we were enabled to make a table for the micrometer, as far as the fcale extended. Thefe experiments were carried yet farther; for, by looking at two bodies whofe diftance from each other was known, we could tell their diftance from the

 place

place of obſervation, to a critical exactneſs; and this was proved by accurate menſuration. Theſe were certainly very diverting experiments to an inquiſitive mind! The gentlemen who aſſiſted us through theſe experiments, and likewiſe in the reſt of our work, were the Hon. Stephen Hopkins, Eſq. Mr. Moſes Brown, Dr. Jabez Bowen, Joſeph Naſh, Eſq. and Capt. John Burrough.

" The regulation of our clocks, being of the utmoſt conſequence in this affair, was what next commanded our attention. In this part of the work we endeavoured to arrive at as great a degree of certainty as the nature of the caſe would admit.—Several workmen were employed in laying a platform of ſeaſoned pine plank, as ſmooth and level as art could make it: This was ſecured from rain, or other moiſture, that it might not warp when expoſed to the Sun. We examined this platform three times a day (when the weather would admit of it) with a very long level. On the ſouth ſide of the platform, and exactly perpendicular to it, we erected a ſtile ten feet high; this was likewiſe examined three times a day. We next perforated a piece of board, into which was fixed the glaſs of a ſcioptric ball, ſo that the center of the glaſs was exactly in the center of the perforation; this board was ſo cut, and let in at the top of the ſtile, that it turned upon an axis, in ſuch a manner, that the center of the glaſs did not alter its poſition. The Sun's rays were tranſmitted through the lens upon the platform, where they were formed into a bright ſpot, and very diſtinctly defined. From the center of the lens was let fall a perpendicular upon the platform; from that point, as a center, was drawn a great number of concentric circles, for taking correſpondent ſhades, in order to trace a meridian line; and, as our wiſhes would have it, the weather proved favorable for this work. When the line was drawn*, I found from calculation, it declined $3''$ in time, eaſt of the true meridian; this

* The magnetic needle, being placed on his exact meridian line, was found to differ from it 6° ½ weſtward.

this error arofe from the increafe of the Sun's declination, between the times of forenoon and afternoon ſhades; this ſmall equation of 3″ was allowed for in regulating the clocks.

" As we were willing to have every corroborating circumſtance to prove our work, we made uſe of the method of correſponding altitudes of the Sun, forenoon and afternoon. The ſextant and reflector were both employed in this buſineſs for ſeveral days preceding the tranſit (and the day following) in order to aſcertain the going of the clocks. In the laſt method (as in that of correſponding ſhades) the equation of time, anſwerable to the increaſe of declination. ought by no means to be neglected. The whole proceſs was conducted with the utmoſt caution, that no errors might eſcape our notice. We found upon the whole, a ſurpriſing agreement in theſe two methods of regulating clocks; they were ſeldom found to differ a ſingle ſecond.

" Being in this readineſs, the morning of the third of June was uſhered in with that ſerenity the buſineſs of the day required; all was calm, and not a cloud to be ſeen. The gentlemen concerned in the buſineſs convened very early at the place of obſervation, to ſee that every thing was in order; and at the ſight of ſuch a morning, the gladneſs of their hearts was viſibly expreſſed, by the pleaſure of their countenance.

" At noon we examined the going of the clocks, as the Sun paſſed the meridian, and found them very regular.

" We began to look for the firſt contact of Venus with the Sun, at leaſt 15 minutes before the time given by calculation, to get as early a ſight of it as poſſible. Venus was firſt perceived, by making a dent upon the ſuperior limb of the Sun, at $2^{h.}\ 29'.\ 43''$. P. M. apparent time. But, as it is likely the exterior contacts will be given different, by different obſervers, they can be of but little conſequence in this affair. The greateſt attention was given to the interior contact; this was at $2^{h.}\ 46'.\ 35.''$ apparent time*.

time*. From a mean of a number of good obſervations, the apparent diameter of the Sun was 31′. 40″,66, and that of Venus 58″,66; though I could not make it myſelf more than 58″, which was the ſame we found it about a fortnight before the tranſit. The proportion of their diameters was nearly as 1 to 33. The neareſt approach of their centers, at the middle of the tranſit, was taken with the micrometer, and found to be 10′. 5″.

" The proportion of the diſtances of the Sun and Venus from the earth, at that time, was as 3,5143 to 1; then (allowing the Sun's parallax at his mean diſtance to be 8″,68 the ſame it was found the 6th of June, 1761) the parallax of Venus was 30″,04; the difference of their parallaxes 21″,49 is the parallax of Venus from the Sun. The angle between the viſible way of Venus and the ecliptic, 8°. 34′. 17″; and the angle made by the axis of the ecliptic and equator, 7°. 3′. 7″; their ſum, 15°. 37′. 24″, was the angle between the axis of the viſible way of Venus, and the Earth's axis. The tranſit line, from total ingreſs to the middle of the tranſit (meaſured in time by the viſible motion of Venus) was $2^{h.}$ 55′. 36″; but Venus was more accelerated in her orbit (by parallax in longitude) at the middle of the tranſit, than at total ingreſs; this difference of acceleration was 1′. 33″; therefore from the total ingreſs to the middle of the tranſit was $2^{h.}$ 54′. 3″.

Thence I conclude, that the——

† Firſt contact was at - - -	$2^{h.}$ 28′. 0″	ap. time.
But ſeen by us, as above, at	2. 29. 43	ap. time.
Interior contact, - -	2. 46. 35	ap. time.
Middle of the tranſit, - -	5. 40. 38	

" Venus's

* At the moment of interior contact, the Sun's altitude was taken with the ſextant, by Mr. Moſes Brown, and by the ſtile by Captain John Burrough; and both gave the time with the clocks within two ſeconds. The total ingreſs was not ſo inſtantaneous as I did expect it would be, but the bright cuſps of the Sun, as they encompaſſed Venus, were much more obtuſe, and there ſeemed to be a faint junction of their limbs for at leaſt 4 ſeconds; the moment this penumbral ligament broke, I proclaimed the time; at firſt I ſuſpected the teleſcope was not adjuſted to a proper focus; but afterwards, by looking at the ſolar ſpots, &c. I was convinced of the contrary. During the time we ſaw Venus upon the Sun, ſhe appeared to be ſurrounded by a ring of a yellowiſh colour; its width was about one tenth of the diameter of Venus. We ſaw nothing that might be taken for a ſatellite.

† When I calculated this tranſit, I ſuppoſed the longitude of our place to be much leſs than we have ſince found it by obſervation. By correcting that error, the error in calculation will appear to be inconſiderable.

" Venus's parallax in longitude, at the middle of the tranſit, was 18″,7; this was paſſed over by Venus's viſible motion in 4′. 44″; ſo that the middle of the tranſit, as ſeen from the center of the earth, was at 5h. 43′. 6″ mean time. The true conjunction was 23′ 21″ before the middle of the tranſit, as ſeen from the earth's center; conſequently the true conjunction was at 5h. 19′. 45″, mean time. At which time, the place of the Sun and planet was *Gemini* 13°. 27′. 3″; and the geocentric latitude of Venus 10′ 19″,8 north. But her heliocentric latitude was 4′. 6″,51; and by the rules of ſpherical trigonometry, the aſcending node of Venus was 1°. 9′. 23″,5 in conſequence of the Sun, or in *Gemini* 14°. 36′. 26″,5.

" From the foregoing calculation it appears, that the mean motion of Venus is 37″ forward of what it ſtands in Dr. Halley's tables, and her aſcending node 2′. 41″.

" It is probable Dr. Halley's ſolar numbers need ſome correction likewiſe; the following may not be far from truth, viz. add to Dr. Halley's mean motion of the Sun, for any year of the chriſtian æra, 25″, and to the apogee 6′. 18″; for each century after 1700 add 14″,666 to the mean motion, and to the apogee 3′. 53″; then by making uſe of the Pariſian* equation of the Sun's center, his place may be had within a ſmall matter of truth.

" By taking the mean of a number of obſervations, the latitude of our obſervatory was found to be 41°. 50′. 41″ north†. The longitude was obtained by obſerving the emerſions of Jupiter's ſatellites, compared with the correſponding obſervations made at Cambridge, in New-England, by Mr. Winthrop, which he was ſo kind as to fa-

vour

* According to the Pariſian hypotheſis, the eccentrity of the earth's orb is 1680 parts, of which the mean diſtance of the earth from the Sun is 100,000.

† The latitude of the place being of great conſequence, and the ſextant and ſtile not giving it exactly alike, the perſevering Mr. Brown contrived to make uſe of the micrometer as a lens, which he placed on his houſe, twenty ſeven feet high, and exactly perpendicular to a center on a horizontal platform below, on which was drawn a meridian line; the Sun's image on this platform was ſeen to move very ſenſibly. By this the latitude was finally determined. The Sun's meridian altitude, being taken for ſeveral days by this long ſtile, the latitudes thence found did not differ from each other more than 15 ſeconds. At the time this was done, we had ſeen no account that a glaſs had been made uſe of, as here deſcribed; but ſince this went to the preſs, we learn from Dr. Long's aſtronomy, that he found the latitude of Cambridge, in England, by the ſame method.

vour us with; and for which we return him our ſincere thanks. Providence was found to be 16′ in longitude weſt from Cambridge. Mr. Winthrop has hitherto found the longitude of Cambridge to be 71°. weſt from the royal obſervatory at Greenwich; ſo that the longitude of Providence is about 71° 16′ from the royal obſervatory.

"I ſhall now give the reader a ſhort account of the parallax herein mentioned, and how the planets are affected thereby.

"The horizontal parallax of the Sun is that angle at the Sun's center, which is included between two lines ſuppoſed to be drawn, one from the Sun's center to the center of the earth, the other from the Sun's center to the ſurface of the earth. Or, in other words, it is the angle, under which the ſemidiameter of the earth would appear to an eye, at the center of the Sun. The way that parallax affects the Sun and planets is, it makes them appear below their true places in the heavens, except they be in the zenith of the obſerver; in that caſe parallax hath no effect at all; and the reaſon is, becauſe the obſerver is in that right line which joins the centers of the earth and planet. Parallax may affect the planets places ſeveral ways; as if the obſerver ſhould view the planet upon a vertical, cutting the ecliptic at right angles; in this caſe, parallax will affect its place in reſpect to latitude only; but if the obſerver be ſituated in the plane of the ecliptic, it will then alter its place, in reſpect to longitude only; and if the planet be viewed in an oblique poſition, with reſpect to the ecliptic, parallax will affect its place both in longitude and latitude. The horizontal parallaxes of the planets are to each other in a reciprocal proportion to their diſtances; that is, the planets which are neareſt have the greateſt parallax, and thoſe which are moſt remote, the leaſt. Thence it follows, if two planets are viewed together, that which is neareſt will appear juſt ſo much below the other, as what the difference of their parallaxes is. The nearer a planet is to the horizon of the obſerver, the greater is its parallax, and in the horizon it is the greateſt poſſible; and is then called the horizontal parallax.

"Hence

" Hence comes the method of inveſtigating the Sun's parallax, from obſervations of Venus on his diſk. At the time of the tranſit, the third day of June, Venus was much nearer to the earth than the Sun was, and, of conſequence, was much more affected by parallax. This effect was produced in a twofold manner, in reſpect to us in the northern regions of our earth. Firſt, Venus was depreſſed upon the Sun, by parallax in longitude, bringing her to a conjunction with the Sun ſooner to our point of view, than to a ſpectator at the center of the earth. In the ſecond place, ſhe was carried nearer to the center of the Sun, by parallax in latitude, thereby lengthening the tranſit-line; both which effects conſpired to accelerate the time of firſt interior contact. Now to an obſerver in Great-Britain, parallax had a ſtill greater effect, by what is ſaid before: That is, ſome minutes paſſed after the contact was formed to the obſerver there, before it was ſeen by us. Now the difference of longitude, between the two places of obſervation, being accurately known, the effect of parallax, between the two places, is likewiſe known; for the difference of longitude, by theſe obſervations, will be conſiderably leſs than the true difference.

" The method of calculating the Sun's parallax, from theſe obſervations, is by trial; the parallax will be ſuppoſed of that quantity, which the obſervations found it in 1761; hence the total effect of parallax, at each place of obſervation, muſt be computed; and if it ſhould be the ſame as given by obſervation, it will prove the aſſumption to be juſt; but if, by obſervation, it ſhould be greater or leſs than by calculation, the Sun's parallax will turn out to be greater or leſs in the ſame proportion.—When the Sun's parallax is known, the diſtance of the earth, and of all the planets, from the Sun, will be known likewiſe."

OBSERVATIONS

OBSERVATIONS *of the* TRANSIT OF VENUS *over the* SUN, *and the* ECLIPSE *of the* SUN, *on June 3d*, 1769, *made at the* ROYAL OBSERVATORY, GREENWICH. *By the Revd.* NEVIL MASKELYNE, *B. D. F. R. S. and* Aſtronomer Royal.

Communicated to the Society by Dr. SMITH, *and ordered to publiſhed at a meeting, May* 18*th*, 1770.

THE weather, which had been cloudy or rainy here, with a ſouth wind, for the greateſt part of the day, began to clear up at four o'clock in the afternoon, the wind having returned to the weſt, the ſame quarter in which it had been the afternoon before, which was remarkably fine and ſerene, though it changed early in the morning preceding the tranſit. Towards the approach of Venus's ingreſs on the Sun, the ſky was become again very ſerene, and ſo continued all the evening, which afforded as favourable an obſervation of the tranſit here as could well be expected, conſidering that the Sun was only $7^{\circ}.\ 3'$ high at the external, and $4^{\circ}.\ 33'$ at the internal contact. I obſerved the external contact of Venus at $7^{h}.\ 10'.\ 58''$ apparent time, with an uncertainty ſeemingly not exceeding $5''$; and the internal contact, by which I mean the completion of the thread of light between the circumferences of the Sun and Venus, at $7^{h}.\ 29'.\ 23''$ apparent time, with a ſeeming uncertainty of only $3''$; for ſo long was the thread of light in forming, or the Sun's light in flowing round and filling up that part of his circumference, which was obſcured by Venus's exterior limb. Nevertheleſs, I would not hence infer, that obſervations made by aſtronomers in diſtant places ſhould agree together within ſuch narrow limits; for I know they will not even in the ſame place, and that a difference in the ſkill or judgment of the obſervers, in the teleſcopes, and perhaps in ſome other little circumſtances, not eaſily diſtinguiſhed, may produce much greater diſagreements, eſpecially if the Sun be low, as it was here; in like manner as in obſerving

ſerving the eclipſes of Jupiter's ſatellites, the immerſion or emerſion ſhall often ſeem inſtantaneous, or nearly ſo, equally to two obſervers in diſtant places, and yet the abſolute times of the obſervations may differ a minute of time or more from each other, owing to the difference of teleſcopes, weather, or other circumſtances. Indeed, in the preſent caſe, the limit of differences is certainly much narrower; but what it is I ſhall not at preſent venture to ſuggeſt, as that may better be done, when all the obſervations that ſhall have been made of the tranſit are collected together. The teleſcope which I uſed, was an excellent reflecting one of two feet focus, made by the late ingenious Mr. Short, and is the ſame with which the laſt tranſit was obſerved here by Mr. Charles Green. I applied the magnifying power of 140 times, and uſed ſmoaked glaſſes to defend the ſight, which are much preferable to black or red glaſſes, as ſhewing the objects more diſtinct, and being much more pleaſant to the eye.

I ſhall now endeavour to deſcribe, as accurately as I can, ſome other phœnomena which I noted during the immerſion of Venus, and to mention ſome others, which by ſome ingenious perſons were expected to have been ſeen, but which I could not diſcover.

It had been thought by ſome, that Venus's circumference might probably be ſeen, in part at leaſt, before ſhe entered at all upon the Sun, by means of the illumination of her atmoſphere by the Sun; I therefore looked out diligently for ſuch an appearance, but could ſee no ſuch thing.

I was alſo attentive to ſee if any penumbra or duſky ſhade preceded Venus's firſt impreſſion on the Sun at the external contact, ſuch a phœnomenon having been obſerved by the Rev. Mr. Hirſt, F. R. S. at the former tranſit of Venus, in 1761, which he obſerved with much care and diligence at Madraſs, in the Eaſt-Indies; but I could not diſcern the leaſt appearance of that kind. I would not, however, be therefore thought to call in queſtion either

Mr. Hirſt's diſcernment or fidelity; as I am ſenſible that the tremors of the limbs of the Sun and Venus, occaſioned by the vapours at the altitude of 7°, might eaſily obſcure a faint object.

When Venus was a little more than half immerged into the Sun's diſk, I ſaw her whole circumference completed, by means of a vivid, but narrow and ill-defined border of light, which illuminated that part of her circumference which was off the Sun, and would otherwiſe have been inviſible. This I might, probably, have ſeen ſooner, if I had attended to it. I continued to ſee it till within a few minutes of the internal contact, and grew apprehenſive that it would prevent the appearance of the thread of light, when it came to be formed; but it diſappeared about two or three minutes before, as well as I can remember: After which the regularity of Venus's circular figure was diſturbed towards the place where the internal contact ſhould happen, by the addition of a protuberance, dark like Venus, and projecting outwards, which occupied a ſpace upon the Sun's circumference, which bore a conſiderable proportion to the diameter of Venus. Fifty-two ſeconds before the thread of light was formed, Venus's regular circumference, ſuppoſed to be continued as it would have been without the protuberance, ſeemed to be in contact with the Sun's circumference, ſuppoſed alſo completed. Accordingly, from this time, Venus's regular circumference, ſuppoſed defined in the manner juſt deſcribed, appeared wholly within the Sun's circumference; and it ſeemed, therefore, wonderful that the thread of light ſhould be ſo long before it appeared, and the protuberance appearing in its ſtead.

At length, when a conſiderable part of the Sun's circumference, equal to one third or one fourth of the diameter of Venus, remained ſtill obſcured by the protuberance, a fine ſtream of light flowed gently round it from each ſide, and completed the ſame in the ſpace of three ſeconds of time, from $7^h. 29'. 20''$ to $7^h. 29'. 23''$ apparent time; and Venus appeared wholly within the Sun's lucid circumference;

circumference; but the protuberance, though diminifhed, was not taken away till about 20″ more, when, after being gradually reduced, it difappeared, and Venus's circular figure was reftored.

An ingenious gentleman of my acquaintance having defired me to examine if there was any protuberance of the Sun's circumference about the point of the internal contact, as he fuppofed fuch an appearance ought to arife from the refraction of the Sun's rays through Venus's atmofphere, if fhe had one; I carefully looked out for fuch a circumftance, but could fee no fuch thing; neither could I fee any ring of light round Venus, a little after fhe was got wholly within the Sun: But, I confefs, I did not re-examine this latter point afterwards, when fhe was further advanced upon the Sun, at which time other perfons at the obfervatory faw fuch an appearance.

How far from the ring of light, which I faw round that part of Venus's circumference which was off the Sun, during the immerfion, may deferve to be confidered as an indication of an atmofphere about Venus, I fhall not at prefent inquire; but I think it very probable, that the protuberance, which difturbed Venus's circular figure at the internal contact, was owing to the enlargement of the diameter of the Sun, and the contraction of that of Venus, produced by the irregular refraction of the rays of light through our atmofphere, and the confequent undulation of the limbs of the two planets; the altitude of Venus being only 4° 48′, though the Sun's limb was more diftinct and fteady than ufual at that altitude. This conjecture feems corroborated by two circumftances: one is, that Venus's limb, from its firft appearance to the total immerfion, as well as afterwards, was very ill defined, and undulated very much; the other is, that her horizontal diameter, which I meafured foon after the internal contact with an excellent achromatic object glafs micrometer, fitted to the two feet reflecting telefcope, was only fifty-five and three fourths of a fecond, by a mean of eight trials, or about 3″

lefs

lefs than it fhould have been, from the obfervations made, with the like inftrument, at the tranfit of Venus, in 1761, by Mr. Short, Mr. Canton, Mr. Haydon, and Mr Mafon, when the Sun was at a confiderable altitude; and moft likely the Sun's diameter was enlarged in proportion, though it might have been difficult to have afcertained it by actual meafure, had time allowed me to make the experiment with the fame micrometer before the Sun entered into a black cloud near the horizon.

Six other perfons alfo obferved the contacts of Venus here, and noted fome other phœnomena. Their names are, the Rev. Malachy Hitchins, a gentleman well acquainted with aftronomy and aftronomical calculations, who has made and examined many belonging to the nautical almanac, and has been fo obliging as to come here and affift me in making aftronomical obfervations, during the abfence of my affiftant, Mr. William Bayley, who is gone to the North Cape, by appointment of the Royal Society, to obferve the tranfit of Venus there. The others are, the Rev. William Hirft, who obferved the former tranfit of Venus, in 1761, at Madras; John Horfley, Efq. a gentleman whom I had the pleafure of firft commencing an acquaintance with during my voyage from St. Helena to England, in the Warwick Eaft-India fhip, and who then, and in feveral voyages fince to the Eaft-Indies and home again, obferved and calculated the longitude from diftances of the Moon from the Sun and fixed ftars with the greateft accuracy; Mr. Samuel Dunn, who has had a good deal of practice in making aftronomical obfervations, and who carefully obferved the former tranfit of Venus, in 1761, at Chelfea; Mr. Peter Dollond, whofe great fkill in conftructing achromatic and reflecting telefcopes; and Mr. Edward Nairne, whofe fkill likewife in the fame way, and in making all kinds of mathematical and philofophical inftruments, are fufficiently known to the public.

Mr.

Mr. Horſley and Mr. Dunn obſerved with me in the great room; Mr. Hitchins and Mr. Hirſt, in the eaſtern ſummer-houſe; and Mr. Dollond and Mr. Nairne in the weſtern ſummer-houſe; by three clocks placed in the reſpective rooms, which were compared with the clock in the tranſit room, before the external contact, and again after the internal contact was paſt; whence the times of the obſervations, as noted by the clocks, were reduced to the time of the tranſit clock, and thence to apparent time.

Their obſervations, together with my own, are given in the following table, as reduced to apparent time.

	External contact.	Regular circumferences in contact.	Thread of light compleated, or, the internal contact.	Teleſcopes made uſe of.	Magnifying power.
	h. m. ſec.	h. m. ſec.	h. m. ſec.		
N. Maſkelyne	7 10 58	7 28 31	7 29 23	2 feet reflector.	140
M. Hitchins	7 10 54	7 28 47	7 28 57	6 feet reflector.	90
W. Hirſt	7 11 11	----------	7 29 18	2 feet reflector.	55
J. Horſley	7 10 44	7 28 15	7 29 28	10 feet achromatic.	50
S. Dunn	7 10 37	7 29 28	7 29 48	3½ feet achromatic.	140
P. Dollond	7 11 19	----------	7 29 20	3½ feet achromatic.	150
E. Nairne	7 11 30	----------	7 29 20	2 feet reflector.	120

Mr. Dollond and Mr. Nairne uſed teleſcopes of their own conſtruction; but they did not wait 'till the thread of light was formed at the internal contact, but noted the time, when they judged it was juſt ready to be formed. The three and an half achromatic teleſcopes were thoſe made with three object glaſſes.

The differences between the different obſervations ſeem pretty conſiderable, and greater than I expected, conſidering that all the teleſcopes may be reckoned pretty nearly equal excepting the ſix feet reflector, which is much ſuperior to them all; and to its greater excellence and diſtinctneſs I principally attribute the difference of 26″, by which Mr. Hitchins ſaw the internal contact before me; as I can depend upon his obſervations. Poſſibly the greatneſs of the differences might ariſe from the low altitude of the Sun and Venus; and then the like differences would not be ſo much to be feared in places where the obſervation may

may be made at higher altitudes; otherwife the Sun's parallax will not be deducible from the tranfit of Venus with that accuracy which has been expected.

The other appearances about Venus, noted by the fix obfervers, which they have communicated to me are as follows:

Mr. Hitchins remarks, that, at the firft contact, though there was a tremulous motion in the Sun's limb, yet that part of it which the planet entered was very well defined, and the firft impreffion of Venus appeared to be inftantaneous, and as a black, fharp point. At the internal coincidence of circumferences, the fluctuation of the Sun's limb was increafed, and the limb of Venus being affected in like manner, there was an uncertainty of about 10″ in eftimating the faid coincidence; but at the breaking in of the thread of light between the limbs, there was not a greater uncertainty than a fecond and a half of time. At the internal coincidence of circumferences, the limb of Venus next to that of the Sun being protuberant, her vertical diameter appeared to be longer than the horizontal one; but when the Sun approached the horizon, and was fcarce above a degree high, Venus's horizontal diameter appeared to be fenfibly longer than the vertical, which was, probably, owing to refraction. After the internal, contact, there appeared a luminous ring round the body of Venus, about the thicknefs of half her femidiameter; it was brighteft towards Venus's body, and gradually diminifhed in fplendor at greater diftances, but the whole was exceffive white and faint. This radiancy round the planet feemed to him to be greater in Mr. Nairne's two feet telefcope than in the fix feet Newtonian reflector.

After the fecond or internal contact, Mr. Hirft left off obferving with Mr. Dunn's two feet reflector, and had a fight of Venus in the fix feet Newtonian reflector, in which he thought he preceived a glimmering of light about the upper part of the circumference of Venus, or that part of the planet which entered laft into the folar difk.

After

After Venus was got within the Sun's diſk, a light a little weaker than that of the Sun, of a purpliſh colour, appeared to Mr. Horſley, to the left hand of Venus, which is really to the right, the teleſcope inverting objects. This light he ſaw for ſix or ſeven minutes.

From $7^h\ 28'\ 26''$ to $7^h\ 28'\ 30''$ apparent time, Mr. Dunn ſaw a very faint rim of light at Venus's exterior limb. After Venus was wholly on the Sun, he ſaw a faint ring of light ſurrounding her, both with the three and a half feet teleſcope, and Mr. Nairne's two feet reflector.

When one third of Venus's diameter was entered upon the Sun, Mr. Dollond firſt ſaw a light about the exterior limb of the planet: This light, during all the time of its continuance, appeared rather reddiſh, and in all reſpects like irregular refracted light. After Venus was wholly entered upon the Sun, he ſaw a faint ring ſurrounding her.

After Venus was wholly entered upon the Sun, and her exterior limb was near one of her ſemidiameters diſtant from the Sun's circumference, Mr. Nairne ſaw a faint light round the planet, rather brighter and whiter than the body of the Sun.

Fortunately, the weather was as favourable for the obſervation of the eclipſe of the Sun, the next morning, as it had been the evening before for that of the ingreſs of Venus upon the Sun; which is of the more conſequence, as the compariſon of it with the obſervations which may be made of it in the northern and eaſtern parts of the world, will ſerve to ſettle the longitudes of thoſe places, and conſequently render the obſervations which may be made there of the tranſit more uſeful and valuable.

I obſerved the beginning of the eclipſe at $18^h.\ 38'.\ 54''$, and the end at $20^h.\ 23'.\ 30''$ apparent time, with the two feet reflector, uſing the magnifying power 90 times. And at $19^h.\ 29'.\ 31''$ apparent time, I obſerved the greateſt eclipſe, at which time I found the remaining lucid parts of the Sun $15'.\ 15''$, with Dollond's micrometer, aſſuming the

the horizontal diameter of the Sun 31′. 31″, whence the value of the ſcale of the micrometer was determined for the preſent purpoſe. Hence the eclipſed parts of the Sun were 16′. 16″, or 6 dig. 11′,62 on the northern part of his diſk.

Mr. Hitchins obſerved the beginning of the eclipſe with a three and an half achromatic teleſcope magnifying 150 times (the ſame with which Mr. Dollond obſerved the contacts of Venus) at 18h. 38′. 59″, and the end of the eclipſe with the ſix feet reflector with the magnifying power 90, at 20h. 23′. 35″ apparent time. And Mr. Samuel Dunn obſerved the beginning of the eclipſe at 18h. 39′. 9″, and the end at 20h. 23′. 33″ with the other three and an half feet achromatic teleſcope, magnifying 140 times, the ſame with which he obſerved the contacts of Venus. Several inequalities in the Moon's circumference, ſeen upon the Sun's diſk during the eclipſe, were diſtinctly diſcerned by all of us, the air being very clear, and the objects ſteady.

The whole ſeries of meaſures of the lucid parts, which I took with the achromatic object glaſs micrometer applied to the two feet teleſcope, was as follows.

Apparent time. h.	m.	ſec.		Lucid parts. m.	ſec.
19	22	13	— — — —	15	40,5
	24	21	— — — —	15	26,5
	26	9	— — — —	15	20,9
	28	26	— — — —	15	15,6
	30	14	— — — —	15	14,5
	31	44	— — — —	15	16,4
	32	30	— — — —	15	16,4
	33	19	— — — —	15	19,8
	34	28	— — — —	15	25,4
	36	19	— — — —	15	35,9
	37	56	— — — —	15	49,1

Some Account of the TRANSIT *of* VENUS, *and* ECLIPSE *of the* SUN, *as obſerved at the* Lizard Point, *June 3d*, 1769. *By Mr.* JOHN BRADLEY.

MR. Maſkelyne, the aſtronomer-royal, who has drawn up this ſhort account, mentions that having had ſome doubts that neither the latitude nor longitude of the Lizard Point were duly fixed, " he had propoſed thoſe doubts to the Board of Longitude, who being ſenſible of the importance of determining the poſition of

a place

place of ſo much conſequence in the Britiſh navigation, reſolved that proper aſtronomical obſervations ſhould be made at the Lizard for that purpoſe; and the tranſit of Venus appeared a convenient opportunity, itſelf affording one of the beſt means of determining the longitude of places; and the eclipſe of the Sun which was to happen the morning after, affording another of determining the ſame.

" Accordingly Mr. John Bradley, nephew of the late Dr. Bradley, and formerly his aſſiſtant at the royal obſervatory, was appointed to make theſe obſervations. The inſtruments which he was provided with, were an equal-altitude and tranſit inſtrument in one, an aſtronomical quadrant, and a reflecting teleſcope of two feet focus, all made by Mr. Bird; and an aſtronomical clock, with a gridiron pendulum, made by Mr. Shelton.

" Mr. Bradley ſtaid at the Lizard 51 days, viz. from May 13th to July 3d, during which time he was lucky enough to make a great many uſeful obſervations; ſome of the principal of which were the following, viz.—

Several meridian altitudes of the Sun and pole ſtar; by which the latitude of the Lizard Point was determined to be 49°. 57′. 30″. N.

The tranſit of Venus and eclipſe of the Sun viz.—

1769	Apparent time.			
June 3d.	6h.	50′.	7″,4	External contact of Venus and the Sun, very exact, the eye being fixed on the place.
	7.	8.	25	Internal contact; doubtful to 4 or 5″, a cloud having hid Venus ſo long; and at the cloud's going off, 2″ after the time ſet down, a thread of light appeared very diſtinct between the circumferences of the Sun and Venus.
	18.	14.	54	Begin. of the eclipſe of the Sun } Both very good
	19.	57.	17	End of the eclipſe.

 " Theſe

"These obſervations were made with the 2 feet reflector, and the magnifying power 120.

D.	h.	m.	ſec.	
June 8.	9.	20.	14	Em. 1ſt ſat. of Jupiter. Jupiter had not been from under the clouds 10″ when he ſaw the ſatellite, yet he reckons the obſervation good.
June 15.	11.	13.	46	Em. 1ſt ſat. A thin haze about Jupiter, but the obſervation pretty good. Theſe emerſions were obſerved with the ſame teleſcope, but with the magnifying power 100.

Comparing the obſervation of the contacts of Venus at the Lizard with his own at Greenwich, making a ſmall allowance for the difference ariſing from the effect of parallax at the two places, Mr. Maſkelyne makes the difference of meridians of Greenwich and the Lizard.—

By the external contact of Venus	20′.	53″	of time.
By the internal contact of ditto	21	01	
The mean by the contacts	20	57	

By the two emerſions, making a ſmall allowance for the difference of brightneſs of the teleſcopes, he makes the difference of meridians as follows, viz.

By the firſt emerſion	-	21′.	07″
By the ſecond emerſion	-	21.	52
The mean of theſe is -	-	21.	29,5
The mean by the contacts	-	20.	57
Mean of the two means	-	21.	13,25

But Mr. Maſkelyne, till he has time to compare the other obſervations, fixes on 21′. 0″ of time=5°. 15′. of the equator, for the difference of longitude of the Lizard weſt of Greenwich.

The above is taken from the nautical almanac for 1771; and it was thought might be a proper addition to the foregoing account of the tranſit of Venus, at Greenwich, drawn up by the Aſtronomer Royal.

A LETTER

A LETTER from the Revd. Nevil Maſkelyne, *B. D. F. R. S. Aſtronomer Royal, to the Revd.* William Smith, *D. D. Provoſt of the College of Philadelphia; acknowledging the receipt of the* NORRITON *Obſervations of the* Tranſit of VENUS, *and giving ſome account of the* Hudſon's-Bay *and other Northern Obſervations of the ſame. Read at a meeting of the American Philoſophical Society, May 18th,* 1770.

Greenwich, Dec. 26, 1769.

Revd. SIR,

"I RETURN you many thanks for the account of the *valuable* obſervations of the late *tranſit of Venus,* made at Norriton by yourſelf and two other gentlemen which I have communicated to the royal ſociety. It is ordered to be printed in the volume of their tranſactions for this year, and I will take care to ſee that it is printed correctly.

" I ſent to the Honourable Mr. PENN, a good while ago, my obſervations of the eclipſes of Jupiter's firſt ſatellite made this year, deſiring that he would communicate them to you, and I hope you * have received them.

" By a mean of your five firſt *Immerſions* (rejecting that of May 5th as too near the oppoſition to the Sun) compared with the *nautical almanac*, the difference of our meridians is $5^h. 1'. 32''$. But by a mean of my two firſt immerſions, the correction of the nautical almanac for a 2 feet reflector of Short's is $+ 20'',5$ which applied to $5^h. 1'. 32''$ gives $5^h. 1'. 52'',5$ for the difference of the meridians of Greenwich and Norriton by the *immerſions*.

" By a mean of your *emerſions*, June 6th and 13th, compared with the *nautical almanac*, the diff. of our meridians is $5^h. 1' 28'',5$; and by a mean my of two emerſions June 8th and July 1ſt the correction of the nautical almanac is $— 11'',5$, which applied to $5^h. 1'. 28'',5$ gives $5^h. 1'. 17''$ for the difference of our meridians by the *emerſions*; but, by the *immerſions* it was found above, $5^h. 1'. 52'',5$. The mean of theſe two reſults is $5^h. 1'. 34'',7$ for the

* They are inſerted above p. 19.

the *true difference of our meridians*, which happens to agree to *a second* with what you deduced from a comparifon of all the obfervations with the almanac alone.

" If any further obfervations of the eclipfes of Jupiter's fatellites fhall be made the enfuing feafon, I fhall be obliged to you for a communication of them; which will ferve further to confirm the difference of our meridians.

" The many curious optical phænomena noted in your account [of the *Norriton* obfervations] cannot but be very acceptable to philofophical readers. The Sun was too low here to give me an opportunity to obferve the firft impreffion of Venus (perhaps I ought to fay of her atmofphere) in the fame manner you faw it. Mr. Hirft's account of his obfervation of the former tranfit 1761, at Madras, feems to have a great refemblance to yours. But I have feen no fimilar * account with refpect to the prefent tranfit. Perhaps none of the obfervers had the Sun fo bright and clear as you had.

" Your meafures of the neareft diftances of the limbs of the Sun and Venus determine very well the neareft approach of Venus to the Sun's center, which was a very important obfervation, and could not be made here. If the appulfes of the limbs of the Sun, and Venus's center, to the hairs of the equal altitude inftrument fhould † arrive in time, I will take care that they be inferted in the place left for them.

" I fee Mr. *Rittenhoufe*, in making his projection, affumed 8″,65 for the Sun's horizontal parallax at the mean diftance; but, by the obfervations of the tranfit in 1761, Mr. Short ‡ and myfelf both found that to be the parallax on

* All the obfervers in this province noted much the fame phænomena as thofe referred to in this letter.

† They were not inferted in our own printed account, for the reafons given in p. 33.

‡ Mr. Rittenhoufe affumed the parallax 8″,65 from Mr. Short's paper in Phil. Tranf. vol. 52, part 2d. page 621, where the parallax of the Sun on the tranfit day, 1761, is certainly made by Mr. *Short* 8″,52 and the mean horizontal parallax 8″,65 as taken in our projection. Mr. Short's words are very clear. After going through his laborious and accurate calculations, from the different obfervations of the tranfit 1761, he concludes as follows——" The parallax of the Sun being thus found, by the obfervations of the internal contact at the egrefs = 8″,52, *on the day of the tranfit*, the MEAN HORIZONTAL PARALLAX *of the Sun* is 8″,65." We prefume then there muft be fome fubfequent paper of Mr. *Short*'s, and the *aftronomer royal*, (which we have not yet feen) that makes the parallax of the Sun 8″,65 on the day of the tranfit 1761. However the fmall difference of lefs than two-tenths of a fecond will not materially affect the projection.

on the day of the tranſit; whence the Sun's mean horizontal parallax ſhould be 8″,84. But what it will be as reſulting from the obſervations of the late tranſit, cannot be known without a number of laborious calculations, which I have undertaken.

" The Swedes and Ruſſians were very unſucceſsful. No complete and thorough good obſervation of the total duration is come to hand from the north. Our obſervers at the North Cape ſaw the ingreſs only, and that in a very bad ſtate of air.

" The *Hudſon's-Bay* obſervers, Meſſrs. Dymond and Wales, had better luck, and obſerved all the contacts, and neareſt approach of the centers, as follows.

1ſt External contact	$0^h, 57'. 4'',5$	All appar. time.
1ſt Internal contact	1. 15. 23	
2d Internal contact	7. 0. 47,5	
2d External contact	7. 19. 21	The laſt very hazy.

" At $4^h. 5'. 30''$, apparent time, was the neareſt aproach of Venus to the Sun's center; when the diſtance of her interior limb from the Sun's limb was 6′. 22″. The diameter of Venus was 59″,5 and the Sun,s horizontal diameter 31′. 32″,4. Hence the neareſt approach of Venus to the Sun's center was about 9′. 54″, or 7″ leſs than by your obſervations; undoubtedly owing to a greater parallax. Their latitude is 58°.47′ 30″ north. They could only obſerve five occultations of ſtars by the moon to determine their longitude, and I have not yet found any obſervations made in Europe, or elſewhere, correſponding to them.

" I could wiſh that the difference of meridians of Norriton and Philadelphia, could be determined by ſome meaſures and bearings, within one-fiftieth or one-hundredth part of the whole; in order to connect your obſervations with thoſe made at Philadelphia and the Capes of Delaware, as alſo to connect your obſervations of the longitude of *Norriton* with thoſe made by Meſſrs. Maſon and Dixon, in the courſe of meaſuring the degree of latitude. I hope to be favoured

favoured with an account of your obſervations of the late *tranſit of Mercury*, if you made any, and of the late eclipſe of the moon. I ſhall be obliged to you for the continuance of your correſpondence, and am,

Sir, yours, &c.
NEVIL MASKELYNE.

Account of the terreſtrial meaſurement of the difference of longitude and latitude, between the obſervatories *of* Norriton *and* Philadelphia.

To the AMERICAN PHILOSOPHICAL SOCIETY, &c.

GENTLEMEN,

AGREEABLE to the appointment you made (at the requeſt of the aſtronomer royal) Mr. *Lukens*, Mr. *Rittenhouſe*, and myſelf, furniſhed with proper inſtruments, met at *Norriton* early on Monday, July 2d, for the above ſervice; and took to our aſſiſtance two able and experienced ſurveyors, viz. Mr. *Archibald M'Clean*, and Mr. *Jeſſe Lukens*. The firſt thing we did, was accurately to aſcertain the variation of our compaſs, which we found 3°. 8′, by Mr. *Rittenhouſe's* meridian line. We then carefully meaſured our chain, and adjuſted it to the exact ſtandard of 66 feet. In the execution of the work, whenever the inſtrument was duly ſet, each courſe was taken off, and entered down ſeparately, by three different perſons, who likewiſe kept ſeparate accounts of all the diſtances, and ſuperintended the ſtretching of every chain, and the levelling and plumbing it, whenever there was any aſcent or deſcent in the road.

July 4th. We finiſhed the ſurvey; and Mr. *M'Clean*, Mr. *Jeſſe Lukens* and myſelf, then agreed to bring out the difference of latitude and departure ſeparately on each courſe and diſtance to four or five decimal places; and there was ſo great an agreement in this part of the work, when executed, that we had all the ſame reſults to a few links, and the whole was at laſt brought to agree in every figure, by comparing

comparing the few places where there was any difference, which ſcarce ever went farther than the laſt decimal place. Mr. *M'Clean* and Mr. *Lukens* took the trouble to bring out their work by multiplying each diſtance by the natural Sine of the courſe, to the radius unity, for the departure; and by the coſine for the latitude. Mine was done by Robertſon's tables. The whole follows, and we think it may be depended on for correctneſs.

Courſes and Diſtances from Norriton obſervatory *to the* obſervatory *in the State-Houſe Square, Philadelphia, and from thence to the* obſervatory *of Meſſrs. Maſon and Dixon, at the ſouth point of the city of Philadelphia; taken July 3d and 4th,* 1770: *With the differences of longitude and latitude, between the ſaid* obſervatories, *thence deduced.*

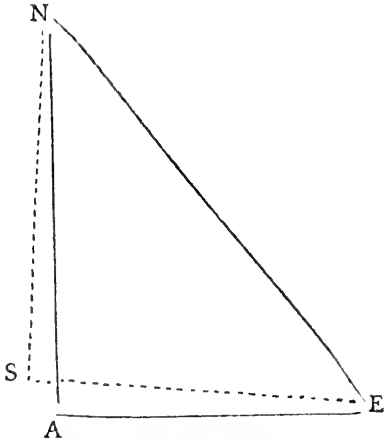
No. of Courſes.	Magnetic Courſes.	Diſtances chains. links	*Northing.	Southing.	Eaſting.	Weſting.
1	S. 27°. 00′ W.	13,00	- - - -	11,5831	- - - -	5,9018
2	S. 68. 00 E.	11,00	- - - -	4,1207	10,1990	- - - -
3	N. 89. 00 E.	8.29	00,1447		8,2887	- - - -
4	S. 66. 00 E.	17,77	- - - -	7,2277	16,2337	- - - -
5	S. 80. 00 E.	10,00	- - - -	1,7365	9,8481	- - - -
6	S. 70. 20 E.	22,00	- - - -	7,4040	20,7166	- - - -
7	S. 68. 30 E.	60,00	- - - -	21,9900	55,8250	- - - -
8	S. 72. 10 E.	26,00	- - - -	7,9624	24,7507	- - - -
9	S. 70. 00 E.	69,00	- - - -	23,5993	64,8388	- - - -
10	S. 50. 00 E.	20,22	- - - -	12,9971	15,4894	- - - -
Sums in 20 courſes.		257,28	00,1447	98,6208	226,1900	5,9018
11	S. 42. 00 E.	12,00	- - - -	8,9177	8,0296	- - - -
12	S. 45. 00 E.	40,00	- - - -	28,2843	28,2843	- - - -
13	S. 60. 00 E.	8,37	- - - -	4,4350	7,6816	- - - -
14	S. 27. 30 E.	24,14	- - - -	21,4124	11,1466	- - - -
15	S. 15. 30 W.	11,00	- - - -	10,5999	- - - -	2,9396
16	S. 34. 30 E.	9,50	- - - -	7,8292	5,3809	- - - -
17	S. 49. 00 E.	44,50	- - - -	29,1946	33,5848	- - - -
18	S. 42. 45 E.	19,00	- - - -	13,9521	12,8972	- - - -
19	S. 22. 00 E.	19,00	- - - -	7,6165	7,1175	- - - -
20	S. 2. 30 E.	26,80	- - - -	26,7745	1,1690	- - - -
Sums in 20 courſes.		472,09	00,1447	267,6370	341,4815	8,8414

No.

* The Northing, Southing, Eaſting and Weſting, are in chains and decimals of a chain, to the ten thouſandth part; or may be read chains and links, calling the two left hand figures of the decimal, links, and the two other figures hundredth parts of links.

No. of Courses.	Magnetic Courses.	Distances. chains. links	Northing.	Southing.	Easting.	Westing.
	Sums in 20 C. brought over.	472,09	00,1447	267,6370	341,4815	8,8414
21	S. 10°. 00′ W.	4,00	- - - -	3,9392	- - - -	0,6946
22	S. 20. 30 E.	54,56	- - - -	51,1048	19,1073	- - - -
23	S. 55. 15 E.	31,80	- - - -	18,1259	26,1284	- - - -
24	S. 50. 00 E.	37,30	- - - -	23,9760	28,5734	- - - -
25	S. 46. 00 E.	91,00	- - - -	63,2139	65,4599	- - - -
26	S 19. 5 E.	10,00	- - - -	9,4504	3,2694	- - - -
27	S. 44. 30 W.	10,00	- - - -	7,1325	- - - -	7,0091
28	S. 2. 00 E.	18,28	- - - -	18,2689	0,6380	- - - -
29	S. 42. 40 E.	23,14	- - - -	17,0151	15,6827	- - - -
30	S. 49. 30 E.	10,00	- - - -	6,4945	7,6041	- - - -
	Sums in 30 courses.	762,17	00,1447	486,3582	507,9447	16,5451
31	S. 44. 45 E.	12,00	- - - -	8,5222	8,4482	- - - -
32	S. 26. 00 E.	21,50	- - - -	19,3241	9,4250	- - - -
33	S. 7. 30 E.	19,20	- - - -	19,0357	2,5061	- - - -
34	S. 4. 00 W.	11,77	- - - -	11,7413	- - - -	0,8210
35	S. 10. 00 E.	23,14	- - - -	22,7884	4,0182	- - - -
36	S. 26. 00 E.	26,20	- - - -	23,5484	11,4853	- - - -
37	S. 11. 00 W.	28,00	- - - -	27,4856	- - - -	5,3426
38	S. 17. 15 E.	24,07	- - - -	22,9873	7,1377	- - - -
39	S. 43. 30 E.	17,35	- - - -	12,5851	11,9429	- - - -
40	S. 59. 45 E.	16,93	- - - -	8,5290	14,6247	- - - -
	Sums in 40 courses.	962,33	00,1447	662,9053	577,5328	22,7087
41	S. 40. 50 E.	15,87	- - - -	12,0075	10,3768	- - - -
42	S. 28. 00 E.	23,50	- - - -	20,7492	11,0326	- - - -
43	S. 63. 00 E.	19,36	- - - -	8,7892	17,2499	- - - -
44	S. 36. 45 E.	49,00	- - - -	39,2614	29,3179	- - - -
45	S. 19. 10 E.	40,87	- - - -	38,6045	13,4183	- - - -
46	S. 10. 00 W.	14,00	- - - -	13,7873	- - - -	2,4301
47	S. 5. 45 W.	28,53	- - - -	28,3875	- - - -	2,8584
48	S. 72. 00 E.	8,00	- - - -	2,4721	7,6084	- - - -
49	S. 61. 30 E.	16,76	- - - -	7,9972	14,7290	- - - -
50	S. 29. 45 E.	12,65	- - - -	10,9827	6,2771	- - - -
	Sums in 50 courses.	1190,87	00,1447	845,9439	687,5428	27,9972
51	S. 60. 00 E.	32,70	- - - -	16,3500	28,3190	- - - -
52	S. 48. 45 E.	6,00	- - - -	3,9560	4,5110	- - - -
53	S. 70. 00 E.	14,50	- - - -	4,9593	13,6255	- - - -
54	S. 42. 00 E.	10,25	- - - -	7,6172	6,8586	- - - -
55	S. 5. 20 E.	13,50	- - - -	13,4415	1,2548	- - - -
56	S. 2. 00 W.	19,90	- - - -	19,8879	- - - -	0,6945
57	S. 18. 00 W.	7,80	- - - -	7,4183	- - - -	2,4103
58	S. 2. 30 W.	17,60	- - - -	17,5832	- - - -	0,7677
59	S. 19. 5 E.	33,18	- - - -	31,3249	10,9391	- - - -
60	S. 40. 40 E.	30,58	- - - -	23,1952	19,9276	- - - -
	Sums in 60 courses.	1376,88	00,1447	991,6774	772,9784	31,8697
61	S. 42. 30 E.	52,00	- - - -	38,3384	35,1307	- - - -
62	S. 20. 30 E.	33,00	- - - -	30,9102	11,5568	- - - -
63	S. 23. 45 E.	17,46	- - - -	15,9813	7,0319	- - - -
64	S. 38. 00 E.	33,00	- - - -	26,0043	20,3168	- - - -
65	S. 21. 00 E.	24,54	- - - -	22,9101	8,7943	- - - -
66	S. 29. 00 E.	35,40	- - - -	30,9615	17,1623	- - - -
67	S. 47. 00 E.	22,72	- - - -	15,4950	16,6163	- - - -
68	S. 13. 00 W.	34,00	- - - -	33,1286	- - - -	7,6483
69	S. 77. 00 E.	1,79	- - - -	0,4027	1,7441	- - - -
	To the center of Philadelphia observatory.					
	Total Sums,	1630,79	00,1447	1205,8095 00,1447	891,3616 39,5180	39,5180
			Total Southing,	1205,6648	851,8436 Total Easting.	

Then



	Chains.	Log.
Then NA diff. of lat.	1205,6648	3. 0812265
To AE depart.	851,8436	2. 9303599
As Rad.		10. - - -
To Tang. of ENA the ∠le of the course 35°. 14′. 33″,08		9. 8491334
And Sine of 35°. 14′. 33″,08		9. 7612048
To Rad.		10. - - -
As 851,8436		2. 9303599
To NE, the distance in a strait line=1476,2336 Chains.		3. 1691551

But the course of NE being 35°. 14′. 33″. E. with respect only to NA the *magnetic south*; add the variation - - - 3. 8. 0

Which gives 38. 22. 33 E. for the course of NE with respect to NS the true meridian.

So that the true course and distance from Norriton observatory to Philadelphia observatory, in a straight line, NE is S. 38°. 22′. 33″ E. 1476,2336 chains.

Then Rad.		10. - - -
To cosine of	38°, 22′. 33″	9. 8942913
As NE	1476,2336	3. 1691551
To NS true diff. of lat.	1157,3013	3. 0634464
And Rad.		10. - - -
To sine of	38°. 22′. 33″	9. 7929637
As NE.	1476,2336	3. 1691551
To SE true diff. of long.	916,4713	2. 9621188

Thus we have—

Chains. Feet.

Norriton observatory, from Philad. observatory, { North, 1157,30=76381,8=12′. 35″,7 difference of latitude. West, 916,47=60487,02=00′. 52″ of time=13′ diff. of longitude=9′,95 of a great circle, or geographic mile.

But the observatory in the State-House Square, with respect to the south point of the city of Philad. (to which Messrs. Mason & Dixon refer their observations), is, { Chains. Feet. N. 40,0685=2644,5=26″,16 diff. of lat. W. 28,7695=1898,8=1″,6 of time.

Therefore Norriton observatory, with respect to the southernmost point of Philadelphia is,

Chains. Feet.

North, 1157,30 +40.0685=1197,3685=79026,3=13′. 01″,86 difference of latitude.
West, 916,47 +28,7695= 945,2395=62385,8=00′. 53″,6 of time.

Hence, by the above measurement and work, we get Norriton observatory 52″ of time west of the observatory in the *State-house* square; which is exactly what we got, by that excellent element, the *external contact* of Mercury

 with

with the Sun November 9th, 1769. The *internal contact* gave it something more; owing no doubt to the difference that will arise among observers, in determining the exact moment when the thread of light is compleated; and the mean of all our other observations, gives the difference of meridians, between *Norriton* and *Philadelphia*, only 4″ of time more than the terrestrial measurement, and the external contact of *Mercury* gave it, which may be taken as a very great degree of exactness for celestial observations; if we consider that the difference of meridians, between the long established observatories of *Greenwich* and *Paris*, as Mr. De La Lande writes, November 18th, 1762, was not then determined within 20″ of time. For he says "some called it 9′. 15″; others 9′. 40″; but that he himself commonly used 9′. 20″, though he could not tell from what observations it was deduced." And it may be needless to add that a short distance is as liable to the differences arising from the use of instruments in celestial observations, as a greater one. Nevertheless, if we apply the difference of meridians between Philadelphia and Norriton, got by this measurement (viz. 52″, instead of 56″,) to the Revd. Mr. *Ewing*'s collection of Jupiter's satellites, (p. 55), rejecting those of the 2d sat. and also the immersions of May 5th, as too near the opposition, we shall get Philadelphia, 5$^{h.}$ 0′. 37″, and Norriton, 5$^{h.}$ 1′. 29″, west from Greenwich. This result is what ought to arise from a diminution of 4″ of time in the difference of meridians, by dividing that difference, and bringing the one meridian 2″ more west, and the other 2″ more east; and we believe future observations will confirm this as exceeding near the truth.

The latitude of *Norriton* comes out, by the measurement, 25″,09 less north, with respect to the southernmost point of the city of Philadelphia, than Mr. *Rittenhouse*'s observations give it; and if the latitude of that point of the city be taken, as fixed by Messrs. *Mason* and *Dixon*, at 39°. 56′. 29″,4 then the lat. of *Norriton* (neglecting fractions of seconds) will be 40°. 9′ 31″ instead of 40°. 9′. 56″. However,

ever, as both were fixed by celeſtial obſervations, and experienced men, the ſmall difference ought perhaps to be divided; and if a mean be taken to reconcile it with the terreſtrial meaſure, the lat. of the ſouth point of Philadelphia would be 39°. 56′. 42″; and that of *Norriton* 40°. 9′. 43″. But. as Mr. *Rittenhouſe* had only *Siſſon*'s two and an half feet quadrant, and Meſſrs. *Maſon* and *Dixon* were furniſhed with a compleat aſtronomical ſector, and did their work to fix the lines of two provinces, it may be thought that their determination is moſt to be relied on. Nevertheleſs, the whole difference of 25″ in the celeſtial arc is ſo inconſiderable, as not to give 40 chains on the ſurface of the Earth.

All the reſult in the above work are got without any ſenſible error, by plain trigonometry, as the different arcs are ſo very ſmall. In eſtimating the length of a degree, to deduce the difference of latitude between the two obſervatories, the ſpheroidal figure of the earth was taken into conſideration; and the degree meaſured by Meſſrs. *Maſon* and *Dixon*, in mean latitude 39°. 12′, = 363771 feet, was made the ſtandard, which being lengthened in the ratio of 59, 7866 to 59,8035 gave 363874 for a degree of the meridian in the mean latitude between Philadelphia and Norriton, which is only 103 feet more than the deg. in lat. 39°. 12′, and makes but a fraction of a ſecond difference in the latitude, ſo that it might have been diſregarded. With reſpect to ſeconds of time in longitude, no ſenſible difference can be obtained in the ſmall diſtance of about 11 miles, whether we conſider the earth as a ſphere of ſpheroid.

In bringing out the 52″ of time diff. of long. a degree of the equator was taken in proportion to Meſſrs. *Maſon* and *Dixon*'s deg. of the merid. in lat. 39″,12, in the ratio of 60 to 59,7866, (agreeable to Mr. *Simſpon*'s table) which gave 365070 for a degree of the equator. By taking a degree of longitude as fixed at the middle point by Mr. *Maſkelyne* in lat. 38°. 7′. 35″, and ſaying as the coſine of that lat. is to coſine of mean latitude between Philadelphia

phia and Norriton, ſo is the length of a degree of long. at the middle point (viz. 284869,5 feet) to the length of a deg. in mean lat. between Norriton and Philadelphia, the reſult was got $52'',13$; being only *thirteen hundreth parts* of a ſecond of time more.

The above account of the work was thought proper, that thoſe who will take the trouble may examine and correct it if in any part neceſſary.

Philadelphia, Auguſt 17, 1770. WILLIAM SMITH.

To the AMERICAN PHILOSOPHICAL SOCIETY, *held at* Philadelphia *for promoting uſeful knowledge.*

GENTLEMEN,

AGREEABLE to the order of laſt meeting, we have collected into one general and ſhort view (from the laſt, or 59th vol. of the philoſ. tranſactions), the following account of the different obſervations of the late tranſit of Venus made in Europe and other diſtant places; containing the *apparent times* of the contacts; the latitude and longitude of the places of obſervation, ſo far as known to us, with ſuch other circumſtances, as we judged proper for anſwering the end you had in view; namely the affording materials to perſons of a curious and mathematical turn, who might be deſirous of enquiring what parallax of the Sun, may be deduced from a compariſon of theſe diſtant obſervations, with thoſe made in this Province, by your appointment. We are, &c.

Nov. 16th 1770.
WILLIAM SMITH, HUGH WILLIAMSON,
JOHN EWING, THOMAS COMBE,
OWEN BIDDLE, D. RITTENHOUSE.

Apparent times of the CONTACTS *of the limbs of the* SUN *and* VENUS; *with other circumſtances of moſt note, in the different* EUROPEAN OBSERVATIONS *of the* TRANSIT, *June 3d*, 1769.

MIDDLE TEMPLE. lat 51°. 30′. 50″ N. lon. 25′ of time * Weſt. By Mr. *Horſefall*, with a Gregorian reflector; mag. power 100 times.

h.	m.	ſec.	
7.	11.	$5\frac{3}{4}$	A penumbra obſerved to ſtrike into ☉'s limb. At 8″ more, viz.
7.	11.	$13\frac{1}{4}$	♀ had made a viſible dent near the vertex of ☉'s limb.
8.	28.	$49\frac{3}{4}$	internal contact. The light juſt cloſing round ♀.

SHIRBURN

* The different longitudes are ſet down in time, Eaſt or Weſt with reſpect to the royal obſervatory of Greenwich, as the firſt meridian.

SHIRBURN CASTLE, the feat of Lord *Macclesfield*. lat. 51°. 39′. 22″. N. long. 3′. 57″ Weft.

H. m. fec.		
7. 7. 4	Ext. contact	By Mr. *Bartle*, Lord *Macclesfield*'s obferver; with 14 feet refractor, mag. power 60 times.
7. 25. 26	Internal ditto	

7. 25. $28\frac{3}{4}$ Internal contact, by Lord *Macclesfield*; judged by the thread of light clofing round ♀. With a treble object glafs refractor $3\frac{1}{2}$ f. power 150. times.

7. 25. $16\frac{1}{2}$ internal contact, by Lady *Macclesfield*, with a 6 f. refractor.

OXFORD Lat. 51°. 45′. 15″ N. Long. 5′. 4″ Weft.

7. 5. 58	Part of Venus's diameter entered on the Sun, he judges the external contact to have happened a few feconds fooner than this.	By Mr. Hornfby, Sav. Prof. Aftr. The Ext. Cont. with a 12f. refractor. Power 68.
7. 23. 16	Reg. circumferences in contact.	
7. 24. $13\frac{1}{4}$	Int. Contact judged of by the completion of the thread of light. About 10″ later than this, viz. 7h. 24′. 23″. the thread of light appeared in breadth= $\frac{1}{10}$ of ♀'s diam. fo that he concludes the true internal contact was about 1′ fooner, viz. at 7h. 23′. 15″. ♀'s diameter meafured, on a mean of fix meafures, 58″,1.	The int. contact with a double object glafs refractor $7\frac{1}{2}$ feet power 90 times
7. 6. 12	External contact certainly paffed, having perceived a fmall impreffion feveral feconds fooner.	By Mr. Lucas of New-College, with a 6 feet Acrom. telefcope power 60.
7. 24. 28	Int. contact, thread of light entirely completed.	By Mr. Clare of St. John's College, with the fame telefcope.
7. 6. 0	♀ fomewhat entered	By Mr. Sykes of Brazen-Nofe College, with $3\frac{1}{2}$ feet Acromatic Telefcope.
7. 24. 22	Int. contact, or thread of light compleated.	
7. 6. 8	External contact.	By Mr. *Shuckburgh* of *Baliol College*, who thinks that at 7h. 23′. 16″ the center of ♀ was removed more than half her diam. from ⊙'s limb, and that the true Internal Contact was then actually paffed. He thinks at leaft 8″ or 10″ are to be allowed for the completion of thread of light.
7. 24. 25	Thread of light complete.	
7. 6. 44	Ext. Contact	By Mr. *Nikitin* of *St. Mary Hall*, — Both with fmall telefopes.
7. 24. $15\frac{1}{2}$*	Internal ditto	
7. 6. 29	Ext. Contact	By Mr. *Williamfon*. — Both with fmall telefopes.
7. 24. $10\frac{1}{2}$	Internal ditto	
7. 5. 39	Ext. Contact	By *Samuel Horfley*, LL. B. with an 18 inch Reflector.
7. 24. 28	Internal ditto	

* When there are fractions of feconds, it is not to be imagined that feconds were divided in pronouncing the times of the contacts by the clocks; but the fractions arife in applying the equation to reduce mean into apparent time.

KEW. 1′. 14″ Weft.

7. 9. 59	A fudden boiling or tremor on ⊙'s limb.	By Dr. Bevis, with a $3\frac{1}{2}$ feet Reflector of 6 inches aperture, and a magnifying power of 120 times.
7. 10. 7	A fmall indent. and fignal given for External Contact.	
7. 28. 8	Limbs tangentical, but ♀ quite entered on ⊙, though ftill joined to his limb by a flender tail or ligament, but not fo black as her difk.	
7. 28. 17	The tail vanifhed fuddenly.	

SPITAL SQUARE. Lat. 51°. 31′. 15″ Long. 17″ W.

7. 10. $44\frac{1}{4}$	Ext. Contact,	By Mr. *Canton*, with a Telefcope magnifying 95 times. ♀'s diam. 59″ on a mean of 4 meafures. ⊙'s diam. 31′. 35″$\frac{1}{2}$.
7. 29. $15\frac{3}{4}$	Internal ditto	

HAMMERSOST

HAMMERFOST ISLE, (in Danish Lapland) near the North-Cape of Europe.
Lat. 70°. 38′. 22″,5 N. Long. 1h. 34′. 55″. E.

— — — Ext. cont. at Ingress not seen, by reason of clouds; but

At 13h. 50′. 0″ per clock, Or 9. 2. 27 ap. time. — Mr. *Jeremiah Dixon*, (who conducted the observation, with a 2 f. Refractor) had an instantaneous view of the Sun through a thin cloud; when Venus seemed completely entered, but no thread of light; the air at this time very hazy, and the Sun was immediately hid again in a cloud.

N. B. Mr. Dixon's clock was kept near siderial time, and as she appears at the noon of June 3d, to be 4h. 49′. 3″ faster than apparent time, gaining thereof 3′. 59″,6 per day, she was at the time of the above hasty glimpse of the internal contact, 4h. 47′. 33″ faster than apparent time.

ISLE MAGGEROE, (near the North Cape of Europe) lat. 71°. 0′. 47″. N. long. 1h. 44′. 6″ of time East.

By Mr. *Bayley* assistant observer at the royal observatory, Greenwich; with a 2 feet reflector.

— — — 1st Cont. not seen, the Sun being in a cloud.
9. 14. 1 ♀'s outer limb in cont. with ☉'s limb, but still joined by a black protuberant ligament.
9. 14. 56 The ligament broke; but the air very red and hazy, & in 10″ or 15″ ♀ appeared $\frac{1}{20}$th part of her diameter within ☉'s limb.

LEICESTER; lat 52°. 37′. 3″ N. long. not given; but may be deduced from beginning of ☉ ecl. 18h. 35′. 21″. end of ditto - - 23. 21. 2.

7. 7. 1 Ext. cont.
7. 25. 9 Int. ditto.
By Rev. Mr. *Ludlam*, with a triple object glass acromatic telescope of $33\frac{1}{3}$ inches; its mag. power 54 times.

QUEBEC, viz. Captain *Holland's* House, S. 56°. W. of the Castle of St. Lewis, $2\frac{1}{2}$ miles.
H. m. sec. Lat. 46°. 47′. 17″. N. long. 4h. 44′. 41″. W.

2. 30. $3\frac{1}{2}$ 1st external contact
— — — 1st internal ditto, missed in a cloud.
By *Samuel Holland*, Esq. Surveyor-General of the Northern District of America. With a Dollond's refractor.

The external contact was likewise observed at the same instant, viz. at 2h. 30′. $3\frac{3}{4}$″, apparent time, by Mr. *St. Germain* of the seminary of Quebec, with a two feet reflector of Short's.

The above latitude of Captain *Holland's* place of observations, is taken from a mean of several results of the latitude, deduced by himself. He has not deduced his longitude, but he has given the following eclipses of Jupiter's first satellite for that purpose, observed with his Dollond's refractor, viz.

1769. Immersions.	Apparent time.	Emersions.	Apparent time.
March 11.	14h. 50′. 47″,7	May 28.	14h. 5′. 44″,7
April 3.	15. 7. 24	June 6.	10. 28. 2,6
19.	13. 27. 41,5		

By a *mean* of the above three immersions, compared with the Nautical Almanac, and applying the corrections which, (by the immersions observed at Greenwich), the almanac seems to require at this time, the difference of meridians of Greenwich and Captain Holland's observatory is 4h. 44′. 35″.

By a mean of the two emersions, compared with the almanac, and applying the necessary correction, the difference of meridians is 4h. 44′. 47″.

The mean of these two results, viz. 4h. 44′. 41″ is the longitude set down above.

ISLE COUDRE; lat. 47°. 17′ 00″ N. long. East of Quebec 3′. 6″. or 4h. 41′, 26″ W. of Greenwich.

2. 32. 56 A small impression on ☉'s limb; external contact a few seconds past.
2. 50. 19 ♀ completely round; or regular circumferences in contact.
2. 50. 50 Thread of light compleated, or internal contact.
By Mr. *Wright*, Deputy Surveyor of the Northern District of America; with a two feet reflector.

SWEDISH OBSERVATIONS.

CAJANEBURG; lat. 64°. 13′. 30″. N. long. 1h. 50′. 47″. E. of Greenwich.

9. 20. $45\frac{1}{2}$ 1st internal contact; lig. just breaking.
15. 32. 27 2d external contact; or total egress, ☉ shining extremely bright.
By Mons. *Planman*; with a 20 feet reflector. He missed the 1st ext. contact in a cloud, and after the 1st int. contact a night of thunder and storm ensued; yet next morning, a little after the 2d int. contact the Sun shone out, and gave him an opportunity of observing the total egress to great satisfaction, at the time marked in the margin.

STOCKHOLM; lat. 59°. 20′. 30″ N. long. 1h. 12′. 26″ E.

H. m. ſec.		
8. 24. 8.	1ſt ext. contact.	By Monſ. *Ferner*, with a 10 feet acromatic teleſcope, magnifying power 90 times.
8. 41. 48.	1ſt int. ditto.	
8. 24. 5	1ſt external contact.	Monſ. *Wilcke*, with 1½ feet reflector.
8. 41. 2	Regular circumferences in contact.	
8. 41. 45	The ligament broke, and ♀ appeared ſomewhat within ☉	
8. 23. 51	External contact.	Monſ. *Wargentein*, with 21 feet refractor.
8. 41. 32	Circumferences in contact internally.	
8. 41. 47	Int. contact; the ligament broke.	

UPSAL; lat. 59°. 51′. 50″ N. long. W. of *Stockholm* 1′. 40″, or 1h. 10′. 46″ E. of *Greenwich*.

- - - -	External contact not ſeen.	Monſ. *Stroemer* with a 3 feet reflector.
8. 39. 58	Regular circumferences in contact.	
8. 40. 32	Internal contact, the ligament broke, and circumferences ſeparated.	
8. 22. 1	External contact.	M. *Melander* with a 20 feet refractor.
8. 39. 57	Circumferences in contact internally.	
8. 40. 12	Thread of light completed, or int. contact.	
- - - -	External contact not ſeen.	Monſ. *Bergman* with a 21 feet refractor.
8. 40. 9	The ligament broke at the int. contact.	
8. 22. 12	External contact	Monſ. *Proſperin* with a 16 feet refractor.
8. 40. 12	Internal ditto, the ligament broke.	
8. 22. 15	External contact; a diſtinct dent in ☉'s limb	Monſ. *Salenius*, with a 12 feet refractor.
8. 39. 46	Regular circumferences in contact.	
8. 40. 15	Thread of light completed, or int. contact.	

GLASGOW; lat. 55°. 51′. 32″ N. long. reckoned 17′. 11″. * Weſt.

6. 54. 31,4	External contact.	By Dr. *Wilſon*, Prof. of Aſtronomy in the College of Glaſgow.
7. 11. 56,7	Int contact; judged by the completion of the thread of light round ♀.	
6. 54. 28	External contact.	By Dr. *Williamſon* and Dr. *Reid*, throwing the ☉'s image of about ſix inches diameter, on white paper, into a dark room; through a Dollond's refractor of 29 inches focus.
7. 10. 24	Reg. circumferences judged in contact.	
7. 12. 24	Int. contact judged by the completion of the thread of light round ♀.	
6. 54. 28	External contact.	By Mr. *Wilſon* (ſon of Profeſſor *Wilſon*) with a reflector of 1 f. of Short's.
7. 12. 24	Int. cont. Thread of light compleated	

N. B. Dr. *Wilſon* writes, that his ſon thinks, he would have given the external contact 8″ ſooner, had he been obſerving apart; but was kept in doubt whether the impreſſion he firſt ſaw was really ♀ on ☉, by finding that Dr. Reid had not then obſerved any impreſſion. The internal contact, he adds, was noted by his ſon, without any notice of the time given by the other two.

HAWKHILL; the ſeat of Lord *Alemoor*; lat. 55°. 57′. 30″ N. long. 12′. 45″ Weſt.

6. 59. 48¾	External contact.	By Lord *Alemoor*, with an 18 inch reflector.
7. 16. 47¼	Internal ditto,	
6. 59. 45¾	External contact.	By Mr. *James Hoy*, with a 3½ feet acromatic teleſcope, power 150 times.
7. 16. 50¼	Internal ditto,	
6. 5. 46	External contact.	By Dr. *Lind*, with a 2 feet reflector. Power 100:
7. 16. 52	Internal ditto,	

Dr. Lind writes, that he ſuſpects all the external contacts at this place were too late. The internal contacts were all carefully judged of by the completion of the thread of light round ♀ and the time accurately noted down. The above latitude of Hawkhill, which lies about 1½ mile

* See p. 19. Some eclipſes of Jupiter's ſatellites for the further aſcertaining the longitude of Glaſgow, in reſpect of the Royal obſervatory, Greenwich.

mile N E. of Edinburgh is given from Dr. Lind's lateſt obſervations; and the longitude (viz. 12′. 45″ of time) is taken from a mean of two reſults, deduced by the aſtronomer royal from Dr. Lind's obſervation of the eclipſe of the Moon in December, 1769. The longitude of Hawkhill may be further deduced from the end of the Solar eclipſe obſerved there June 3d, 1769, which was at 20h. 19′. 45″ apparent time.

KIRKNEWTON; lat. 55°. 54′. 30″ N.

H. m. ſec.
7. 14. 28¼ Internal contact. Judged of by the completion of the thread of light. This obſervation was made by the Rev. Mr. *Bryce*. He did not ſee the external contact; nor has he fixed the longitude of his place of obſervation. He ſays it is 17 miles Weſt of Hawkhill. But the longitude may be deduced pretty near the truth from the end of the ſolar eclipſe, which was obſerved here at 20h. 18′. 23″ apparent time.

GIBRALTAR; lat. 36°. 4′. 44″ N.

6. 51. 8 External contact. }
7. 8. 21 Internal contact. } By Lieutenant *Jardine*.

The longitude of this place is not fixed; but for fixing the ſame Mr. *Jardine* gives the following obſervations, viz.

June 8th,	1ſt ſat. emer.	9h. 22′. 34″	clock 1′. 16″½	before mean time.
15th,	1ſt ſat. emer.	11. 15. 54½	clock 1. 28	before mean time.
25th,	3d ſat. emer.	11. 59. 56	clock 1. 44	before mean time.

CAMBRIDGE, New-England; lat. 42°. 25′. N. long. 4h. 44′. Weſt.

2. 30. 4 External contact. }
2. 47. 30 Internal ditto, } By *John Winthrop*, Eſq. F. R. S. Holliſian Profeſſor of Mathematics.

He makes ☉'s horizontal diameter at 9 in the morning=31′. 33″,2; and ♀'s diameter 58″,6, the leaſt diſtance of the centers 9′. 59″,7; ſo that the true duration of the ingreſs ſhould be 18′. 56″; but this being contracted at Cambridge 15″ by parallax leaves 18′. 41″, and therefore he thinks the 1ſt contact happened nearly 1′. 15″. before the impreſſion was diſcovered by him. The time of the neareſt approach of the centers he makes at 5h. 37′; all apparent time.

Mr. Winthrop, with a power of the great teleſcope, magnifying 260 times, could perceive no ſuch duſkineſs round ♀ when on ☉, as he ſaw at the internal contact, nor that imperfect light which Mr. Dunn mentions in reſpect to the tranſit of 1761. He gives the above longitude as near the truth; but for the better fixing his longitude, he adds the following eclipſes of Jupiter's ſatellites, as obſerved at Cambridge, New-England, viz.

1768.	Apparent time. 1ſt Sat.	1769.	Apparent time. 1ſt Sat.
April 25.	9h. 13′. 52″	May 14.	10h. 19′. 7″
May 18.	9. 27. 27	Aug. 23.	7. 31. 50
June 10.	9. 37. 25		
July 3.	9. 45. 54	June 7.	9. 1. 15 2d Sat.

FRENCH OBSERVATIONS.

PARIS.

H. m. ſec.		
7. 38. 43	Int. cont.	M. *Meſſier*, with an acromatic teleſcope, 12 feet focus, aperture 3¾ inch. Power 180.
7. 38. 33	Int. cont.	M. *Du Sejour*, } with ſmaller teleſcopes.
7. 38. 43	Int. cont.	M. *Caſſini* the ſon. } with ſmaller teleſcopes.

MEUTE, near Paris.

7. 38. 45 Internal contact. Meſſ. *de Fouchy*, *Bailly*, *de Borry*, and two opticians.

ROYAL OBSERVATORY of PARIS; lat. 48°. 50′. 14″. N. long. 9′. 15″ E.

7. 38. 53	Int. cont.	M. *Caſſini de Thury*,	Both with 3½ feet acromatic teleſcopes of Dollond.
7. 38. 57	Int. cont.	Duke *de Chaulnes*	Both with 3½ feet acromatic teleſcopes of Dollond.
7. 38. 50	Int. cont.	M. *Maraldi*,	with a 3 feet ditto, made at Paris.

ST. HUBERT.

7. 38. 51 Internal contact. M. *Le Mannier*.

BORDEAUX.

7. 38. 50. Internal contact. *M. Foguere*.

BREST.

7. 38. 58 Internal contact. M. *Verdun*.

All

All the above obſervations of the *Internal Contact*, are reduced to the time of the royal obſervatory of Paris, allowing for the difference of meridians, &c.

N. B. The *External Contact* was miſſed by all the French obſervers, the Sun being in a cloud. Monſ. *Meſſier* meaſured the diameter of ♀, and found the greateſt meaſure 56½″; and the leaſt 53″½.

CAPE FRANCOIS; Lat. 19°. 47′. Long. not given.

H. m. ſec.
2. 26. 12 Ext. cont. } Monſ. *Pingré*, with a 5 feet acromatic teleſcope.
2. 44. 44 Int. ditto. }

M A R T I N I C O.

3. 15. 14 Ext. cont. } By a miſſionary. Neither latitude nor longitude given.
3. 33. 57 Int. ditto. }

AUSTIN AFFAIRS, London; 3″ of time eaſt of St. Paul's*; that is 18″½ weſt of Greenwich.

7. 10. 28¾ Ext. cont. } Mr. *Albert*, with a 2 feet reflector; power 110. He ſays that 6′
7. 29. 00¾ Int. ditto. } after the time marked for the internal contact the light of ☉'s limb was completed.

WINDSOR CASTLE; lat. 51°. 28′. 15″. N. long. 2′. 24″½ W.

7. 8. 29¾ Ext. cont. } By Mr. *Harris*, mathematical maſter, of Chriſt's Hoſpital; with
7. 26. 37½ Int. ditto. } an 18 inch reflector of *Short*'s power 55 times. ♀'s diameter he makes 59″½; ☉'s diameter 31′. 42″.

EAST DEREHAM, Norfolk; Lat. 52°. 40.

7. 14. 54¾ Ext. cont. } By Rev. Mr. *Wollaſton*; who likewiſe obſerved the, Beginning of ☉'s eclipſe at 18h. 44′. 39″
End of the ſame at 20. 30. 23.

P. S. The following liſt of correſpondent eclipſes of Jupiter's ſatellite are given, for the better aſcertaining the difference of meridians of Greenwich and Glaſgow.

G L A S G O W O B S E R V A T O R Y.

1762. Apparent Time.
Sept. 11. Im. 10h. 55′. 33″½ }
Oct. 4. Im. 11. 13. 22½ } Good.
1763. Nov. 1. Im. 9. 28. 29⅓ }
1765. Dec. 22. Im. 15. 54. 25 indiff.

The above obſervations were made by Dr. *Wilſon*, with a reflector of *Short*'s of 18 inches.

1762. Apparent Time. CORRESPONDING OBSERVATIONS.
Sept. 11. Im. 11h. 12′. 43″ *Surry-ſtreet*, 2 feet reflector; by Mr. *Maſkelyne*.
Oct. 4. Im. 11. 31 1 } *Surry-ſtreet*. 2 feet reflector, obſerved by Mr. *Short*.
1763. Nov. 1. Im. 9. 45 25 }
1765. Dec. 22. Im. 16. 12 19 *Greenwich*, 6 feet reflector; by Mr. *Maſkelyne*.

N. B. Mr. *Short*'s houſe in *Surry-ſtreet*, where three of theſe four obſervations were made, is 26″½ of time weſt of Greenwich. By comparing the three firſt obſervations in each of the above liſts, making an allowance of 4″½ of time for the difference of the two reflectors; Glaſgow Obſervatory comes out 17′. 10″. weſt of Mr. *Short*'s houſe in *Surry-ſtreet*, or 17′. 36″½ of time weſt of the royal obſervatory but in the above liſt it is only reckoned 17′. 11″ weſt. By an immediate compariſon of the two immerſions of December 22d, allowing 20″ of time for the difference of aperture of the 6 feet reflector, and the reflector of 18 inches, Glaſgow will come out 17′. 34″ weſt of Greenwich; agreeing within 2″ with the reſult obtained from the three former obſervations.

I. *An Account of the Contacts of the limbs of* VENUS *and the* SUN, *June 3d*, 1769, *as obſerved by the Right Hon.* WILLIAM *Earl of* STIRLING, *at his ſeat at Baſkenridge, New-Jerſey.*

Apparent Time. Lat. 40°. 40′. N. long. 4h. 58. of time weſt.
2h. 16.′ 00″ Firſt diſcovery of the external contact at the ingreſs.
2. 34. 12 Total ingreſs.

The above account is extracted from his Lordſhip's letter of June 29th, 1770, to the Rev. Dr. *Smith* Provoſt of the College of Philadelphia, and was communicated to the Society, July 20th

* St. Paul's London is 22″½ Weſt of the royal obſervatory; and its latitude 51°. 30′. 45″.
N. B. The latitude of the royal obſervatory at Greenwich, is 51°. 28′. 37″.

following, together with his Lordſhip's obſervations of the comet, which are inſerted below. He writes that he had no opportunities of making any other obſervations reſpecting the *tranſit* of Venus except the contacts, and that his clock was properly regulated.

2. *Obſervation of the contacts of the limbs of* VENUS *and the* SUN, *June 3d,* 1769, *made by Mr.* William Poole, *at Wilmington, in Pennſylvania.*

Lat. * 39°. 44′. 3″. N. Long. 5h. 2′. 9″. W.

Extracted from a letter to Mr. *Owen Biddle*, and communicated to the Society, Dec. 21ſt 1770.

Apparent Time.		
2h. 12′. 48″¾	1ſt Ext. cont.	With a refractor of 12 feet magnifying power about 50 times. Mr. *Poole* thinks the external contact was ſeveral ſeconds before the time marked in the margin.
2. 30. 20½	1ſt Int. ditto.	The internal contact was taken juſt as the Sun's light began to ſurround the planet; though his limb was not viſible beyond the planet, till a ſecond or two afterwards.

To the AMERICAN PHILOSOPHICAL SOCIETY, *held at* Philadelphia *for promoting uſeful knowledge.*

GENTLEMEN,

I TAKE the liberty of communicating to you an improvement in the conſtruction of *Godfry*'s double reflecting quadrant, which I have diſcovered about two years ago, which may be of ſervice to ſuch as uſe that excellent inſtrument. The greateſt inconveniencies ariſing from the former conſtruction of it are owing to the badneſs of the glaſſes, the planes not being ground parallel to each other, and to its ſtanding in need of a new and careful adjuſtment almoſt every time it is uſed. Both theſe imperfections, I apprehend, are thoroughly removed by the new conſtruction propoſed. I have heard, that Mr. William Grant, an ingenious mathematician of London had alſo made ſome improvement in that inſtrument; but I had not heard it before eighteen months had elapſed, after I had perfected my demonſtration of it, and ſpoke to the workman to conſtruct it accordingly.

As the propoſed alteration makes the inſtrument capable of affording a number of obſervations, the unavoidable errors

* Mr. *Poole* had no opportunity of aſcertaining the latitude or longitude of Wilmington by celeſtial obſervations, but they are both to be gotten with ſufficient exactneſs from Mr. *Biddle*'s meaſurement between New-Caſtle and the Philadelphia obſervatory p. 87. From that meaſurement, we get Wilmington weſt of Philadelphia obſervatory 6741¾ perches=23′. 38″,8 diff. of meridians, or 1′. 34″,6 of time; and ſouth of the ſame 4732½ perches=12′. 52″,6 diff. of latitude. Whence the latitude and longitude of Wilmington in reſpect to Greenwich, are as above ſet down. *W. SMITH.*

rors arifing from them may be greatly leffened, by taking a mean of them: So that angles may be meafured by it with much greater precifion than can be attained by the common quadrants. This will make it peculiarly ferviceable for finding the longitude at fea, from the obferved diftance of the Moon from the Sun, or from a known ftar near her path. For unlefs this diftance is meafured accurately, it will occafion a confiderable error in the deduced longitude.

That the inftrument may anfwer thefe purpofes, it is defigned that the arch fhall contain an hundred and twenty whole degrees, and be numbered from the middle to 120 both ways, and that inftead of one central fpeculum two fhould be affixed to the index, and inclined to each other in an angle of 60 degrees. When they are once adjufted to this inclination, let them be fcrewed faft by the inftrument maker.

Now the largenefs of the arch will enable us to meafure much greater angles than can be meafured by the fore obfervation of the common octant. If the Sun be within 30 degrees of the zenith, the double fextant will give his altitude either above the fouthern or northern horizon, as may be moft convenient; or for the fake of greater precifion, both may be taken in the fame manner as by the fore obfervation; and then half the difference between their fum and 180 degrees, being added to the leffer altitude when the fum is lefs than 180 degrees, or fubtracted from it, when greater, will give his true altitude from neareft horizon more accurately than either of them feparately could give it. This may be done by one central fpeculum alone and one half of the arch. The fame may be repeated by the other, and the mean of all the four obfervations taken as ftill nearer to the truth. Hereby the error of adjuftment is taken away, and that of the obfervations, leffened. Or thefe errors may be corrected by the mean of four obfervations, when only one horizon can be made ufe of, in the following manner. Let the altitude be taken in the common

way,

way, as by a fore obſervation, by one central ſpeculum and noted; let the index be puſhed ſtill farther along the arch and the image of the Sun will again be brought down to the horizon by the other central ſpeculum, which affords another obſervation of the altitude to be noted alſo; counting from the end of the arch next to the obſerver in the firſt caſe, and from the middle of it in the latter. Then let the arch of the inſtrument be held upwards, and the center downwards, and the index be moved the contrary way; this will give two other altitudes. The mean of any two of theſe obſervations that depend on the ſame glaſſes gives the true altitude free from the abovementioned errors. The ſame may be ſaid of taking any other angles.

The inverting of the inſtrument is not neceſſary in taking angles, when it is indifferent which of the objects is brought to the other by reflection; as in meaſuring the diſtance between two ſtars. But when one of the objects is brighter than the other, it is neceſſary to bring the brighter to the other by reflexion, in that caſe it is neceſſary to invert the double ſextant. In other caſes it will be found more convenient to make all the obſervations, by only moving the index both ways.

When the diſtance of two objects is continually changing, and expedition is neceſſary in the obſervation; two or more pieces of braſs ſhould be made to ſlide on the arch of the inſtrument, that the degrees noted by the index may be marked, by bringing one of them up to the index and ſcrewing it faſt to the arch, where it muſt remain, until all the obſervations are made. In the ſame manner may all the obſervations but the laſt be marked; that no time may be loſt in reading off the degrees and minutes and writing them down. When the obſervations are completed, they may be read off, by bringing the index cloſe up to the abovementioned pieces, and written down at leiſure.

That the moving the index backwards, will give the altitude of the Sun or ſtar above the horizon, when the arch hangs

hangs downwards, will appear very evident, by confidering, that the image of the Sun is brought down to the horizon, by pufhing the index from the obferver, and confequently the image of the horizon is alfo funk as much below the true horizon; therefore, when the index is moved in a contrary direction or towards the obferver, the image of the horizon is thereby raifed up to the Sun in the Heavens, and their diftance is fhewn on the arch. But as it is requifite to bring the image of the Sun to the horizon, by moving the index both ways, this is effected by inverting the inftrument; holding the arch downwards, while one obfervation is made, and upwards while the other is made.

The above illuftration is fufficient to anfwer all the purpofes of a demonftration to fuch as are acquainted with the theory and principles of this inftrument; as it fhews, that the demonftration is nearly the fame for the obfervations made both with the arch hanging down, and with it inverted. But as it may be defired by fome, I fhall infert the demonftration for the obfervation with the inverted double fextant, which will fhew more clearly the reafon of graduating the arch both ways from the middle.

Let the double fextant inverted be reprefented by APQR; (See Plate IV. Fig. II.) QAR being the common fextant, and QAP the additional part propofed; in which it is to be proved, that while the index moves from the pofition QCA, to that of AFD, the folar image will move twice as far from S, down to the horizontal line IDG, and will be feen by the eye at I, in the horizontal line IG, parallel to HO; fo that the angle QAD fhall be half of the angle SFH, which is the Sun's altitude.

Let SF be a ray of light from the Sun at S, falling on the fpeculum at F, and from thence reflected to the fpeculum at G, and from thence reflected again to the eye at I, where the folar image will be feen in the horizontal line IG; the fpeculum at G, being fet parallel to the line AQ, or to the larger fpeculum at F, when the index is at Q, or the

the beginning of the graduations. Now it is to be proved, that the angle SFH, is equal to twice the angle QAD, which is the diſtinguiſhing peculiarity of this inſtrument.

DEMONSTRATION.

Since NGM, is parallel to CBA, the angle NGC, is equal to GCB, and the angle MGB, is equal to GBC, being alternate; but the angles NGC, and MGB, are equal from the laws of reflexion, which make the angle of incidence equal to that of reflexion. Therefore GBC is an iſoſceles triangle, having the angles at B, and C, equal.

Again, ſince HFS+SFD=(HFD=QAD+FEA=QAD+ +DEA=QAD+FBC=QAD+QAD +BFA=2QAD+BFA =1QAD+GFA=) 2QAD+SFD. Therefore, HFS=2 QAD.

That the inſtrument may be held with greater eaſe, an handle may be affixed to the back of it, or another ſextant might be added directly oppoſite to the middle of the other two, and the index continued to the oppoſite arches, moving on the center; which would have its advantages eſpecially on land. And as the errors of adjuſtment and obſervation may be corrected without the ſecond central ſpeculum, it may be neglected.

This improvement of an inſtrument, which was firſt invented and conſtructed by Mr. *Godfrey* of this city, and which, I do not heſitate, to call the moſt uſeful of all aſtronomical inſtruments that the world ever knew, I hope will make it ſtill more ſerviceable to mankind. But however this may be, it is ſubmitted with all due reſpect to the ſociety, by

Their very humble Servant,

JOHN EWING.

To

To the AMERICAN PHILOSOPHICAL SOCIETY, *held at Philadelphia, for promoting uſeful Knowledge.*

GENTLEMEN,

SINCE my delivering in the ſhort account of the improvement, which I propoſed in the conſtruction of Mr. *Godfrey*'s double reflecting octant, at a late meeting of this ſociety, I have been induced to ſubjoin a relation of the manner in which I was firſt led into it, and of the time when it was effected. In the beginning of the year 1767, finding that the common arch of the octant was too ſhort, for taking large angles by a fore obſervation, I thought that it might be conveniently enlarged; and ſoon after found that this enlargement might anſwer valuable purpoſes both at ſea and on land. I communicated, to Mr. *Benjamin Condy*, mathematical inſtrument-maker of this city, my propoſal for making the inſtrument with double the uſual arch, and the addition of a ſecond ſpeculum on the index, inclined to the other in an angle of half the length of the arch; as appears by his certificate, which I have here inſerted in the following words, viz.

"*THIS is to certify, That ſometime in the ſpring or ſummer of the year* 1767, *the Revd. Mr. John Ewing, of this city, communicated to me a propoſal of his, for making Godfrey's Sextant with double the uſual arch, and the addition of another ſpeculum affixed to the index, and inclined to the other in an angle of half the enlarged arch; and that we had frequently converſed together on the purpoſes deſigned to be anſwered by this new conſtruction. As witneſs my hand this* 10*th day of January*, 1770.

BENJAMIN CONDY."

About two years after I had thought of this conſtruction of the inſtrument and perfected the demonſtration of it, which I laid before the ſociety on the original ſcrap of paper, on which it was firſt written, I learned by converſing with

with Mr. *William Grant*, an ingenious mathematician and merchant of London, who came to this city about April or May 1769, that he had alſo propoſed an improvement in the ſame inſtrument, but different from mine in theſe reſpects, viz. His was a complete ſemicircle, having the horizon glaſs and place of the eye fixed on the arch, and without the ſecond ſpeculum on the index; which anſwered nearly the ſame purpoſes, with mine; excepting that by its wanting the above mentioned ſpeculum, it afforded but half the number of obſervations which my conſtruction admits of. The firſt intimation I ever had of his improvement was from the Rev. Dr. *William Smith*, provoſt of the college in this city, in May laſt; to whom I had ſome time before mentioned, that I had thought of ſomething, which might be deemed an improvement in the conſtruction of *Godfrey*'s quadrant. This Dr. *Smith* intimated to Mr. *Grant*, upon his informing him that he had improved that inſtrument before he left London; which circumſtance induced the Doctor to promiſe him an introduction to my acquaintance, as appears by his certificate in the following words, viz.

Philadelphia, 12th Jan. 1770.

" REV. SIR,

" *IN anſwer to your requeſt, that I ſhould certify the occaſion of my introducing Mr. Grant to you, I do well remember it to have been as follows.-----That ingenious gentleman having been recommended to my acquaintance, by ſome of my friends to the northward, we happened, one day about the beginning of laſt May, to fall into converſation upon ſome literary ſubjects. Among other things, Mr. Grant mentioned an improvement which he had made in the conſtruction of Godfrey's quadrant, and with a truly communicative ſpirit ſeemed willing to explain the nature of his improvement, by making out a draft or ſketch of it for me. It happened that I was to ſet out the day following, on a journey to Northampton County, and Mr. Grant was apprehenſive*

henſive that he ſhould leave Philadelphia before my return. I then recollected what you had told me ſome time before, concerning your improvement of Godfrey's quadrant, and ſpoke to Mr. Grant as follows: I am ſorry, I am obliged to go out of town to morrow, as I could wiſh to have ſome further converſation on this ſubject; but there is a gentleman of this city, the Rev. Mr. Ewing, who ſome time ago mentioned to me an improvement of a ſimilar nature, which he had made, and I believe he has engaged a workman to finiſh a quadrant for him, on the plan he has projected. Are you acquainted with Mr. Ewing? If not, I will bring you together, for I would wiſh you to compare your ſchemes, and to have a conference with each other. Mr. Grant expreſſed his deſire to be acquainted with Mr. Ewing, and I accordingly introduced them to each other, before I went on my journey.

WILLIAM SMITH."

To the Rev. Mr. Ewing.

Theſe things I have mentioned not from a ſolicitude about the invention, but to ſhew, that, what has often been ſuppoſed probable in affairs of this nature, has actually taken place in the preſent inſtance; that men at the diſtance of many thouſand miles might fall nearly upon the ſame inventions, about the ſame time, without any previous correſpondence or acquaintance with each other. J. E.

An ESSAY *on the Uſe of* COMETS, *and an Account of their* LUMINOUS APPEARANCE; *together with ſome Conjectures concerning the Origin of* HEAT.

By HUGH WILLIAMSON, *M. D.*

Read before the Society, Nov. 16th, 1770.

A COMET is a ſolid dark body revolving round the Sun in ſtated periods, receiving light and heat from the Sun. Comets revolve as other planets do in an ellipſis,

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one part of which is much farther from the Sun than another; ſome of them are very eccentric; that which appeared Anno 1680 was twelve thouſand millions of miles from the Sun in aphelio, it was not half a million in perihelio. The period of the comet which appeared Anno 1758 is 75 years. That of 1661 is 120 years. And that of 1680 is 575 years. Though comets doubtleſs move in an ellipſis, yet from the extreme length of their path, the ſmall part that falls under our obſervation, the difficulty in determining the comet's abſolute diſtance or velocity, &c. we have obtained no certainty concerning the period of any comet except the three I have mentioned, nor ſhall we ever determine their periods in all probability, except by a ſeries of obſervations on the return of each particular comet, which may require ſeveral thouſands of years.

Comets receive their light and heat from the Sun, for they appear to have no light of their own, and are thence inviſible, except on their near approach to the Sun. In the year 1723, an aſtronomer had the fortune to diſcover a comet by means of his teleſcope before it was bright enough to become viſible by the naked eye. The great comet which appeared Anno 1743 ſeemed no larger than a ſtar of the fourth magnitude when firſt diſcovered; as it came down towards the Sun it acquired a tail, and increaſed gradually in ſize and luſtre till it obtained that amazing form with which it terrified half the world. As this comet departed from the Sun, its tail decreaſed, it loſt its brightneſs, till in a ſhort time it became inviſible; this has alſo been the fate of every other comet; hence it is plain that their light, like that of other planets, is borrowed from the Sun.

Having juſt mentioned thoſe general properties in which comets evidently agree with other planets, I ſhall now try to account for that luminous train which attends them on their approach to the Sun, from which they are generally denominated blazing ſtars, and are ſuppoſed to differ eſ-

ſentially

ſentially from every other planet or ſtar. If I ſhould be ſingular in any part of my opinion on this ſubject, I preſume I ſhall be indulged, ſince it is matter of mere hypotheſis.

Comets are not blazing ſtars, they do not burn at all, nor is there any remarkable heat in that tail which has ſo often terrified the nations, and been thought to portend diſſolution to the world itſelf. The comet of 1743 had acquired a tail ſome thouſands of miles long above two months before he paſſed the Sun, while he was yet three hundred millions of miles from the Sun. Surely this could not be a flame of fire kindled by the Sun, elſe comets take fire in a place where every drop of water on this globe would inſtantly freeze. There is no greater reaſon to think that comets burn by their own heat, ſince their tail, whatever it be, as well as their light, evidently depends on the Sun, as we have already explained.

Philoſophers have differed greatly in their attempts to account for the tail of a comet. One imagines that comets are ſurrounded on all ſides by a lucid fiery vapour, or atmoſphere, which on account of the Sun's ſuperior light, is only viſible in the dark, whence we ſee no part of it but that which is in the ſhadow of the comet on the ſide oppoſite to the Sun. According to him their atmoſphere extends in all directions ſeventy or eighty millions of miles, for ſome comets have appeared with a tail of that length, ſo that from the near approach of comets to the earth we muſt frequently have been enveloped in that ſame lucid atmoſphere.

From the extreme viciſſitudes which comets ſeem to endure, at one time penetrated with intolerable cold, at another time blazing with deſtructive heat, ſome have irreverently conjectured that they were deſigned as a place of future reſidence for the unhappy tranſgreſſors in this ſtate, and thus vainly ſuppoſe that fifty or an hundred worlds were created for the ſake of puniſhing the inhabitants of this little globe. It is ſufficient to have mentioned ſuch conjectures.

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The great Sir *Iſaac Newton* was of opinion, that comets were deſigned, among other purpoſes, to nouriſh and refreſh this earth and all the neighbouring planets. He imagined that by vegetation and putrefaction, a great deal of radical moiſture is conſumed or changed into earth; that the tail of a comet is a thick vapour exhaled from the comet by the heat of the Sun, which vapour is ſcattered through the planetary regions, and part of it being received within our atmoſphere, occaſionally ſupplies our loſs of moiſture.

Whatever properties have been aſcribed to heat, it ſeems very clear that evaporation cannot be performed unleſs by means of an atmoſphere whereby the fluid is attracted, ſuſpended and carried off. Therefore if we ſuppoſe that the earth and all the planets are ſupplied with radical moiſture from the comets, we muſt alſo ſuppoſe, that the ſolar ſyſtem is univerſally filled with an atmoſphere ſufficient for attracting and ſuſpending fluids, which hypotheſis would certainly deſtroy our preſent ſyſtem of aſtronomy. Beſides this we may obſerve, that from the moſt accurate chymical analyſis, there ſeems great reaſon to believe, that all the apparent changes in matter depend on combination and ſolution alone. That water may be combined with earth and again ſeparated from it; but, that ſince the creation, this globe has not ſuſtained the abſolute loſs of one ounce of water, or gained one ounce of earth. Therefore we do not require any nouriſhement from the vapour of comets.

I ſee no reaſon to doubt that comets were created like this world, to be the reſidence of intelligent beings; ſome of them no doubt which travel to immenſe diſtances through the Heavens, may be inhabited by an order of beings, greatly ſuperior to this ſhort lived race of mortals, and much better fitted for comprehending and admiring the works of their divine original, which they behold in greater perfection. One of the primary ideas we form of the Supreme Being is, that he is the ſource of life, intelligence and happineſs, and delights to communicate them; the earth

earth we tread, the water we drink, and the very air in which we breathe, ſwarm with living creatures, all fitted to their ſeveral habitations. Are we to ſuppoſe that this little globe is the only animated part of the creation, while the comets, many of which are larger worlds, and run a nobler courſe, are an idle chaos, formed for the ſole purpoſe of being frozen and burnt in turns. We cannot admit the thought; the comets are doubtleſs inhabited. The great viciſſitudes of climate, is the only plauſible objection that has been made to this opinion. The comet of 1680 came within one hundred thouſand miles of the Sun, but the Sun's whole diameter is more than ſeven hundred thouſand miles. The comet's heat was then ſuppoſed to have been two thouſand times hotter than red hot iron; but the ſame comet was about twelve thouſand millions of miles from the Sun, at his greateſt diſtance, when it is ſuppoſed, that he perceived ten thouſand times leſs heat than we uſually enjoy. Hence it is ſuppoſed, that ſuch a planet could never afford a comfortable reſidence for rational creatures.

But here philoſophers have taken for granted that the heat of every body is inverſely as the ſquare of its diſtance from the Sun, a proportion which I greatly ſuſpect; for I apprehend that it is contrary to experiment.

Were heat a certain body proceeding immediately from the Sun, the quantity of heat in any ſpace would doubtleſs be inverſely as the ſquare of its diſtance from the Sun. But I ſee no reaſon to believe that heat comes from the Sun, while there is much reaſon to think that it does not. We perceive that light comes from the Sun. We alſo perceive that heat is produced in the bodies on which the rays of light fall, hence we are apt to confound light and heat together, though it be demonſtrable that light is not heat and that heat is not light. So contracted is our knowledge of the primary conſtituent parts of bodies, that we cannot readily determine why any particular cauſe ſhould not excite heat with equal facility in all bodies. But we are taught by experience that different quantities are produced by the ſame cauſe, according to the medium on which it operates. It alſo appears that the particular aptitude of any body to be heated is nearly as the elaſticity of that body, or the coheſion of its parts. Whatever produces a tremulous motion in the particles of any body, excites heat in that body, and *vice verſa* whatever excites heat produces a tremulous motion in the particles of the body. Does heat therefore conſiſt in nothing elſe than the rapid vibrations of the minute particles of any body? or is there an elementary principle of fire diffuſed through all bodies, which is only excited or brought into action by any cauſe which produces a tremulous motion in the particles of thoſe bodies? The latter ſeems moſt probable, though in ſolving the preſent hypotheſis there is no difference whether heat depends on the ſimple vibration of the particles of matter, or whether it depends on the fire which was only brought into action by the vibration of thoſe particles, provided it ſhould appear that the heat in every body is uniformly as the vibratory motion of the particles of that body.—This I apprehend is the caſe, and ſhall beg leave to mention ſuch evidence as ſeems to render the matter at leaſt very probable.

Philoſophers have enumerated five methods by which heat it generated, viz. 1. by attrition, 2. chymical mixture, 3. fermentation, 4. inflammation, and 5. by the Sun. In all theſe caſes it appears that the heat depends on a vibratory motion which by one means or another is excited in the particles of the body.

1. Heat is produced by attrition, or by the ſtriking or rubbing of one body againſt another. In this caſe there can be no doubt that the heat depends on the vibratory motion of the particles, hence bodies are ſooneſt heated where the friction is conſiderable, provided the bodies have alſo a proper degree of elaſticity. For the motion once communicated to the particles of an elaſtic body, are retained a conſiderable time, and increaſed by every ſucceeding ſtroke of the cauſe which put them into motion. The

quantity

quantity of heat produced in any body by friction, depends greatly on the body being fit to preferve the motion once communicated. Thus a faw fixed in a hand vice fo that it may long retain its tremulous motion, will foon be heated, whilft the file with which it is rubbed is not foon heated, being held in the foft unelaftic hand, whereby the vibratory motion of its particles are immediately deftroyed. The facility with which fome bodies are heated before others, and with which the fame body may be heated in one pofition rather than in another, abundantly prove that the quantity of heat produced in any body by friction will not be as the motion communicated, but as the ftrokes communicated, together with the number of vibrations retained and communicated in confequence of each ftroke.

2. The heat which is produced by chymical mixture has been the fubject of much fpeculation.—There are fundry bodies which joined together produce confiderable heat as water with oil of vitriol; others produce cold, as falt of nitre with water. Why fhould one union produce heat the other cold? It appears in general that all mixtures, properly fo called, produce heat, all folutions produce cold. But in every mixture the bodies undergo a certain change in their qualities, whereas bodies undergo no change by folution. This may point out to us the true origin of heat in one cafe, and cold in the other, and the pores of the one body are fo conftituted as that the minute particles or atoms of the other body may penetrate into them, a general diffolution of the conftituent parts of the body muft enfue, the minute particles being rent afunder by the attractive force of the parts; fuch diffolution of the conftituent parts of a body neceffarily alters the qualities of that body. We may eafily perceive that in the rapid union of fuch bodies by which the minuteft particles are rent afunder, the vibratory motion of thofe parts muft be greatly in creafed. Hence the generation of heat by mixtures. Hence too the heat in fuch mixtures, feems to be in proportion to the number of particles, which in any body

body of a determinated bulk, rush into union with and deſtroy the texture of one another.

In ſolutions or cooling combinations no change is produced in the qualities of the bodies. Thus by a ſolution of nitre in water cold is produced, and the ſalt may be depoſited from the water, or the water be evaporated, and neither of the bodies undergo the leaſt change. In this caſe it appears, that there is no diſſolution of the conſtituent parts of either body, by the attractive force of the other, or by the conſtruction of their parts; but that the globules of one body adhere ſuperficially to thoſe of the other, and the particles of the fluid are ſimply charged with thoſe of the ſolid, by which means the vibratory motion of the particles is diminiſhed, whence cold is neceſſarily produced.

It has been obſerved that ſpirit of nitre mixed with water produces heat, while the ſame ſpirit mixed with ſnow produces the moſt intenſe cold. This may be probably urged as an objection to the above theory of heating and cooling combinations, under the apprehenſion that ſnow being nothing elſe than frozen water, ſhould on theſe principles produce the ſame effects, on combination with any third body. But it muſt be obſerved, that one is a mixture, the other a ſolution. Water joined with ſpirit of nitre produces a mixture, the bodies undergo a change of qualities, and heat is generated. Pour the ſpirits of nitre into ſnow and nothing will follow, at leaſt nothing has followed but a ſolution of the ſnow in the ſpirit. For theſe experiments have always been made when the temperature of the ſpirits was much below the freezing point of water, ſo that the ſnow could not be melted by ſuch combination. Hence there being no intimate union of the parts, nor any thing elſe than a proper ſolution, cold was generated as in all ſimilar caſes.

3. Heat produced by fermentation or putrefaction, may be accounted for in the ſame manner as that produced by chymical mixture, there being no doubt that new mixtures are conſtantly forming in every putreſcent or fermenting body.

4. Heat

4. Heat which is produced, by inflammation ſeems alſo to depend on the chymical mixture of bodies. In all bodies which blaze there is found an acid and mephytic air, which ſeem to abound in thoſe bodies in proportion to their different degrees of inflammability. The ſeparation of theſe two bodies conſtitutes a flame; this we obſerve can only be effected by means of a third body, *viz.* common air. The union of the acid with the water that is ſuſpended in the air, and the union of the mephytic with the common air, produces two heating mixtures. Hence heat is excited by flame.

5. Heat is produced by the Sun: Does that heat proceed immediately from the Sun, as is generally ſuppoſed, or is it mechanically excited by the action of the rays of light; The latter is moſt probable. We have ſeen a variety of methods by which heat is produced. They appear in different forms, but they all terminate in the ſame thing; they are different methods of exciting a tremulous motion in the particles of the body. By ſome of them the moſt intenſe heat is produced, and yet in no caſe is there any actual addition of fire. When heat is excited by the Sun, there is alſo a tremulous motion excited in the particles of the body, they are expanded, *&c.* The phenomena reſemble thoſe of heat excited by other means, whence it ſeems unphiloſophic to ſuppoſe that there ſhould be an acceſſion of fire in this caſe more than in the others. I therefore ſuppoſe *that all the heat which is cauſed by the Sun, depends on a tremulous motion excited by the rays of light, in the particles of the body which is heated.* Hence it will follow that *the heat of any body will not be according to its diſtance from the Sun, but according to the fitneſs of that body, to retain and propagate the ſeveral vibrations which are communicated to its particles by the rays of light.* Hence it is that the air which is very elaſtic, when well compreſſed by the weight of the incumbent atmoſphere, will receive a great degree of heat near the ſurface of the earth, while the light thin air whoſe particles are removed

to a conſiderable diſtance, as on the top of a high mountain, is always in a freezing ſtate within the torrid zone.

Let us ſee how this theory of the generation of heat may be ſubſervient to the inhabitants of the cometary worlds.

It is evident that comets are ſurrounded with an atmoſphere very different from that of our globe; the heighth of our atmoſphere is hardly ſuppoſed to exceed 60 or 70 miles, while that of a comet is frequently 8 or 10,000 miles. Why ſhould they have ſuch a weight of atmoſphere more than us? This is doubtleſs ſubſervient to ſome very extraordinary purpoſe. We may alſo ſuppoſe with great probability, that the atmoſphere of a comet differs greatly from ours. The particles may be ſmaller, more ſubtile, elaſtic, and much more eaſily heated, whence the Sun's rays may be enabled to warm ſuch an atmoſphere compreſſed together by the weight of eight or ten thouſand miles, at a diſtance from the Sun, in which we ſhould perceive the moſt intenſe cold. This will explain the manner in which the inhabitants of a comet may be ſufficiently warm at their greateſt diſtance from the Sun; but if they were proportionably heated on their neareſt approach to the Sun, their ſummer heats would be intolerable; but this muſt certainly be the caſe if their atmoſphere were in a permanent ſtate, and continued in all ſeaſons of equal denſity and weight. We are certain however from obſervation, that this is not the caſe; for as the comet approaches the Sun, we can eaſily perceive its atmoſphere greatly rarified, and thence rendered leſs fit for generating or retaining heat. But this is not the principal relief which cometarians receive from the ſummer's heat. The atmoſphere of a comet ſeems to undergo a change which is peculiar to itſelf. It is removed by the rays of light, and thrown off to a conſiderable diſtance behind the planet. It is demonſtrable that the rays of light paſs with amazing velocity, they travel above thirteen millions of miles in a minute; ſuch amazing velocity multiplied into their weight, however ſmall they be, muſt give them a *conſiderale momentum* or impelling force, which muſt be great in regions near the Sun; by this force they repel the extremely ſubtile and light particles of air, and drive them off to ſuch a diſtance behind the comet that their weight is hardly perceived on its ſurface. The atmoſphere being thus repelled by the Sun's rays, and thrown as it were into a ſhelter behind the planet, will be there extended longitudinally in the form of a ſhadow, being very rare towards the top. Every particle near the ſurface of this immenſe ſtream of air muſt be illuminated by the refraction and reflection of the Sun's rays, whence they will exhibit the faint appearance of a blaze. Thus we are apt to imagine that a comet is intenſely hot, and that a prodigious flame proceeds from it, while we ſee nothing elſe than its enlightened atmoſphere.

As the inhabitants of comets are not preſſed by day, when they come near the Sun, with a thouſandth part of the atmoſphere which uſually ſurrounds them, and which is doubtleſs the mediate and principal cauſe of their perceiving heat, we may eaſily ſee how they may be tolerably cool at noon day, on their neareſt approach to the Sun.

If we might form any conjecture concerning the life of a cometarian, from the annual periods of the world which he inhabits, we ſhould apprehend that he far exceeds the years of an antedeluvian. Or might we attempt to meaſure the continuance of this globe, from the length of time which will be neceſſary to bring the aſtronomy of comets, as well as every other ſcience to that perfection at which they muſt doubtleſs arrive, we ſhould infer that a ſmall portion of that time is yet elapſed. On which ever of theſe ſubjects the mind is ſuffered to ſtray for a few minutes, it will find ſufficient ſubject of a pleaſing ſpeculation.

A letter from David Rittenhouse, A. M. of Norriton, to William Smith, D. D. Provost of the college of Philadelphia; containing observations of the COMET, *which appeared in June and July,* 1770; *with the elements of its motion, and the* Trajectory *of its path. Communicated to the Society, August 3d,* 1770.

REV. SIR,

HEREWITH *I send you the fruit of three or four days labour, during which I have covered many sheets, and literally drained my ink stand several times. It is an account, &c. of the* COMET *which lately appeared, and I have no objection to its being made public. I might, indeed, have been a little more careful to have the precise time of my observations, as the near approach of this* Comet *required ten times the accuracy, that is necessary for computing the place of any planet. I am, however, quite satisfied that the situation I have given its orbit will be found very near the truth.*

THE circumstances most remarkable in this comet were, its prodigious apparent velocity, the smallness of its size, and the shortness of the time it continued visible. Its velocity was at first surprisingly accelerated, and before it disappeared again retarded, from which its near approach to the earth may be inferred.

I did not see it till Monday the 25th of June; and from its situation at that time, I expected it would have been visible for many weeks, if not months; and therefore did not prepare, with such expedition as I might have done, for observing its place with accuracy. But from the 27th to the 30th, the weather continuing fair, every evening about nine, I took the distance of the comet from *Lucida Lyræ* and *Lucida Aquilæ*, with a common Hadley's quadrant.

July the first, it was cloudy in the evening. At 10 however, I saw both lucida lyræ and the *Comet* through the clouds, and observed their distance; but the comet was

was again hid before I could take its diſtance from the pole ſtar, which ſeemed to be about 5 or 6 degrees. This evening it was diſtant from lucida lyræ 49°. 17′. whereas the evening before it had been but 5°. 42′. from the ſame ſtar at 9*h*. It had therefore moved above 45°. in the laſt 25 hours, and now appeared much brighter than it had been before; there being alſo ſome appearance of a tail on the ſide oppoſite to the Sun. July the 2d it was cloudy with rain in the evening; but in the morning of the 3d about 3^h. I obſerved its diſtance from the pole ſtar, from Capella, and from a ſtar of the ſecond magnitude in Caſſiopeia, which was the laſt time I ſaw it.

From the above obſervations, and many very laborious calculations, I have endeavoured to ſettle the elements of this comet's motions (ſuppoſing it to move in a parabola, and to be governed by the Sun's attractive force) as follows, viz.

The place of the aſcending node -	Leo 14°. 21′. 45″.
The place of the perihelion - -	Piſces 26°. 19′. 28″.
Inclination of the orbit - - - - - -	1°. 49′. 5″.
Perihelion diſtance from the Sun, in ſuch parts, as the earth's mean diſtance is 100000	62757,5 Log. 9.7976653
The logarithm of its daily mean motion -	0.2636300

Time of the comet's being in perihelio, Auguſt 8th, 19^h. 26′. equal to Auguſt 8.80965

Its motion direct; that is, according to the order of the ſigns.

From theſe elements, and Dr. *Halley*'s *tabula generalis motuum cometarum, in orbe parabolico*, it will be eaſy to compute this comet's viſible place for any time; during its ſtay in the planetary regions, in this manner.

Find the difference between the time propoſed and the time of the perihelion; that is, Auguſt 8. 80965, in days and decimal parts of a day; and to the log. thereof add the log. of the daily mean motion. The ſum is the log. of the mean motion from the perihelion. To the mean motion

ſo

ſo found, take the angle correſponding out of Dr. *Halley*'s table abovementioned, which angle being added to or ſubtracted from the place of the perihelion, as the time propoſed is after or before Auguſt 8th, 19*h*. 26′, gives the heliocentric place of the comet in its orbit; and, as that is ſo nearly parallel to the plane of the ecliptic, I have, for the more eaſy calculation, neglected the reduction entirely, which could ſcarcely exceed 50″ at any time. Likewiſe, to the mean motion, take out of the table aforeſaid the *Logarithmus pro diſtantia à ſole*; from which ſubtract the compliment of the log. of the perihelion diſtance, viz. 2023347 always, and you have the log. of the comet's diſtance from the Sun. The inclination and geocentric place may then be found by the ſame method we uſe for the planets.

EXAMPLE. Let the viſible place of the Comet for June 27th, 9*h*. be required.

From Auguſt 8. 80965
Subtract June 27. 375
Remain days 42. 43465 log. 1.6277207
Log. daily motion add - - - 0.2636300

Mean motion before perihel. 77.86652. 1.8913507
Angle correſponding 80°. 5′. 12″.
Sub. from perihelion ♓ 26°. 19′. 28″.

Remains the Comet's heliocentric longitude ♑. 6°. 14′. 16″
Sub. from longitude ⊖ ♑. 6°. 16′. 7″

Difference =1′. 51″

Log. pro diſtantia - - - 5.2320440
Compliment log. perihelion diſt. ſubtract .2023347

Comet à ⊙ 107082,2 Log. 5.0297093
⊖ à ⊙ 101678,2 Log. 5.0072280

Comet à ⊖ 5404 Log. 3.7327153

Tangent 6.7308977
Add the Log. of ⊖ diſtance à ⊙ 5.0072280

Sum 11.7381257
Subtract the Log. of the Comet à ⊖ 3.7327153

Remains Tangent 34′. 48″ 8.0054104
Which ſub. from ♑. 6°. 14′. 16″ The heliocentric longitude.

Remains ♑. 5°. 39′. 28″ The Comet's viſible place.
Place of the node ♒. 14°. 21′. 45″ Deſcending.

Argument of lat. 38°. 7′. 29″ Sine 9.7905493
+Sine inclin. of orbit 1°. 49′. 5″ 8.5014111

—Rad.=Sine heliocent. lat. 1°. 7′. 20″ 8.2919604

Tangent ditto 8 2920434
+Log. Comet à ⊙ 5.0297093

Sum 13.3217527
Log. Comet à ⊖=3.7327153
+Secant 34′. 48″—Rad.=515 } Sub. 3. 7327668

Remains Tangent viſible lat. 21°. 13′. = 9.5889859

Obſerved

Obſerved diſtances of the COMET,

From D. h.	*Lucida Lyræ.*	*Lucida Aquilæ.*	*Capella*	*In flexura ad Coxas Caſſiopeiæ*	*Longitude obſerved.*	*Longitude computed.*	*N. Lat. obſerved.*	*N. Lat. computed.*
June 27. 9.	40°. 44′	22°. 6′	- - - -	- - - - -	♑ 5°. 41′	♑ 5°. 39′	21°. 15′	21°. 13′
29. 9.	22. 25	18. 8	- - - -	- - - - -	♑ 10. 9	♑ 10. 12	39. 21	39. 47
30. 9.	5. 42	34. 50			♑ 23. 36	♑ 23. 38	64. 0	64. 0
July 2. 15.	- - - -	- - - -	12°. 7′	35°. 31′	♊ 24. 32	♊ 24. 35	33. 50	33. 29
3. 15,$\frac{1}{4}$	95. 56	- - - -	8. 18	- - - - -	♊ 27. 29	♊ 27. 29	21. 30	21. 35

This laſt obſervation was taken by the Rev. Mr. EWING.

In making the above obſervations, the time (as hath been already hinted) was not ſtrictly noted to minutes; and therefore a *perfect* agreement, between the *obſerved* and *computed* places, cannot be expected. Beſides, the comet approached ſo very nigh, that an error of 1′. in computing its heliocentric place, might produce an error of a degree in its viſible place, and more than two degrees in its longitude in the ſigns.

It is remarkable of this comet, that in any future returns, whilſt it continues to move in the ſame orbit, it can never approach the earth nigher than it did this time. On the firſt of July, it was about one ſixtieth part of the Sun's diſtance from us.

Perhaps, if the apparent diſtance of the NUCLEUS, *from ſome fixed ſtar near which it paſſed, had been meaſured with a micrometer, at different places on the earth conveniently ſituated, the* SUN'S PARALLAX *might, by this means, have been determined nearer than we can ever hope for, by any other method.*

This comet, notwithſtanding its nearneſs, appeared but ſmall and continued viſible but a few days; and, in all probability, had it paſſed the earth's orb but three weeks ſooner, we ſhould never have ſeen any thing of it. This affords ground for a probable conjecture, that there are numbers of theſe wandering bodies, which traverſe the vaſt ſpace encircled by the planets, entirely unperceived by us. I remember one, about ten or twelve years ago, that appeared much ſmaller than this, moved very faſt, and diſappeared in a few days likewiſe.

Nothing

Nothing but the ſmallneſs of the preſent Comet can prevent its being ſeen at this time (if indeed it be not ſeen); for it muſt riſe in the morning before day, and continue to do ſo for ſome months; but will at length retire to a prodigious diſtance beyond the reach of the beſt glaſſes, in the 26th degree of Virgo, and very little north of the ecliptic.

The earth's place June 27th, 14^h. at the meridian of Greenwich, is computed to be $9^s \cdot 6^o . 16' . 7''$ and the excentricity of its orb 168 ſuch parts, as its mean diſtance is 10000. If any one would compute the viſible place of the Comet, from the principles above laid down, he muſt find the Sun's place, or rather the earth's, by the tables he makes uſe of, to June 27, 14^h. at Greenwich, and as much as he finds it faſter or ſlower than $9^s \cdot 6^o . 16' . 7''$ ſo much muſt he add to, or ſubtract from, the place of the perihelion, not neglecting ſeconds, otherwiſe a very great difference might ariſe in the calculation.

If the reduction to the plane of the ecliptic be applied, $50''$ may be ſubtracted from the place of the perihelion.

NORRITON, *July* 24, 1770. D. RITTENHOUSE.

L E T T E R II.

DEAR SIR,

I WAS much pleaſed with a paragraph in the Gentleman's Magazine, for July 1770, by which it appears, that M. Meſſier diſcovered the laſt Comet in France, ten or twelve days ſooner than we did here; becauſe it affords another opportunity of comparing this Comet's motion with my theory.

According to M. Meſſier's obſervation, on the night between the 15th and 16th of June, the Comet's right aſcenſion was $270^o . 57' . 37''$ with $15^o . 55' . 24''$ South declination. The hour of the night is not mentioned, but the place of the Comet was no doubt determined by its paſſing the meridian, which he ſays was about midnight, that is at Philadelphia, June 15th, 7^h.

Time

Time of the perihel. Aug. 8. 8096
Subtract June 15. 2916

Remain Days, 54. 518 Log. 1,736540
Add the log. of the daily mean motion, ,263630

Mean motion, 100,04 Log. 2,000170
Angle corresponding 90°. 0′. 54″
Which sub. from the perihel. } 356. 19. 28

Comet's heliocent. long. 8s. 26°. 18′. 34″=266. 18.34
☉do. 8. 24. 44. 53

differ. 1. 33. 41

Let S, (Plate I. Fig. 3.) be the place of the Sun; E, the place of the Earth; and C, of the Comet.

Log. pro distantia à Sole 0,301260
Subtract, - - ,202335

Comet's dist. from ☉=CS 125,581 Log. 0,098925
Earth's distance from ditto 101,627 Log. 0,007011
Secant, 1°. 33′. 41″—Rad. sub. 161

PS - 101,590 Log. 2,006850
Sub. from CS=125,581 | +Tang. 1°. 33′. 41″ 8,435490

Rem. CP= 23,991 | Sum, 10,442340
Sub. CP. Log. 1,380048

Remains Tang. ECS=6°. 35′. 3″= 9,062292
+heliocent. long. 8s. 26°. 18′. 34″

The sum is the geocent. place of the Comet, 9s. 2°. 53′ 37″

Long. of the descending node 10s. 14°. 22′. 45″
Sub. heliocent. long. of Com. 8. 26. 18. 34

Argument of latitude, 48. 4. 11 Sine, 9,871548
+The Sine of the inclinat. of orbit 1. 49. 5 8,501454

—Rad.=Sine heliocent. latitude, 1. 21. 9 8,373002

As the Cosine of 6°. 35′. 3″=ECS 9,997126
Is to Radius - - - 10, - -
So is CP=23,991 - - - 1,382922

To CE=24,15028 - - 1,380048

As CE=24,15028 1,382922
To CS=125,581 2,098925
So is tang. heliocent. lat. 1°. 21′. 9″=8,373091

10,472016

To the tang. of the geocent. lat } 7°. 0′ 9,089094

Hence the visible place of the Comet was ♑ 2°. 53′. 37″ with 7°. 0′ North latitude. The right ascension and declination I find as follows.

Let C, (Plate I. Fig. 4) be the place of the Comet; A, the first point of Aries; AP, a portion of the ecliptic; CP, perpendicular to it; AR, part of the equator; and CR, perpendicular thereto. Then shall AP, be equal to the complement of the Comet's longitude=87°. 7′, and PC, its North latitude=7°. 0′. AR, the complement of right ascension; and RC, the declination.

Cosine AP=87°. 7′ - - - - 8,701589
+Cosine CP=7. 0 - - - - 9,996751

—Rad.=Cosin. AC=87°. 8′. 20″=8,698340

Rad. +Sine 7°. 0′ - - - - 19,085895
—Sine 87°. 8′. 20″ - - - - - 9,999458

=Sine - - - 7°. 1′. - - - 9,086437

=Sine

=Sine - - -	7°. 1'. - - -		9,086437
Sub. from	23. 28 obliquity of the ecliptic.		
Rem.	16°. 27'	Sine,	9,452060
+Sine - - -	87. 8'. 20'		9,999458
—Rad. =Sine	16. 26=CR=		9,451518
Rad.+Cosi.	87°. 8'. 20''		18,698340
—Cosine - -	16. 26.		9,981886
=Cosine AR=87. 1			8,716454

Which subtracted from 360, leaves 272°. 59'. right ascension.

	Right Ascension.	Declination South.
Therefore, by calculation from the theory, we have	272°. 59'	16°. 26'
But by Mr. Messier's observation,	272. 57½	15. 55½

The difference in right ascension is, 0°. 1'½ and 0°. 30½ in declination.

Hence it appears, that the observation of M. Messier entirely agrees with the magnitude I have assigned the Comet's orbit, and likewise with the time and place of the perihelion; but the inclination of the orbit ought perhaps to be increased four or five minutes. I am,

Ever yours, &c.

December 2, 1770. D. RITTENHOUSE.

To Rev. Dr. SMITH.

P O S T S C R I P T.

Mr. *Rittenhouse*, when he wrote his first paper, expressed his hopes of obtaining a further confirmation of his theory of this Comet's motion, by seeing it on its ascent from the perihelion. But it was not then seen (so far as we have yet heard) by any person in America. This disappointment, however, he did not ascribe to any defect in a theory which he had endeavoured to establish from the best principles, and with great labour of calculation, but to the difficulty of finding a body of such small size in the heavens; especially with such a large unwieldy refractor, as he himself was obliged to use. The account, therefore, of M. Messier's observation, who saw the Comet ten or twelve days sooner than we did here, being so acceptable to him, (as it gave a further opportunity of confirming his theory by the above paper of December 22d) I imagined that any account of the Comet, after its return from

from the Sun, would be ftill more acceptable; and therefore, when the Gentleman's Magazine, for Auguft laft, fell into my hands, I loft no time in fending him the following, viz,

" Though we were not lucky enough in America to " difcover the late Comet in its afcent from the Sun, yet " I have the pleafure to acquaint you, that it was feen in " England. I find in the Gentleman's Magazine for Au- " guft, that Mr. *Six* fays, he had the unexpected pleafure " (to you it would not have been unexpected) of feeing " the Comet on its afcent from the Sun towards its *Aphe-* " *lion*, and though not vifible to the naked eye, yet with " a telefcope magnifying 25 times, it appeared much like " the Nebula in *Andromeda*'s Girdle. Auguft 22d, half paft " two, *mané*, it had 106°. 20′. right afcenfion, and 21°. N. " declination. The two fucceeding days its longitude in- " creafed daily 1°. 15′. but its latitude both days not more " than 5′. Its apparent motion, he fays, was nearly pa- " rallel to the ecliptic. If thefe fubfequent obfervations " agree as well as Mr. Meffier's previous obfervation, with " your theory on this Comet, I think it will thereby be " eftablifhed paft doubt. I am yours, &c.

WILLIAM SMITH."

Mr. RITTENHOUSE's *Anfwer. December 26th*, 1770.

I was favoured with your extract from the Gentleman's Magazine, for Auguft, by which I find Mr. *Six* was lucky enough to difcover the Comet with his telefcope, after it had paft its perihelion, though it was not vifible to the naked eye. I have computed the Comet's place to Auguft 22d, half paft two in the morning, and make its right afcenfion 108°. 46′. with 21°. 0′. North declination; agreeing with Mr. *Six*'s obfervation entirely in declination, but differing from it about 2°. in right afcenfion, which I cannot think material, unlefs I knew what method he took to determine the right afcenfion of a heavenly body, out of the meridian. *D. R.*

N. B.

N. B. In the *Parabolic Trajectory* of this Comet (Plate I. Fig. 2.) ſuppoſe that part, from A to B, a little elevated above the plane of the ecliptic; and the remainder, from B to C, as much depreſſed below it; the two planes interſecting each other in the line of the nodes, at an angle of 1°. 49′.

Some account of the ſame COMET, *in a letter from the Right Honorable* WILLIAM *Earl of* STIRLING, *to* WILLIAM SMITH, D. D. *Provoſt of the College of Philadelphia. Communicated to the Society, Aug.* 17, 1770, *viz.*

BASKENRIDGE, *June* 29, 1770.

DEAR SIR,

YOU have reaſon to think me negligent in not communicating (according to my promiſes, to you) my obſervations of the laſt *Tranſit of Venus*. I now ſend them*, and you ſhould have had them before, but I have been ſo much engaged in buſineſs the laſt twelve months, that I have had but little time to think of any thing elſe.

Laſt night, about ten o'clock, I diſcovered a *new ſtar*, about 78°. diſtant from the pole. It would paſs the meridian, I imagine, about midnight, and a little before lyra. Its appearance was larger than a ſtar of the firſt magnitude, of a dull light, with a bright ſpeck or *nucleus*, in the center. I take it to be a comet, and that its tail is from us. But whether it be a comet or not, will be determined in a few days; for as it changes its place, and the earth moves on in its orbit, the poſition of the tail, with regard to the earth, muſt be altered, and will then appear to encreaſe in length.

June 30th. Laſt night I again obſerved the new diſcovered ſtar. Its appearance was much as it was the night before, but I think rather larger. Its ſituation was about 70°. from the pole, and it paſſed the meridian with lyra almoſt half after eleven. I think I have its place ſo well marked,

* They are inſerted above, P. 125.

marked, that in two or three evenings I ſhall be able to determine its courſe. What further obſervations I make before I have an opportunity of ſending this, I will add hereto.

July 1ſt, The new ſtar, which, I no longer doubt, is a comet, on his way to the Sun, paſſed the meridian laſt night about twelve o'clock, and nearly half an hour after lyra, and was advanced to within 48°· of the pole, being a little to the northward of our zenith. It ſeemed to me to be encreaſed in ſize, the ſhape rather more oval than circular, the *nucleus* no longer in the center, but advanced towards the northern part of the whole appearance.

July 2d, laſt night at twelve o'clock, the comet was nearly Eaſt from the pole ſtar, and about 8°· diſtant from the pole.

July 4th. The night before laſt, being cloudy, the comet was not viſible; and laſt night, (July 3d) although the ſky was clear, the ſtars bright, and myſelf on the watch for it till day light began to appear in the Eaſt, I could not diſcover any appearance of the comet. It muſt now be gone to the region of light, and we ſhall not ſee it more until its return from the Sun.

The apparent velocity of this comet, for the laſt three days of its appearance, has been prodigiouſly great, which, together with its apparent ſize, induces me to think, that its real ſize is but ſmall; and that its path lay at no very great diſtance from the earth. But theſe matters may be better determined, if we have an opportunity of ſeeing the comet again, in its return from the Sun.

I am,

Dear Sir,

Your moſt humble Servant,

STIRLING.

EQUATION

EQUATION of EQUAL ALTITUDES of the SUN, for the Latitude of PHILADELPHIA.
Calculated by JOHN EWING.

Months and Days.		Sun's Longitude.		Half the Interval of the Obſervations in Time.								
				2h. 0′.	2h. 30′.	3h. 0′.	3h. 30′.	4h. 0′.	4h. 30′.	5h. 0′.	5h. 30′.	6h. 0′.
				—	—	—	—	—	—	—	—	—
M.	D.	s.	c.	″ ‴	″ ‴	″ ‴	″ ‴	″ ″	″ ‴	″ ‴	″ ‴	″ ‴
Decemr.	22,	9.	0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
	26,		5	1. 53	1. 53	1. 53	1. 53	1. 53	1. 53	1. 54	1. 55	1. 56
	31,		10	3. 42	3. 42	3. 43	3. 43	3. 43	3. 44	3. 45	3. 49	3. 51
Jan.	5,		15	5. 27	5. 27	5. 28	5. 28	5. 29	5. 32	5. 35	5. 38	5. 43
	10,		20	7. 6	7. 7	7. 7	7. 9	7. 11	7. 15	7. 19	7. 23	7. 31
	15,		25	8. 37	8. 38	8. 39	8. 41	8. 45	8. 50	8. 55	9. 3	9. 15
	20,	10.	0	9. 58	10. 1	10. 6	10. 6	10. 1	10. 16	10. 25	10. 36	10. 51
	24,		5	11. 9	11. 13	11. 18	11. 21	11. 3	11. 36	11. 46	12. 1	12. 20
	29,		10	12. 11	12. 15	12. 19	12. 26	12. 3	12. 46	13. 1	13. 19	13, 43
Feb.	3,		15	13. 0	13. 6	13. 11	13. 20	13. 3	13. 46	14. 4	14. 27	14. 56
	8,		20	13. 38	13. 44	13. 52	14. 4	14. 1	14. 36	14. 58	15. 26	16. 2
	13,		25	14. 4	14. 13	14. 23	14. 38	14. 5	15. 17	15. 4	16. 17	17. 0
	18,	11.	0	14. 21	14. 33	14. 45	14. 54	15. 2	15. 48	16. 20	16. 59	17. 49
	23,		5	14. 29	14. 44	14. 59	15. 17	15. 41	16. 10	16. 48	17. 32	18. 29
	28,		10	14. 28	14. 41	15. 3	15. 23	15. 51	16. 24	17. 7	17. 57	19. 1
March	5,		15	14. 18	14. 37	14. 56	15. 21	15. 53	16. 32	17. 18	18. 15	19. 25
	10,		20	14. 13	14. 23	14. 44	15. 12	15. 48	16. 30	17. 22	18. 25	19. 41
	15,		25	13. 41	14. 3	14. 26	14. 56	15. 35	16. 20	17. 19	18. 27	19. 49
	20,	0.	0	13. 13	13. 36	14. 1	14. 35	15. 16	16. 7	17. 8	18. 21	19. 50
	25,		5	12. 41	13. 5	13. 32	14. 7	14. 51	15. 46	16. 49	18. 9	19. 43
	30,		10	12. 3	12. 28	12. 58	13. 36	14. 23	15. 19	16. 25	17. 49	19. 29
April	4,		15	11. 22	11. 49	12. 20	13. 0	13. 49	14. 47	15. 56	17. 23	19. 6
	9,		20	10. 38	11. 5	11. 38	12. 19	13. 9	14. 9	15. 21	16. 50	18. 36
	15,		25	9. 52	10. 19	10. 53	11. 35	12. 26	13. 27	14. 41	16. 11	17. 41
	20,	1.	0	9. 4	9. 32	10. 5	10. 48	11. 40	12. 41	13. 56	15. 25	17. 14
	25,		5	8. 14	8. 42	9. 16	9. 58	10. 51	11. 51	13. 6	14. 34	16. 22
	30,		10	7. 26	7. 53	8. 26	9. 6	9. 58	10. 57	12. 11	13. 38	15. 22
May	5,		15	6. 36	7. 3	7. 35	8. 14	9. 4	10. 0	11. 12	12. 35	14. 14
	10,		20	5. 48	6. 12	6. 43	7. 21	8. 7	9. 1	10. 8	11. 27	13. 2
	16,		25	5. 1	5. 23	5. 51	6. 28	7. 9	8. 0	9. 1	10. 13	11. 41
	21,	2.	0	4. 15	4. 34	5. 0	5. 32	6. 9	6. 55	7. 50	8, 56	10. 15
	26,		5	3. 29	3. 47	4. 9	4. 37	5. 8	5. 49	6. 37	7. 33	8. 42
	31,		10	2. 44	2. 59	3. 18	3. 41	4. 7	4. 41	5. 20	6. 7	7. 4
June	5,		15	2. 1	2. 13	2. 28	2. 44	3. 6	3, 32	4. 2	4, 37	5. 22
	11,		20	1. 20	1. 21	1. 38	1. 49	2. 4	2. 22	2. 42	3. 6	3. 36
	16,		25	0. 39	0. 45	0. 49	0. 55	1. 2	1. 12	1. 21	1. 34	1. 49
				+	+	+	+	+	+	+	+	+
June	21,	3.	0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
	26,		5	0. 39	0. 45	0. 49	0. 55	1. 2	1. 12	1. 21	1. 34	1. 49
July	2,		10	1. 20	1. 29	1. 38	1. 49	2. 4	2. 22	2. 41	3. 5	3. 36
	7,		15	2. 1	2. 13	2. 28	2. 44	3. 6	3. 32	4. 0	4. 36	5. 22
	12,		20	2. 43	2. 59	3. 18	3. 40	4. 8	4. 41	5. 18	6. 5	7. 3
	17,		25	3. 27	3. 46	4. 9	4. 35	5. 8	5. 48	6. 34	7. 31	8. 40
	23,	4.	0	4. 14	4. 33	4. 58	5. 30	6. 8	6. 54	7. 48	8. 53	10. 11
	28,		5	5. 0	5. 21	5. 50	6. 24	7. 7	7. 57	8. 57	10. 11	11. 37
Auguſt	2,		10	5. 47	6. 10	6. 41	7. 17	8. 4	8. 59	10. 4	11. 22	12. 56
	7,		15	6. 35	6. 58	7. 31	8. 11	8. 59	9. 57	11. 7	12. 29	14. 9
	12,		20	7. 24	7. 49	8. 22	9. 3	9. 52	10. 52	12. 6	13. 31	15. 15
	18,		25	8. 11	8. 38	9. 11	9. 53	10. 44	11. 45	13. 0	14. 27	16. 13
	23,	5.	0	9. 0	9. 26	9. 56	10. 42	11. 33	12. 34	13. 49	15. 17	17. 4
	28,		5	9. 47	10. 13	10. 47	11. 28	12. 18	13. 20	14. 33	16. 2	17. 49
Septem.	2,		10	10. 31	10. 58	11. 31	12. 10	13. 1	14. 1	15. 13	16. 41	18. 26
	7,		15	11. 15	11. 41	12. 12	12. 51	13. 40	14, 36	15. 47	17. 12	18. 55
	13,		20	11. 58	12. 20	12. 50	13. 27	14. 13	15. 9	16. 17	17. 38	19. 18
	18,		25	12. 33	12. 56	13. 23	13. 59	14. 42	15. 35	16. 40	17. 57	19. 33

EQUATION of EQUAL ALTITUDES of the SUN, for the Latitude of PHILADELPHIA.
Calculated by JOHN EWING.

Months and Days.		Sun's Longitude.		Half the Interval of the Observations in time.								
				2h. 0′. +	2h. 30′. +	3h. 0′. +	3h. 30′. +	4h. 0′. +	4h. 30′. +	5h. 0′. +	5h. 30′. +	6h. 0′. +
M.	D.	s.	o.	″ ‴	″ ‴	″ ‴	″ ‴	″ ‴	″ ‴	″ ‴	″ ‴	″ ‴
	23,	6.	0	13. 6	13. 27	13. 53	14. 26	15. 7	15. 57	16. 57	18. 10	19. 39
	28,		5	13. 33	13. 53	14. 18	14. 48	15. 26	16. 12	17. 8	18. 16	19. 39
October	3,		10	13. 56	14. 13	14. 36	15. 3	15. 38	16. 20	17. 12	18. 14	19. 30
	8,		15	14. 12	14. 27	14. 47	15. 12	15. 44	16. 21	17. 9	18. 4	19. 14
	13,		20	14. 21	14. 34	14. 52	15. 14	15. 41	16. 16	16. 58	17. 47	18. 50
	18,		25	14. 22	14. 33	14. 48	15. 8	15. 32	16. 2	16. 39	17. 23	18. 18
	23,	7.	0	14. 14	14. 25	14. 36	14. 54	15. 3	15. 40	16. 12	16. 50	17. 39
	28,		5	13. 58	14. 6	14. 15	14. 31	14. 48	15. 9	15. 36	16. 9	16. 31
Novem.	2,		10	13. 32	13. 37	13. 46	13. 58	14. 12	14. 29	14. 51	15. 19	15. 55
	7,		15	12. 54	13. 0	13. 5	13. 15	13. 27	13. 41	13. 57	14. 21	14. 50
	12,		20	12. 5	12. 10	12. 15	12. 21	12. 31	12. 42	12. 54	13. 14	13. 37
	17,		25	11. 5	11. 9	11. 14	11. 18	11. 24	11. 32	11. 43	11. 58	12. 16
	22,	8.	0	9. 55	9. 58	10. 1	10. 5	10. 8	10. 14	10. 22	10. 34	10. 47
	27,		5	8. 35	8. 37	8. 38	8. 41	8. 44	8. 47	8. 53	9. 1	9. 12
Decemb.	2,		10	7. 5	7. 6	7. 7	7. 8	7. 10	7. 12	7. 17	7. 21	7. 30
	7.		15	5. 27	5. 27	5. 28	5. 28	5. 29	5. 31	5. 34	5. 38	5. 43
	12,		20	3. 42	3. 42	3. 43	3. 43	3. 43	3. 45	3. 45	3. 49	3. 51
	17.		25	1. 53	1. 53	1. 53	1. 53	1. 53	1. 54	1. 54	1. 55	1. 56

An easy method of deducing the true time of the SUN's *passing the meridian per clock, from a comparison of four equal altitudes, observed on two succeeding days. By* DAVID RITTENHOUSE, *A. M. of Norriton. Communicated Aug. 17th 1770; by* WILLIAM SMITH, *D. D.*

THE method of obtaining the true time of the Sun's passing the meridian, by correcting the *mean noon*, deduced from observed equal altitudes of the Sun, by the help of the tables of the *equation of corresponding altitudes*, being attended with some trouble, and not being so ready as might be wished; perhaps the communication of the following method, which I frequently make use of, may be acceptable, as it is practicable without any tables, and will save a good deal of labor, when the necessary corresponding altitudes can be obtained.

Suppose, then, there are four setts of *altitudes* obtained on two successive days, (viz. one sett in the morning, and one in the afternoon each day) the instrument being kept exactly at the same height both days; then the exact time of the Sun's passing the meridian per clock, may be readily obtained by the following— *RULES.*

RULES

Take the difference in the time between the forenoon obſervations of the two days, and alſo between the afternoon obſervations.

Call half the difference of the two differences X;

And half the ſum of the two differences Y.

Let the half interval, between the two obſervations of the ſame day, be Z.

Then, if the times of the altitudes obſerved on the ſecond day be both nearer 12, or both farther from 12 per clock, than on the firſt day---X will be the daily variation of the clock, from apparent time, and Y will be the daily difference in time of the Sun's coming to the ſame altitude, ariſing from the change of declination. And the proportion will be --

$24^{h.}$: Y : : Z : E, the equation ſought; which will be found the ſame (without any ſenſible difference) as the equation obtained from the tables.

But if one of the obſervations on the ſecond day be nearer 12, and the other more remote from 12, than on the firſt day---

Then Y will become the daily variation of the clock from apparent time, and X will be the daily difference in time of the Sun's being at the ſame altitude;

And the proportion will be---24^{h}. : X : : Z : E.

The equation, E, thus obtained, is to be ſubtracted from the mean noon, if the Sun's meridian altitude be daily increaſing; but to be added if it be daily decreaſing. The reaſon of all this is very plain; and an example or two will make the method familiar---

Suppoſe the following correſponding altitudes were taken---

		Morning.			Afternoon.		
	D.	H.	m.	ſec.	H.	m.	ſec.
Nov.	8.	9.	58.	31	2.	4.	9
	9.	10	1.	16	2.	1.	52

Required

Required the time of the Sun's paffing the meridian; and hence of apparent noon, per clock, November 8th.

Diff. between the morning obfervations of the two days,	$0^h. 2'. 45'$
Diff. of the afternoon obfervations,	0. 2. 17
Sum,	$5'. 2''$
Half Sum,	2. 31=Y
Diff. of the two differences, - - -	$28''$
Half do. - - - -	$14''$=X
The half interval between the two obferv. of Nov. 8th, is,	$2^h. 2'. 49''$=Z

Now becaufe both the obfervations on the *fecond day* are nearer 12 than on the *firft day*, X only gives the daily variation of the clock from apparent time; and the proportion for the equation, agreeable to the rule is,---

24^h. : Y : : Z : E. That is $24^h : 2'. 31'' : : 2^h. 2'.49 : 12''$,88=E

And adding *Z*, or the half interval, to the forenoon obfervation of Nov. 8th,

We have $9^h. 58'. 31'' + 2^h. 2'. 49'' = 12^h. 1'. 20''$ mean noon, Nov. 8

Add E, the equat. becaufe the Sun's merid. altitude is daily decreafing	+12,88
Which gives the true time of the Sun's paffing merid. per clock,	$12^h. 1'. 32''$,88

And thus the clock is $1'. 32''$,88 fafter than apparent time, on the noon of November 8th.

Or fuppofe the correfponding altitudes as follows,----

	Morning.	Afternoon.
D.	H. m. fec.	H. m. fec.
Nov. 8.	9. 58. 31	2. 4. 39
9.	10. 4. 16	2. 5. 22

Diff. between the morning obfervations of the two days,	$5.45''$
Diff. of the afternoon obfervations	43
Sum, -	6. 28

Sum

Sum, - 6. 28
Half Ditto, - 3. 14=Y

Diff. of the two Differences, - - 5′. 2″
Half Ditto, - - 2. 31=X

Half interval between the two observations of Nov. 8th, } $2^{h.}$. 3′. 4′=Z

Now as one of the obfervations on the *fecond* day is nearer 12, than on the *firft*, and the other more remote, Y is the daily variation of the clock from apparent time, and the proportion for the equation, agreeable to the rule, is 24^{h} : X : : Z : E. Or; 24^{h} : 2′, 31″ : 2^{h}, 3′, 4″ : 12″,9 =E.

The mean noon is, $9^{h.}$ 58′. 31″ +2^{h} 3′. 4″=12h. 1′. 35″

To which add the equation, E= - - - 12,9

And the correct time of noon per clock, is - 12. 1. 47,9

So the clock would here be 1′. 47″,9 fafter than apparent time.

Account of the Tranfit *of* MERCURY *over the* SUN, *November 9th*, 1769, *as obferved at* NORRITON *in Pennfylvania, by* William Smith, *D. D.* John Lukens, *Efq*; *Meffrs.* David Rittenhoufe, *and* Owen Biddle; *the committee appointed for that obfervation, by the American Philofophical Society. Drawn up and communicated, by direction and in behalf of the committee, by Dr.* SMITH.

THE inftruments ufed in this obfervation, were the fame as are already defcribed, in the Norriton account of the tranfit of Venus.

The forenoon of November 9th was, for the moft part, cloudy, and made us almoft defpair of obtaining any favourable fight of *Mercury* on the Sun; but about one o'clock the Sun fhone out perfectly clear, and continued undifturbed undiſturbed by clouds till about half an hour after three, which gave us an opportunity, as favorable as could be deſired, not only for obſerving the external and internal contacts at the ingreſs, but alſo for making ſome material micrometer obſervations.

The external contact was noted to the very ſame inſtant of time by all the three obſervers without having any communication with each other; the ſame method, of giving ſignals to perſons ſtationed by the clock, being purſued now, as at the tranſit of Venus.

Mr. *Rittenhouſe* and myſelf likewiſe gave the internal contact the ſame inſtant, but Mr. *Lukens* was 2″ ſooner.

A teleſcope could not be procured for Mr. *Biddle* to obſerve the *contacts*; but he gave a ready aſſiſtance in the parts of the buſineſs.

The whole work of the day ſtands as follows, viz.

1769. Apparent time. D. h. m.			Inches. 20ths. 500ths.	
Nov. 9. 9. 30 *A. M.*	Sun's diam.		3. 13. 7	per micrometer.
9. 35 *ditto,*			3. 13. 6	

Mean of theſe gives ☉'s diam. = 32′. 20″,18.

Firſt external contact.

P. M. 2. 35. 17	Dr. Smith, with a 2 f. reflector. Magnifying power 200.	
	Mr. Lukens, with a 42 f. refractor. Magnifying power 140.	
	Mr. Rittenhouſe, with a 36 f. refractor. Magnifying power 144.	

Firſt internal contact.

2. 36. 33	By Mr. Lukens,	Each obſerver having the ſame teleſcopes, and magnifying powers, as at the external contact.
2. 36. 35	By Dr. Smith, and Mr. Rittenhouſe.	

Micrometer meaſures of the leaſt diſtance of the neareſt limbs of the Sun and Mercury.

Apparent time. H. m. ſec.	Inches. 20ths. 500ths.	Value in M. Sec.
3. 2. 44	0. 5. 04	2. 15,52
3. 10. 9	0. 6. 12	2. 50,5
3. 19. 17	0. 8. 1	3. 31,84
3. 31. 11	0. 10. 0	4. 23,78
4. 33. 20	0. 18. 11	8. 7,44

From 31′ paſt three, the Sun was conſtantly obſcured in a cloud that deſcended with him, 'till about 30′ paſt four, at which time he ſhone out for about 3′. During this

this interval the laſt micrometer meaſure was taken, which is therefore a little doubtful, as the Sun entered another cloud as ſoon as the artificial contact of the limbs of ☉ and ☿ was formed, and before we could be certain that the micrometer ſtood in the direction of the leaſt diſtance. The firſt micrometer meaſure is alſo a little doubtful, the micrometer having been accidentally moved, while we were reading off the vernier. Both of them however are near the truth; and the other three meaſures may be perfectly depended on.

On a mean of ſundry meaſures taken backwards and forwards (during the intervals of the other micrometer meaſures) Mercury's diameter was found no more than 8″,22. The utmoſt attention was paid to this point, as one of the moſt important obſervations of the whole.

The following obſervations were alſo taken of the appulſes of the limbs of the Sun, and Mercury's center, to the croſs wires of the tranſit teleſcope, viz.

Apparent time. H.	m.	ſec.	
3.	3.	30	☉'s Lower limb at horizontal wire.
3.	3.	42	☉'s Precedent limb at vertical wire.
3.	5.	58	☿'s Center at vertical wire.
3.	6.	31	☉'s Subſequent limb at vertical wire.
3.	6.	32	☿'s Center at the horizontal wire.
3.	7.	18	☉'s Upper limb at the horizontal wire.
			2.
4.	30.	34	☉'s Lower limb at the horizontal wire.
4.	31.	4	☉'s Precedent limb at the vertical.
4.	32.	39	☿'s Center at the vertical.
4.	33.	41.	☉'s Upper limb at the horizontal wire.

The other two obſervations of this ſet could not be completed, the Sun being again hid under clouds, and appeared no more during that day.

Several more micrometer meaſures of the diſtance of the neareſt limbs of ☉ and ☿ might have been taken, between the time of the total ingreſs, and half an hour paſt three, when the Sun was firſt obſcured. But a meaſure of this kind, taken carefully once in every 8′ or 10′, was judged ſufficient; and the intervals were employed in attempting by frequent meaſures (as already hinted) to aſcertain the diameter of Mercury on the Sun, to the greateſt poſſible exactneſs.

From

From the above meaſures, and the appulſes of the Sun and planet to the wires of the teleſcope, a projection of the tranſit might be made, were it neceſſary. But the chief advantages to be derived from obſervations of a tranſit of Mercury, are the perfecting the theory of his motions, and fixing the longitude of places on the earth. For the firſt, the leaſt diſtance of the centers, and the diameters of ☉ and ☿, which may be got from the foregoing obſervations, are the moſt material elements; and for the ſecond, the contacts and their exact times are ſufficient.

With reſpect to the *theory* of mercury's motion, the late Dr. *Halley* hath left but little to be ſettled. He obſerves (Philoſophical Tranſactions, vol. VI. No. 39.) a remarkable period in this planet's motion, wherein he makes 191 revolutions about the Sun, and correſponding tranſits over his *diſk*. Thus, if at the *aſcending node*, the planet hath paſſed over the Sun, it will, in 46 Julian years, 4 hours, 51 minutes, (if there have been 12 intercalations) paſs over the Sun again, only 1′. 22″ more northerly; or in one day more, if there have been but 11 intercalations. At the *deſcending node*, the period is 46 years, 7 hours, 14 minutes, or one day more, according as the intercalation requires. Thus, if one tranſit of any ſeries or claſs hath been obſerved, the times of the following correſpondent ones are obtained by addition only; and all we have to do, is examine the theory by the obſervations, to ſee if it needs correction.

The firſt time that ever *mercury* was obſerved on the *Sun's* diſk, was by Gaſſendus, at Paris, October 28th, 1631, O. S; and the late tranſit of November 9th, was the fourth in that claſs the two intermediate ones, each at 46 years diſtance, being obſerved by Dr. *Halley*, in 1677 and 1723. This claſs, therefore, will afford as good a compariſon as any.

Thus, at Paris, 28th October, 1631, at $10^{h.}\,28''$ *mané*, Gaſſendus obſerved the laſt external contact. Whence the middle reduced to the meridian of Greenwich was, in the aſtronomical

aſtronomical reckoning, October 27, 19$^{h.}$ 37$'$. 55$''$; and the leaſt diſtance of the centers, acccording to Dr. *Halley*, 3$'$. 20$''$. Taking this as our ground work, let us compare theory with obſervaɿion.

By the THEORY.			By OBSERVATIONS.			
October.	Middle reduced to Greenwich.	Leaſt diſt. of centers.	Middle reduced to Greenwich.	Difference later in 46 years.	Leaſt diſt. of Centers.	Difference more N. in 46 years.
Years.	D. h. m. ſec.	M. ſec.	D. h. m. ſec.	H. m. ſec.	m. ſec.	m. ſec.
1ſt Tranſit 1631.	27, 19. 37. 55	3. 20	27, 19. 37. 55		3. 20	1. 18
+46	0, 4. 51	+1. 22 N.		4. 50. 5		
2d Tranſit 1677.	28, 0. 28. 55	4. 42	28, 0. 28. 0		4. 38	
+46	1, 4. 51	+1. 22 N.				1. 18.
3d Tranſit 1723.	28, 5. 19. 55	6. 4	28, 5. 14. 30	4. 46. 30	5. 56	
+46	0, 4. 51	+1. 22 N.		4. 47. 22		1. 36
4th Tranſit 1769.	28, 10 10. 55	7. 26	28. 10. 1. 52		7. 32	

Thus it appears, that the obſervations do not quite agree with the theory; the latitude being increaſed by the laſt tranſit about $\frac{1}{4}$ of a minute more north, than the theory would give, and the time of the middle falling about 4$'$ too ſoon. Whether this can be accounted for from a re-examination of the obſervations themſelves, or by any correction in the motion of ☿'s nodes, may be worthy of further enquiry.

The SUN'S PARALLAX *deduced from a compariſon of the* NORRITON *and ſome other* American *obſervations of the tranſit of Venus*, 1769; *with the* GREENWICH *and other* European *obſervations of the ſame.* *By* WILLIAM SMITH, *D. D. Provoſt College Philadelphia.*

ONE can ſcarcely enter upon this ſubject, without admiring the ſagacity of the great Dr. *Halley*, who firſt conceived the method of aſcertaining the Sun's parallax (that is, the angle which the earth's ſemidiameter ſubtends at the Sun,) and conſequently the dimenſions of the whole ſolar ſyſtem, either from the total duration of a tranſit of Venus, duly obſerved in one ſingle place of the earth properly ſituated, or from the difference of abſolute time that elapſes between the obſervations of the contacts of the Sun and Venus in different places.

The latter of theſe methods is what aſtronomers in general prefer; yet, even in that, a concurrence of ſo many circumſtances

circumſtances is requiſite, that neither the former tranſit of 1761, nor, it is feared, this of 1769, will enable aſtronomers to do juſtice to the Doctor's noble problem in all its parts. For it is neceſſary——

Firſt, That the different obſervers ſhould have good teleſcopes, time-pieces well adjuſted, and the latitude and longitude of their places of obſervation determined with the moſt ſcrupulous exactneſs.

Secondly, That the abſolute difference of time between the contacts, at the different places to be compared with each other, be ſo great, as to render the unavoidable ſmall defects of inſtruments and obſervation inſignificant.

Thirdly, That all the obſervers be favoured with a clear ſky, and the Sun of a ſufficient altitude, not leſs than 8°· or 10°· above the horizon.

Granting therefore, what I believe will not be denied, that all the circumſtances mentioned under the firſt head, concurred in favor of the American as well as European obſervations made uſe of in the following deduction of the Sun's parallax; yet the abſolute difference of time, being on a mean, but about 3′. 4″, was ſcarce one fourth part of the greateſt abſolute difference that might be obtained from obſervations made at two places ſituated in the moſt favourable manner, with reſpect to each other.

But though this circumſtance did not concur in favor of the European and American obſervers, yet, if the Sun had been ſufficiently high to the former, and as reſplendent and well defined as he was to us, notwithſtanding the ſmall difference of abſolute time between our obſervations, his parallax might have been deduced from them, perhaps to as great exactneſs as ever it can be expected from a tranſit of Venus. For any two obſervers with us, having eyes and inſtruments equally good, and taking the ſame method of judging concerning any phænomenon, could ſcarcely have differed more than 5″ or 6″; and where ſeveral obſervers were at one place, it is probable the mean of all, might have brought the time within the limits propoſed by Dr. *Halley*, that is within 2″ of the truth. But

But ſcarce any of the European obſervers, in the following liſt, had the Sun above 8°. high at the external contact; and, at the internal contact, in France and Sweden, he was ſcarce 2° above the horizon, and even at Greenwich not quite 5°. This circumſtance therefore, and the form Venus put on, hanging to the Sun's limb by a ſort of protuberant ligament, muſt have rendered it very difficult to pronounce the moment of the internal contact. Moreover, the whole duration of the ingreſs, or time between the contacts, given by the European obſervers, being near 1′ longer than it was obſerved in America, when it ought rather to have been ſhorter, tends further to ſhew that the true internal contact muſt have been paſt, before they ſaw the Sun's light compleated, round the dark body of the planet.

And here, as Dr. *Halley* * expreſſes it, "Since Venus, like her ſex, is exceeding coy, and deigns but in certain † ages, to come before the eyes of men, diveſted of her borrowed dreſs;" an American, who has the leaſt of the ſpirit of an aſtronomer in him, cannot help lamenting for his brother-aſtronomers in Europe—men of fame and great abilities—that they were condemned, amid horizontal vapors, only to a tranſient glimpſe of this rare phænomenon (*ſpectaculum inter aſtronomica longe nobiliſſimum*); and that they could not have ſhared with us ſome part, at leaſt of that luxury gazing, which we enjoyed here.

However, notwithſtanding theſe unfavourable circumſtances, the parallax of the Sun, as deduced from the beſt obſervations of the tranſit 1761, will be greately confirmed by the following compariſons of the American and European obſervations of 1769; eſpecially thoſe of the external contacts, which on this occaſion, perhaps, are only to be relied on. For a diſturbance or alteration firſt ariſing on the Sun's limb, and that at a greater altitude, was certainly

* Venus, *quamvis ſyderum omnium ſpecioſiſſima, more ſexus ſui, ſine mutuato cultu ac ſplendore aſcititio in conſpectum prodire veretur: Hoc etenim ſpectaculum, inter aſtronomica longe nobiliſſimum, inſtar ludorum ſecularium, integri ſeculi mortalibus invident motuum arctæ leges.* Philoſ. Tranſ. Vol. I. No. 100.

† Venus will not be ſeen on the Sun again, till the year 1874; ſo that ſcarce even the grand-children of the obſervers of the laſt tranſit will ſee the next.

tainly a circumſtance that could be more eaſily judged of as to time, than the completion of a ſmall thread of the Sun's light, almoſt in the horizon.

But, before I proceed to draw the concluſions, although it may be unneceſſary to perſons verſed in aſtronomical ſubjects and calculations, yet to the generality of thoſe who may be readers of the tranſactions of an American Philoſophical Society, and particularly the youth in our different ſeminaries of learning, it may be acceptable to ſhew the whole proceſs by which the concluſions are obtained, and how to calculate the effect which the parallaxes of Venus from the Sun have, both in latitude and longitude, with reſpect to the contacts here and in Europe.

It need hardly be obſerved that the true place of a planet in the heavens, Venus for inſtance, is that where ſhe would be ſeen if viewed from the center of the earth; and that unleſs ſhe is in the ſpectator's * zenith, her apparent place will be lower than her true place. This difference of place is called the planet's parallax in altitude, and is meaſured in a vertical circle; being greateſt in the horizon, and decreaſing at the altitudes increaſe, till in the zenith it becomes nothing. The method of determining the quantity of this parallax at different altitudes, and of reducing into thoſe of latitude and longitude, ſo as to know their effect on the planet's place, is as follows.

Let V. (Plate III. Fig. 7.) be the place of the Sun and Venus; ZV, a verticle circle; EC, the ecliptic, PVD, a circle of declination; OVN, part of the orbit of Venus; and C, the firſt point of Aries.

Then the following things are known, viz;

ZP, the co-latitude; VD, the declination; VP, its compliment; CV, the Sun's longitude; CD, the right aſcenſion; and ZPV, the hour angle from noon.

From theſe *data*, the parallaxes of Venus from the Sun, namely VL, in the vertical, VN, in longitude, and LN, in latitude, may be found for any given place and time.

 Let

* This matter being very well explained by Mr. *Benjamin Weſt*, in his account of the Providence Obſervations, (p. 104.) need not be repeated here.

Let the place be Norriton, at $2^h. 12'. 50''$, the moment of the firſt external contact.

Then, in the ſpherical triangle ZVP, we have two ſides, and the included angle, viz.

ZP,$=49^\circ. 50'. 29''$, the co-latitude

VP,$=67. 34. 17$, the co-declination.

ZPV$=33. 12. 30=2^h. 12'. 50''$. the time turned into deg. &c.

Hence we get the angle ZVP	$=49^\circ. 55'. 33''$
And the zenith diſtance of ☉'s center ZV	$=33. 9. 42\frac{1}{2}$
Subtract for ♀ higher than ☉'s center,	$15. 18$
Remains the zenith diſt. of ♀'s lower limb,	$32. 54. 24\frac{1}{2}$
Complement of which is the height ♀'s lower limb above the horizon,	$=57. 5. 35\frac{1}{2}$

Aſſuming now any number for the Sun's horizontal parallax on the tranſit day, let us ſay $8'',5212$ (the nearer to the true parallax the better); then the horizontal parallax of Venus will be to that of the Sun, inverſely as their diſtances from the earth; that is

$28887 : 101512 :: 8'',5212 : 29''.9444$=the hor. parallax of ♀. Subtract Sun's parallax$=8.5212$

The remainder $21. 4232$ = horizontal parallax of Venus from the Sun on the tranſit day.

Then, Radius is to the Sine of the zenith diſt. of Venus, as her horizontal parallax from the Sun, is to her parallax at the altitude aforeſaid; viz.

Rad : S. $32^\circ,54',24\frac{1}{2} :: 21'',4232 : 11'',6387$=LV } the paral. of ♀ à ☉ in the vertical, at the alt. $57^\circ. 5'. 35''\frac{1}{2}$.

Moreover, in the right-angled ſpherical triangle CVD, we have two ſides, viz.

CV the Sun's longitude$=2^s. 13^\circ. 20'. 31''=73^\circ. 20'. 31''$.

DV the declination$=22^\circ. 25'. 43''$.

Whence we get CD$=71^\circ. 55'. 33''$.

And likewiſe the meridian angle CVD$=82^\circ. 54'. 21''$.

The

The next thing to be found is OVE, or CVN, the angle of the viſible way, which is got as follows. Let ♀ ☋ ⊖ (Plate III. Fig. 9,) be the inclination of the orbit of ♀ with the ecliptic= 3° 23′. 20″. Let ⊖ ☋ be ⊙'s horary motion, with the menſtrual equation, as from Mayer's tables=143″,53 and ♀ ☋ the horary motion of ♀ as ſeen from ⊙ taken from Halley's tables=238″,334. Then, by trigonometry, the ☋ ⊖ ♀ will be found = 171°. 30′. 35″; the complement of which ♀ ⊖ A, is the angle of the viſible way=8°. 29′. 25′.*

The ſide ♀ ⊖ is the horary motion ♀ á ⊖ as ſeen from the Sun=95″,418; which encreaſed in the ratio of ♀ 's diſtance from ⊖, to her diſtance from ⊙, gives her horary motion in the viſible way=239′,891.

Now, returning to fig. 7; we had got the meridional angle CVD, } = 82°. 54. 21″.

But we had before ZVP, or DVL=49°.55′.33 }
And we have now got the angle of the viſible way, CVN, } =8.29.25 } =58.24.58

Subt. their ſum from CVD, and we have LVN,=24.29.23,

Wherefore, in the right-angled triangle LNV (which being ſmall may be reſolved as a plain triangle) having found one angle LVN and the hypothenuſe LV, we get the remaining ſides, viz.

VN the parallax in longitude=10″.592.

LN the parallax in latitude= 4.8245.

Now the parallax of longitude VN contributes to accelerate the contact of Venus and the Sun, by its whole length; but the parallax of latitude LN contributes to accelerate the ſame by a ſpace different from its whole length.

There are ſeveral ways of explaining this matter, and of converting the ſpace LN into a proportionable part for acceleration. The following method, given by Mr. *Rittenhouſe*, is that which we made uſe of, and is as plain and ſtrictly mathematical as any. "Let

* This angle, in the Norriton account of the tranſit, was called 8°. 28′. 27″, that is near 1′ leſs; the ſide ⊖ ☋ being computed from Halley's tables, not having Mayer's tables at that time.

" Let S (plate III. fig. 6) be the center of the Sun and of the circle ABC, whoſe radius=975″ the ſum of the ſemidiameters of the Sun and Venus. Let D L o be the true tranſit line, and *D the place of Venus's center* at the time of the external contact, as ſeen from the earth's center; and B its place as ſeen from any part on the ſurface of the earth, ſuppoſe Greenwich. Make B E perpendicular to D o; then will D E be the parallax in longitude, and E B in latitude; and D L ſhall be the whole ſpace by which Venus is brought ſooner into contact with the Sun to a ſpectator at Greenwich, than as ſeen from the center of the earth.

" Now if the parallax of longitude only took place, the center of Venus would be removed thereby only along her true path from D to E, and ſo the tranſit would not yet be begun. But the parallax of latitude E B makes her center appear to be removed in another direction from E to B, and brings her to touch the Sun's limb by the ſpace E L ſooner than if only the parallax of longitude took place. The length of this ſpace E L, (which is here leſs than E B) may be determined as follows.

" Having aſſumed the Sun's horizontal parallax as before it follows from the Norriton obſervations, that the leaſt diſtance of the centers of the Sun and Venus, as ſeen from the earth's center, was 610″. Make therefore, o S =610″, perpendicular to D o r; and o m = half the parallax of latitude BE, calculated as above for the given place. Drawn m I, parallel to o L; join S I, which ſhall be perpendicular to B L. Make S p, perpendicular to S I, or parallel to BL. Then the triangles B E L, I m S, are ſimilar; for they are both ſimilar to S m p; whence I m : m S : : B E : E L. But m S, =610—m o, half the parallax of latitude already found; and $\sqrt{SI^2 - mS^2} = mI$. Thus, the three firſt terms of the proportion being known, the fourth E L is known alſo.

" In like manner let F be the geocentric place of Venus's center, and H its place as ſeen at Norriton at the time of the external contact. Draw H G perpendicular to D L o. Then

Then F G will be the parallax of longitude, and G H of latitude. Make o n = half the parallax of latitude found above. Draw q n K parallel to D L o. Join SK which ſhall be perpendicular to H L. Then the triangles F H G, K S n are ſimilar; and K n : n S :: H G : G L. Thus G L may be found. Let us, for an example, take Norriton.

HG the parallax of latitude (under the denomination of LN) was already found $=4'',8245$; whence $\frac{HG}{2}=2'',4122$ = o n. And o S—o n = nS; that is $610''-2'',4122=607'',5878$ = n S. Moreover $\sqrt{SK^2 - nS^2} =$ Kn; That is $\sqrt{975^2 - 607,5878^2} = 762''536$ = K n. Wherefore ſince K n : n S :: HG : GL; we have $762'',536 : 607'',5878 :: 4'',8245 : 3'',8432$ = GL.

	ſeconds.
Thus the parallax of latitude HG=4″,8245 accelerates the contact only by GL	=3,8432
To which add the parallax of longitude EG, found above for Norriton	=10,592
And we have the whole ſpace F L by which the contact is haſtened at Norriton, by the parallaxes both of longitude and latitude	=14,4352

Now as the motion of ♀ in an hour is $239'',891$; ſhe will require $216'',624$ of time, to paſs over the above parallactic ſpace of $14'',4352$. And by ſo much will the external contact be accelerated at Norriton in time; viz. $216'',624$.

By the like proceſs for Greenwich, (uſing fig. 8, where we had fig. 7 before), we ſhall find the whole parallactic ſpace, DL=$27'',0441$

which gives in time=$405'',846$ {for the acceleration of ext. contact at Greenwich.

But, 216,624 was the acceleration at Norriton.

The difference $189'',222$, is the abſolute time, by which the external contact ſhould have been ſeen ſooner at Greenwich than at Norriton, if the Sun's horizontal parallax were truly aſſumed $=8'',5212$ on the tranſit day.

But at Norriton the ext. contact was obſerved, at $2^h. 12'. 50''$

Add

	h. m. sec.
Add for the diff. of merid. of Greenw. & Norriton,	5. 1. 29
The Sum gives the time for Greenwich, if there were no parallax	7. 14. 19
But the contact was observed at Greenwich, at	7. 11. 2

The difference is the observed effect of paral.=3′.17″=197″

But this observed effect 197″ is greater than the calculated effect 189″,222 and therefore the Sun's true parallax on the transit day is (by this comparison) greater than the parallax assumed for the calculation, and will be found 8″,8715.

For 189′,222 : 197″ : : 8″,5212 : 8″,8715.

In like manner, for the internal contacts, after computing the parallaxes of ♀ à ☉ in long. and lat. for the respective places and times of observation, agreeable to the foregoing rules, the parallaxes in latitude were reduced to their proportionable space for acceleration, by taking the difference of the semidiameter of ☉ and ♀=918″ for the radius of the circle (Plate III, Fig. 6) instead of their sum=975″. In all other respects the operation is the same as for the external contacts.

So far concerning the necessary preparations. The following table contains the names of places, their latitudes and longitudes, and such other requisites as enter into the comparisons for deducing the Sun's parallax from the observations.—

Names of places.	EXTERNAL CONTACT. Latitude North.	Longitude from Greenwich.	in Time from Norriton.	1st ext. cont. app. time.	Numb. of observers.	Calculated acceleration in time, by par.
		h. m. sec.	h m. sec.	h. m. sec.		
Greenwich,	51°. 28′. 37″	0. 00. 00	5. 1.29E.	7. 11. 2	7	405″.846
Spital Square,	51. 31. 15	0. 00. 17 W.	5. 1. 12	7. 10. 44¼	1	405. 852
Middle Temple,	51. 30. 50	0. 00. 25 W.	5. 1. 4	7. 11. 5¾	1	405. 841
Kew,	— — —	0. 1. 14 W.	5. 0. 15	7. 10. 44¼	1	405. 755
Windsor Castle,	51. 28. 15	0. 2. 24½ W.	4.59. 4½	7. 8. 30	1	405. 664
Shirburn Castle,	51. 39. 22	0. 3. 57 W.	4. 57. 32	7. 7. 4	1	405. 452
Oxford,	51. 45. 15	0. 5. 4 W.	4. 56. 25	7. 5. 58	5	405. 236
Glasgow,	55. 51. 32	0. 17. 11 W.	4. 44. 18	6. 54. 29	3	400. 867
Upsal,	59. 51. 50	1. 10. 46 E.	6. 12. 15	8. 22. 9½	3	398. 632
Stockholm.	59. 20. 30	1. 12. 26 E.	6. 13. 55	8. 24 1	3	399. 388
Mean	— — —	— — —	5.12.44.,95	7. 22.30,55	2	403. 853
Norriton	40. 9. 31	5. 1. 29 W.	0.00.00	2. 12. 50		216. 624
			Diff.	5. 9. 40,25	—	187. 229

Thus

Thus fubtracting the time of the external contact at Norriton, from the mean of the ten external contacts in the above table, we have 5h. 9′. 40″,25 for the mean difference of longitude by the obfervations. But the true mean diff. of long. is 5h. 12′. 44″,95. The difference of thefe two=3′. 4″,7=184″,7 is the mean obferved effect of parallax. But the mean calculated effect=187″,229.

Whence 187″,229 . 184″,7 : : 8″,5212 : 8″,406. Thus, by one fingle comparifon of the mean of the above ten obfervations with the Norriton obfervation, we get the Sun's parallax on the tranfit day=8″,406, agreeing to the laft decimal place with what is got by making all the comparifons feparately, and taking the mean of the refults, as in the following table. It would therefore have been needlefs to enter down thefe feparate comparifons, if it were not to fee how they differ from each other, and which (if any) ought to be rejected.

Norriton and Greenwich.

H. m. fec.		feconds.	
2. 12. 50	*Norriton.*	405,846	*Greenw.*
5. 1. 29=diff. of merid.		216,624	*Norriton.*
7. 14. 19		189,222	
7. 11. 2	*Greenwich.*		+7″,778
3. 17=197″			
Sun's Parallax=8″,8715			

Norriton and Middle Temple.

2 12. 50	*Norriton*	405,841	*M. Temp.*
5. 1. 4=diff. merid.		216,624	*Norriton.*
7. 13. 54		189,217	
7. 11. 5¾	*Mid. Temple.*		—20″,967
2. 48¼=168″,25			
Sun's Parallax=7″,5776.			

Norriton and Windfor Caftle.

2. 12. 50	*Norriton.*	405,664	*Windfor.*
4. 59. 4½=diff. merid.		216,624	*Norriton.*
7. 11. 54½		189,04	
7. 8. 30	*Windfor.*		+15″,46
3. 24½=204″,5			
Sun's Parallax=9″,2181.			

Norriton and Oxford.

2. 12. 50	*Norriton*	405,236	*Oxford.*
4. 56. 25=diff. merid.		216,624	*Norriton.*
7. 9. 15		188,612	
7. 5. 58	*Oxford.*		+8″,388
3. 17=197″			
Sun's Parallax=8″,9002.			

Norriton and Upfal.

2. 12. 50	*Norriton.*	398,632	*Upfal.*
6. 12. 15=diff. merid.		216,624	*Norriton.*
8. 25. 5		182,008	
8. 22. 9	*Upfal.*		—6″,008
2. 56=176″			
Sun's Parallax=8″,23399.			

Norriton and Spital Square.

H. m. fec.		feconds.	
2. 12. 50	*Norriton.*	405,852	*Spital Sq.*
5. 1. 12=diff. merid.		216,624	*Norriton.*
7 14. 2		189,228	
7. 10. 44¼	*Spital Square.*		+8″,522
3. 17¾=197″,75			
Sun's Parallax=8″,9055.			

Norriton and Kew.

2. 12. 50	*Norriton.*	405,755	*Kew.*
5. 0. 15=diff. merid.		216,624	*Norriton.*
7. 13. 5		189,131	
7. 9. 59	*Kew.*		—3″,131
3. 6=186″.			
Sun's Parallax=8″,3804.			

Norriton and Shirburn Caftle.

2. 12. 50	*Norriton.*	405,452	*Shirb. Caft.*
4. 57. 32=diff. merid.		216,624	*Norriton.*
7. 10. 22		188,828	
7. 7. 4	*Shirb. Caftle.*		+9″,172
3. 18=198			
Sun's Parallax=8″,9351.			

Norriton and Glafgow.

2. 12. 50	*Norriton.*	400,867	*Glafgow.*
4. 44. 18=diff. merid.		216,624	*Norriton.*
6. 57. 8		184,243	
6. 54. 29	*Glafgow.*		—25″,243
2. 39=159″.			
Sun's Parallax=7″,3537.			

Norriton and Stockholm.

2. 12. 50	*Norriton.*	339,388	*Stockholm.*
6. 13. 55=diff. merid.		216,624	*Norriton.*
8. 26. 45		182,764	
8. 24. 1	*Stockholm.*		—18″,764
2. 44=164″.			
Sun's Parallax=7″,6464.			

Mean of the whole, 8″,403.

Names

INTERNAL CONTACT.

Names of places.	Reg. circumf. in contact.	Number of observers.	Long. in time, from Norriton.	Calcul. acceleration in time, by Parallax.	Thread of light complete.	Number of observers.	Long. in time, from Norriton.	Cal. acceleration in time, by parallax.
	h. m. sec.		h. m. sec	seconds.	h. m. sec.		h. m. sec.	seconds.
Greenwich,	7. 28. 31	3	5. 1. 29 E.	423,821	7. 29. 18	6	5. 1. 29 E.	424,768
Spital Square,	- - -	—	- - -	— —	7. 29. 15¼	1	5. 1. 12	424,741
Middle Temple,	- - -	—	- - -	— —	7. 28. 49½	1	5. 1. 4	424,701
Kew,	- - -	—	- - -	— —	7. 28. 17	1	5. 0. 15	424,454
Windsor Castle,	- - -	—	- - -	— —	7. 26. 37	1	4. 59. 4½	424,221
Shirburn Castle,	- - -	—	- - -	— —	7. 25. 24	3	4. 57. 32	424,103
Oxford,	- - -	—	- - -	— —	7. 24. 20	7	4. 56. 25	423,956
Glasgow,	- - -	—	- - -	— —	7. 12. 15	3	4. 44. 18	421,01
Upsal,	8. 39. 54	3	6. 12. 15	418,247	8. 40 16	5	6. 12. 15	418,947
Stockholm.	8. 41. 17	2	6. 13. 55	416,769	8. 41. 47	3	6. 13. 55	417,275
Mean	8. 16. 34	-	5. 49. 13	419,6123	7.40.37,8	-	5. 12. 44,95	422,617
Norriton,	2. 30. 6	3	- - - -	238 . -	2.30.26	2	- - - -	238,075
Diff.	5. 46. 28	-	- - - -	181,6123	5.10.11,8	-	- - - -	183,842

Thus the true mean diff. of meridians of *Norriton* and the three places where the reg. circumferences are noted in contact, is } 5. 49. 13

Both the mean diff. of meridians, by the observations, is } 5. 46 28

The diff. of these two, is the mean observed effect of Parallax, - - } =2. 45=165″

But the mean calculated effect of Parallax, is - - - - - } 181″,6123

And, 181″,6123 :: 165″ :: 8″,5212 : 7″,742.
Whence, 7″,742=☉'s Parallax.

In like manner, for the ten places, which noted the completion of the thread of light, for the internal contact; we have—

M. diff. merid. 5. 12. 44,95

But, by the observations, the mean diff. merid. is } 5. 10. 11,8

The diff. of these two, is the mean observed effect of Parallax, } 0.2.33,15=153,15

But the mean calculated effect of Parallax is } 183″,842

And,
183″,84 : 153″,15 : : 8″,5212 : 7″,08
Whence 7″,08=☉'s Parallax.

Both these results are the same as the *mean* results of their respective classes, got by the separate comparisons in the following table.

INTERNAL CONTACT.

Comparisons from the regular circumferences in Contact.

Norriton and Greenwich.

H. m. sec.		Seconds.	
2. 30. 6.	*Norriton.*	423,821	*Greenwich.*
5. 1. 29.=diff. merid.		238.	*Norriton.*
7. 31. 35.		185,821	
7. 28. 31.	*Greenwich.*	—1″,821	

3. 4=184″.
Sun's Parallax=8″,44.

Norriton and Stockholm.

2. 30. 6.	*Norriton.*	416,769	*Stockholm.*
6. 13. 55.=diff. merid.		238,---	*Norriton.*
8. 44. 1.		178,769	
8. 41. 17.	*Stockholm.*	—14″,605.	

2. 44.=164″.
Sun's Parallax=7″,82.

Norriton and Upsal.

H. m. sec.		seconds.	
2. 30. 6.	*Norriton.*	418,247	*Upsal.*
6. 12. 15.=diff. merid.		238,---	*Norriton.*
8. 42. 21.		180,247	
8. 39. 54.	*Upsal.*	—33″,247	

2. 27=147″.
Sun's Parallax=6″,95.

The *mean* of these three comparisons gives the Sun's Parallax 7″,74.

Comparisons from the completion of the thread of light.

Norriton and Greenwich. H. m. sec. — seconds. 2. 30. 26. *Norriton.* — 424,768 *Greenwich.* 5. 1. 29.=diff. merid. — 238,975 *Norriton.* 7. 31. 55. — 185,793 7. 29. 18. *Greenwich.* — —28″,793. 2. 37=157″. Sun's Parallax=7″2006.	*Norriton and Spital Square.* H. m. sec. — seconds. 2. 30. 26 *Norriton.* — 424,741 *Spital S* 5. 1. 12=diff. merid. — 238,975 *Norriton.* 7. 31. 38 — 185,766 7. 29. $15\frac{1}{4}$ *Spital Square.* — —43″,01 2. $22\frac{3}{4}$=142″,75. Sun's Parallax=6″,548.
Norriton and Middle Temple. 2. 30. 26. *Norriton* — 424,701 *Mid. Temple.* 5. 1. 4.=diff. merid. — 238,975 *Norriton.* 7. 31. 30. — 185,726 7. 28. $49\frac{3}{4}$ *Mid. Temple.* — —25″,476 2. $40\frac{1}{4}$=160″,25. Sun's Parallax=7″,3523.	*Norriton and Kew.* 2. 30. 26 *Norriton.* — 424,454 *Kew.* 5. 0. 15=diff. merid. — 238,975 *Norriton.* 7. 30. 41 — 185,479 7. 28. 17 *Kew.* — —41″479 2. 24=144″. Sun's Parallax=6″.6156.
Norriton and Windsor. 2. 30. 26 *Norriton.* — 424,221 *Windsor.* 4. 59. $4\frac{1}{2}$=diff. merid. — 238,975 *Norriton.* 7. 29. $30\frac{1}{2}$ — 185,246 7. 26. $37\frac{1}{4}$ *Windsor.* — —12″,246 2. 53=173″. Sun's Parallax=7″,9579	*Norriton and Shirburn Castle.* 2. 30. 26 *Norriton.* — 424,103 *Shirb. Cast.* 4. 57. 32=diff. merid. — 238,975 *Norriton.* 7. 27. 58 — 185,128 7. 25. 24 *Shirb. Castle.* — —31″,128 2. 34=154″. Sun's Parallax=7″,0846.
Norriton and Oxford. 2. 30. 26 *Norriton.* — 423,95 *Oxford.* 4. 56. 25=diff. merid. — 238,975 *Norriton.* 7. 26. 51 — 184,975 7. 24. 20 *Oxford.* — —33,975 2. 31=151. Sun's Parallax=6,9561.	*Norriton and Glasgow.* 2. 30. 26 *Norriton.* — 421,01 *Glasgow.* 4. 44. 18=diff. merid. — 238,975 *Norriton.* 7. 14. 44 — 182,035 7. 12. 15 *Glasgow.* — —33″,035 2. 29=149″. Sun's Parallax=6″9748.
Norriton and Upsal. 2. 30. 26 *Norriton.* — 418,947 *Upsal.* 6. 12. 15=diff. merid. — 238,975 *Norriton.* 8. 42. 41 — 179,972 8. 40. 16 *Upsal.* — —34″,972 2. 25=145″. Sun's Parallax=6″,8654.	*Norriton and Stockholm.* 2. 30. 26 *Norriton.* — 417,275 *Stockholm.* 6. 13. 55=diff. merid. — 238,975 *Norriton.* 8. 44. 21 — 178,3 8. 41. 47 *Stockholm.* — —24″,3. 2. 34=154″. Sun's Parallax=7,″3599.

Mean of the above Ten, 7″,09.

Let us next see what parallax of the Sun will be got from the Philadelphia observations, compared with those made at the ten places above specified; wherein a single comparison will be sufficient, since the result will be the same, as from a mean of the ten comparisons made separately.

PHILADELPHIA.

PHILADELPHIA, and *Ten* Places in *EUROPE*.

External Contact.

H. m. fec.			feconds.	
2. 13. 46,6 Philadelphia mean of 5 obferv.			403,853	mean parallax for the 10 places.
5. 11 52,95=mean diff. merid.			215,12	parallax for Philadelphia.
7. 25. 39,55=time for the 10 places without parallax,	}	diff.	188,733=calculated effect of parallax.	
7. 22. 30,25=mean of the obferved times.				+ 0″,567.

Diff. 3. 9,3=189″,3=mean obferved effect of parallax.
Whence, 188″,733 : 189″,3 :: 8″,5212 : 8″,5468=☉'s parallax on tranfit day.

Internal Contact.

H. m. fec.			feconds.	
2. 31. 28. Philadelphia mean of 5 obferv.			422,817	mean parallax for the 10 places.
5. 11. 52,95=mean diff. merid.			237,94	parallax for Philadelphia.
7. 43. 20,95=time for the 10 places without parallax.	}	Diff.	184,877=calculated effect of parallax.	
7. 40. 37,8=mean of the obferved times.				—21,″727

Diff. 2. 43,15=163″,15 mean obferved parallax.
Whence, 184″,877 : 163″,15 :: 8″,5212 : 7″,5198=☉'s parallax on tranfit day.

Thus, by the *External Contact*, we have the Sun's Parallax—

	feconds.
From the Philadelphia Obfervations	8,5468
And from the Norriton Obfervations	84060
	16,9528

The Mean of both is, $\frac{16,9528}{2}$ =8″,4764.

In like manner, by the *Internal Contact*, we have the Sun's Parallax—

	feconds.	
From the Norriton obfervations.	7,74	comparifon, reg. circumf. in contact.
	7,08	comparifon, thread of light complete.
From Philadelphia obfervations,	7,52	comparifon thread of light complete.
	22,34	

The Mean of thefe is, $\frac{22,34}{3}$ =*7″,447.

Now the mean parallax thus got by the comparifon of all the ten external contacts in the above table, with thofe of Philadelphia and Norriton, being 8″,4764 on the tranfit day, is nearly the fame that was got by the beft obfervations in 1761, and gives 8″,6045 for the Sun's horizontal parallax at the mean diftance. And there is reafon to think, that is as large as perhaps any good obfervations will give it.

But

* *In the comparifons with the Greenwich internal contacts, the obfervation of Mr.* Dunn, *as differing fo confiderably from the reft, was left out: but in thofe of the external contact, it was included. If it be included at the internal contact alfo, the* mean *of the whole will be* 7″,362, *inftead of* 7″,447.

But the Aſtronomer Royal writes me, that he has undertaken the final ſettlement of this matter; and, no doubt, he has ſeveral obſervations (whereon to found compariſons) that have not come to our hand, and will likewiſe conſider every nicety that can enter into this truly delicate calculation, making the proper allowances for the difference of teleſcopes, &c. I therefore thought it needleſs to be very particular in my compariſons, and contented myſelf with thoſe places whoſe latitude and longitude could be well depended on, and where the ſky was clear, and the Sun any tolerable height above the horizon. Indeed, ſome of the ten places in the above table ought, perhaps, to be rejected. The longitude of Glaſgow, for inſtance, does not ſeem fully determined. For the eclipſes of jupiter's ſatellites, obſerved there by Dr. *Wilſon*, would give the longitude different from what the Doctor calls it in his account of the tranſit. If that obſervation were left out, the mean parallax would come out a ſmall fraction larger by the external contact.

As to the parallax deduced from the internal contact, viz. 7″,447 on the day of the tranſit, I think no dependence can be placed upon it, for the reaſons given above. For, unleſs our internal contacts had all been noted about 22″ later, they would not give the ſame quantity of parallax as the external contacts. And the truth of obſervation would by no means permit us to lengthen out our internal contacts ſo much; for, in 22″ after the times noted by us, Venus appeared not only ſurrounded wholly by the Sun's light, but a conſiderable way within his diſk. And indeed the aſtronomers in Europe, ſeem ſenſible of the little dependence that can be placed on obſervations made ſo near the horizon, as thoſe of the int. cont.

Monſieur Ferner writes from Stockholm, that he is more ſurprized that " the times or the contacts ſhould agree ſo well together than he is at their difference. For the nearneſs of the Sun to the horizon, and the extraordinary quantity of vapors with which the atmoſphere was loaded, not only

only caused the limb of the Sun to tremble and undulate, but gave it, as it were, the form of a large saw, the eminences being luminous, and the cavities black, which shifted places like a tempestuous ocean." These things made it difficult to fix even the time of the external contact to greater certainty than 5 or 6 seconds; but, at the internal contact, he found difficulties of another kind. For "when he thought Venus ought to be entirely within the Sun, the luminous cusps did not join immediately behind her; but on the contrary, she seemed to carry the limb of the Sun along with her, which appeared to bend towards her, leaving a black cavity in his limb; and the body of the planet, though he thought he saw it all within the Sun, still shot out a black column or ligament towards his limb."

It was intended to have compared all the other American observations (as well as those of Norriton and Philadelphia,) with the European observations, for deducing the Sun's parallax; but I could only find leisure to make the calculations for two places more, viz the Capes of Delaware, and Baskenridge, New-Jersey. Mr. *Biddle*'s external contact at the Capes, compared with the ten places above, gives 9″,254 for the Sun's parallax on the transit day; and deducting 8″ of time, by which he thinks he noted his internal contact too late, on account of the tremulous motion on the Sun's limb, occasioned by the dense vapors from the sea, that contact gives 8″,862. The external contact (observed at Baskenridge, by Lord Stirling) gives, on a like comparison 7″,756, and his internal contact 8″,1668.

His Lordship has not yet had an opportunity to ascertain the longitude of Baskenridge with the necessary precision; and the contacts by Mr. Biddle being about 16″ later, than they ought to be from his difference of longitude (allowing for parallax) compared with Philadelphia and Norriton; he apprehends that the time of his clock could not be depended on nearer than to about one quarter of a minute, having only a very small equal altitude instrument mounted

on

on a theodolite, to regulate by, and the wind very high on June 2d. In other refpects, there cannot by the leaft doubt of the accuracy of his obfervations, having an excellent telefcope, and acknowledged abilities for the ufe of it; nor can there be an uncertainty of fo much as 3″ of time in the longitude of his obfervatory, in refpect to the places abovementioned.

Neverthelefs, if the parallax of the Sun deduced from thefe two obfervations of the external contact, be joined with thofe of Norriton and Philadelphia, and the mean of all the four be taken, it will give 8″,4907 for the Sun's parallax on the tranfit day, agreeing exceedingly near with what was got before by the comparifon from the Philadelphia and Norriton external contacts, viz. 8″,4764.

There is one fmall nicety, which the extreme ftrictnefs of the modern aftronomy might have required to be taken into the foregoing calculations; and which was not thought of in time. In the hypothefis of the earth's being an oblate fpheroid, the true latitude of places is more fouth than the apparent latitude, or that deduced from obfervations. Thus, the calcul. were made with lat. 40°. 9′. 31″ for Norriton.

But, on account of the fpheroidal figure of the earth, fubtract,	0. 14. 38
Remains the true latitude, that fhould have been ufed in the calculation,	=39. 54. 53

In like manner the latitude for Greenwich fhould be 51°. 14′. 19″, inftead of 51°. 28′. 37″.

Moreover the horizontal parallax affumed in the calculations, being to be confidered as the equatoreal parallax, fhould bear a fmall reduction likewife for different latitudes.

With this reduction, therefore, both of latitude and parallax, the calculations for Greenwich and Norriton were repeated, and the Sun's parallax came out, for the external contact 8″,805, inftead of 8″,8715. The difference is fo fmall, ſmall, that it was not thought worth while to repeat any more of the calculations on that account; eſpecially as the final determination of the Sun's parallax, from the late tranſit, as was hinted already, will not be left to depend on our calculations in America. I ſhould have been glad, if time had permitted, to have gone over the work a ſecond time, to be ſure of its correctneſs. Some of the calculations were made by Mr. *Rittenhouſe* and myſelf jointly, and of the reſidue, made by myſelf ſingly, which were the greateſt part, we have here and there ſelected out ſome re-examination. And though, among ſuch a multitude of figures, as neceſſarily entered into theſe calculations, it is difficult to avoid miſtakes wholly, either in writing or printing, yet I think, there can be none of any ſignificancy.

METEOROLOGICAL OBSERVATIONS *made at Philadelphia, in December*, 1770; *and in January, and part of February*, 1771. *By* THOMAS COOMBE, *Eſq. Communicated by Dr.* SMITH.

THOUGH part of the following obſervations ought not, in the order of time, to come into this volume, yet the ſingular moderation of the weather, for more than ten weeks of what is uſually the ſevereſt part of our North-American winters, makes it proper not to ſeparate obſervations which many people will wiſh to preſerve entire, for a compariſon with future winters, when we ſhall be favoured with any of the like mildneſs.

DECEMBER, 1770.

Days.	Hours.	Barom.	Therm. Farenh. op. air.	in d.	Wind.	Weath.
1	9 a.m.	30. [illegible]			n.	clou.
	2 p.m.	29. 9	39		n. w.	do.
2	9 a.m.	30. 1	27	32	ditto.	fair*
	2 p.m.	30. - -	30	32	ditto.	clou.
3	9 a.m.	30. 2	26	29	ditto.	fair
	2 p.m.	30. 1½	33	33	w.n.w.	do.
4	9 a.m.	30. [illegible]	28	32	ſ. w.	do.
5	9 a.m.	29. 9½	35	35½	w.	clou.
6	9 a.m.	29. 6½	38	40	ditto.	do.
	2 p.m.	29. 7¼	43½	43½	n. w.	do.
7	9 a.m.	30. ½	31	36	ditto.	fair
	2 p.m.	29. 9⅞	36½	36½	n.	do.
8	9 a.m.	29. 8	35	37	w.	do.
9	8 a.m.	29. 9	33	36	ſ. w.	do.
10	8 a.m.	29. 8½	36	40	ditto.	do.
	2 p.m.	29. 8¼	46	46	ditto.	do.
11	9 a.m.	30. ¼	38½	41	n. e.	clou.
	2 p.m.	29. 9		41	ditto.	do. †
12	9 a.m.	29. 8	43	43	n.	do.
	2 p.m.	29. 7¾	43	43	ditto.	do.
13	9 a.m.	29. 8⅓	35½	41	n. w.	ſnow
	2 p.m.	29. 9	38	41	ditto.	clou.
14	9 a.m.	30. 2½			n. w.	fair. ‡
	2 p.m.	30. 2½	39	39	w.	do.
15	9 a.m.	30. 2½	30	33		do.
16	9 a.m.	30. ½	39	41	ſ. w.	do.
	2 p.m.	29. 9½		44½	ditto.	do.

Days.	Hours.	Barom.	Therm. Farenh. op.	in	Wind.	Weath.
17	9 a.m.	29. 8½	42	[illegible]	w.	clou.
	2 p.m.	29. 9½	45	46	n. w.	do.
18	9 a.m.	30. 2½	37	43½	ditto	do.
	2 p.m.	30. 2½	44	44	ſ. w.	fair
19	9 a.m.	29. 9½	40	43	w.	clou.
	2 p.m.	29. 9	49	48	n. w.	[illegible]
20	9 a.m.	29. 8¾	37	42	w.	fair
21	9 a.m.	29. 1½	43	45	ſ. w.	rain
	2 p.m.	29. 1½	47	47	w. by [illegible]	clou.
22	9 a.m.	29. 5½	32	35	n. w.	w &
	2 p.m.	29. 6½	34¼	36	ditto.	clou.
23	9 a.m.	29. 6½	32	36	n. e.	ſnow
	2 p.m.	29. 6½	34	37½	n. n. e	clou.
24	9 a.m.	30. ½	27	32	ſ. w.	do.
	2 p.m.	30. ½	31	32	n. w.	do.
25	9 a.m.	30. 1½	28	32	n.	do. §
	2 p.m.	30. 1⅔	31	31½	n. w.	do.
26	9 a.m.	30. 3[illegible]			ſ. w.	fair
	2 p.m.	30. 3½	31	31½	w.	do.
27	9 a.m.	30. 3¾	31	32	n. e.	do.
28	9 a.m.	30. 3½	29	33½	ditto.	do.
	2 p.m.	30. 3½	36	37½	n.	do.
29	9 a.m.	30. 2¼			w.	fair
30	9 a.m.	30. ½	34	36½	ditto.	do.
	2 p.m.	30. ½		42	ſ. w.	do.
31	9 a.m.	29. 8[illegible]	37	37	n. e.	rain
	2 p.m.	29. 7¾	41	41	ditto.	clou.

* Snow the preceeding night. † Rain at times. ‡ A ſharp froſt in the night. § Snow in the night.

JANU-

JANUARY, 1771.

Days.	Hours.	Barom.	Therm. Farenh. op. air.	in d.	Wind.	Weath.
1	9 a.m.	30. $\frac{1}{4}$			n. w.	clou.*
	2 p.m.	30. $1\frac{1}{2}$	$38\frac{1}{2}$	39	n. n. e.	do.
2	9 a.m.	30. $3\frac{1}{2}$	31	$35\frac{1}{2}$	n. w.	fair †
	2 p.m.	30. $2\frac{1}{4}$	37	$37\frac{1}{2}$	f. w.	do.
3	9 a.m.	29. $9\frac{3}{4}$	35	$37\frac{1}{2}$	n. w.	rain
	2 p.m.	29. $8\frac{1}{4}$	39	41	f. w.	clou.
4	9 a.m.	29. $7\frac{1}{4}$	39	$41\frac{1}{2}$	f. w.	fair
	2 p.m.	29. 8	44	44	w.	do.
5	9 a.m.	29. 8	35	39	f. w.	do.
	2 p.m.	29. $7\frac{3}{4}$	45	$43\frac{1}{2}$	w.	do.
6	9 a.m.	30. $3\frac{7}{8}$	$33\frac{1}{2}$	$38\frac{1}{2}$	n. e.	do.
	2 p.m.	30. $3\frac{7}{8}$	37	$36\frac{1}{2}$	n.	do.
7	9 a.m.	30. $1\frac{1}{3}$	$32\frac{1}{2}$	36	n. e.	do.
	2 p.m.	30. $\frac{1}{2}$	37	$37\frac{1}{2}$	n.	clou.
8	9 a.m.	30. $2\frac{1}{2}$	$30\frac{1}{2}$	34	n. n. e.	fair
	2 p.m.	30. $2\frac{1}{2}$	36	36	n. n. e.	do.
9	9 a.m.	30. $\frac{1}{2}$	30	$31\frac{1}{2}$	n. e.	clou.
	2 p.m.	29. $8\frac{1}{2}$	40	$41\frac{1}{2}$	f.	do.
10	9 a.m.	29. 8	36	37	f. w.	fair
11	9 a.m.	30. $\frac{1}{2}$	34	36	n. w.	do.
	2 p.m.	30. $\frac{1}{2}$	46	45	w.	do.
12	9 a.m.	29. $9\frac{7}{8}$	$43\frac{1}{2}$	44	f. w.	do.
	2 p.m.	29. $9\frac{1}{4}$	$52\frac{1}{2}$	$44\frac{1}{2}$	f. w.	clou.
13	9 a.m.	29. 8	43	49	w.	rain
	2 p.m.	29. $6\frac{3}{4}$	42	$46\frac{1}{2}$	n. w.	clou. ‡
14	9 a.m.	30. $2\frac{1}{2}$	25	$33\frac{1}{2}$	n. w.	fair
15	9 a.m.	30. 3	28	39	n.	do.
	2 p.m.	30. 3	35	$35\frac{1}{2}$	f. w.	clou.
16	9 a.m.	30. $1\frac{1}{4}$			n. e.	rain.
	2 p.m.	30.	$42\frac{1}{2}$	$42\frac{1}{2}$	f. e.	do. §
17	9 a.m.	29. $9\frac{1}{2}$	47	48	n. w.	cloudy.
	2 p.m.	29. 9	$46\frac{1}{2}$	$46\frac{1}{2}$	n. w.	do.
18	9 a.m.	29. $8\frac{1}{2}$	35	41	n. w.	cloudy.
19	9 a.m.	30. $\frac{1}{2}$	$30\frac{1}{2}$	$33\frac{1}{2}$	do.	fair.
20	9 a.m.	30. $\frac{1}{2}$	31	35	f. w.	cloudy.
	2 p.m.	29. $9\frac{7}{8}$	36	$36\frac{1}{2}$	do.	do.
21	9 a.m.	29. $9\frac{1}{2}$	35	36	n.	do.
	2 p.m.	29. $9\frac{1}{4}$	40	41	n. w.	fair.
22	9 a.m.	29. $7\frac{1}{2}$	36	38	n. e.	fnow. ‖
	2 p.m.	29. 7	36	36	do.	do.
23	9 a.m.	29. $9\frac{1}{2}$	35	36	do.	cloudy.
24	9 a.m.	29. 91	31	34	do.	do.
	2 p.m.	29. $8\frac{3}{4}$	35	$32\frac{1}{2}$	do.	do.
25	9 a.m.	29. $8\frac{3}{4}$	33	36	do.	do. ¶
	2 p.m.	29. $8\frac{1}{2}$	35	$33\frac{1}{2}$	do.	do.
26	9 a.m.	29. $9\frac{1}{3}$	29	31	n.	fair.
	2 p.m.	29. $9\frac{1}{3}$	33	33	n.	do.
27	9 a.m.	30.	31	33	f. w.	cloudy.
	2 p.m.	30.	36	36	f. w.	do.
28	9 a.m.	30. $2\frac{1}{2}$	32	35	n. w.	do.
29	9 a.m.	30. $6\frac{3}{4}$	29	33	n. *by* e.	fair.
	2 p.m.	30. $6\frac{3}{4}$	34	33	n.	do.
30	9 a.m.		35	36	n. e. *by* e.	rain. ‡‡
	2 p.m.	29. $6\frac{2}{3}$	40	40	n. e. *by* e.	do.
31	9 a.m.	28. $5\frac{1}{2}$	40	40	w.	cloudy.
	2 p.m.	29. 5	45	$43\frac{1}{2}$	w.	do.

* Rain in the night. † Sharp froft in the night. ‡ And fun-fhine. § And wind. ‖ And wind. ¶ Snow in the night. ‡‡ And wind;—fnow in the night, and early this morning.

FEBRUARY, 1771.

Days.	Hours.	Barom.	Therm. Fahren. op. air.	in d.	Wind.	Weather.
1	9 a.m.	30.			n. w.	Fair and windy.
	2 p.m.	30. $1\frac{2}{3}$	38	39	n. w.	Fair.
2	9 a.m.	30. $1\frac{1}{2}$	31	32	f. w.	Ditto.
	2 p.m.	30. $1\frac{1}{2}$	40	39	do.	Clouds, and fun-fhine at times.
3	9 a.m.	30. $1\frac{3}{4}$	35	$38\frac{1}{2}$	n. w.	fair.
	2 p.m.	30. $1\frac{1}{4}$	39	39	do.	cloudy.
4	9 a.m.	30. 1	20	35	do.	fair.
	2 p.m.	29. $8\frac{7}{8}$	$42\frac{1}{2}$	$42\frac{1}{2}$	f. w.	Ditto.
5	9 a.m.	30. $\frac{1}{2}$	33	38	n. w.	fair and windy—Smart froft in the night.
	2 p.m.	30. $1\frac{3}{4}$	$33\frac{1}{2}$	$36\frac{1}{2}$	do.	Ditto.
6	9 a.m.	29. $9\frac{1}{2}$	25	23	n. *by* e.	fair; intenfely cold this morning.
	2 p.m.	30. $3\frac{1}{4}$	$26\frac{1}{2}$	26	n. w.	cloudy.
7	9 a.m.	29. $7\frac{3}{4}$	$32\frac{1}{2}$	$33\frac{1}{2}$	n. e.	rain; fnow in the night.
	2 p.m.	29. $5\frac{3}{4}$	35	35	n. w.	Ditto.
8	9 a.m.	29. 8	$32\frac{1}{2}$	$35\frac{1}{2}$	do.	fair—much rain and wind at night.
9	9 a.m.	28. $3\frac{3}{4}$	$39\frac{1}{2}$	$46\frac{1}{2}$	f. w.	cloudy and ftormy;—a remarkable high tide.
	2 p.m.	28. 7	$39\frac{1}{2}$	41	w. f. w.	cloudy and windy.
10	9 a.m.	29. 7	$24\frac{1}{2}$	$27\frac{1}{2}$	w.	fair and windy.
	2 p.m.	29. 7	28	$28\frac{1}{2}$	do.	Ditto.
11	9 a.m.	30. $\frac{1}{2}$	$26\frac{1}{2}$	28	n. e.	overcaft.
12	9 a.m.	29. $\frac{3}{8}$	$38\frac{1}{2}$	$38\frac{1}{2}$	w.	foggy;—much rain in the night.
	2 p.m.	29. $3\frac{3}{4}$	$32\frac{1}{2}$	$35\frac{1}{2}$	n. w.	wind and Sun-fhine.
13	9 a.m.	29. $8\frac{7}{8}$	15	21	do.	cloudy and very windy—Delaware full of ice.
	2 p.m.	29. $8\frac{1}{8}$	26	26	do.	wind and Sun-fhine.
14	9 a.m.	29. $8\frac{1}{6}$	25	27	f. w.	overcaft.
	2 p.m.	29. $7\frac{1}{2}$	35	34	do.	fun-fhine.
15	9 a.m.	30. $\frac{1}{4}$	$22\frac{1}{2}$	28	n. w.	fair.
	2 p.m.	30.	31	$31\frac{1}{2}$	do.	Ditto.

The

The thermometer marked open air, is ſuſpended in a North window, about thirteen feet from the ground, the caſement of which ſtands on a jar. That marked in doors, hangs in an open entry of a ground floor, the door of which fronts the eaſt. The former thermometer was made by the late ingenious Mr. Ayſcough, and compared with one made by the accurate Mr, Bird; the latter was made by Mr. Nairne, and compared with that of Ayſcough, with which it agrees.

From the accounts of the weather at Plymouth, in England, in January, 1768, as publiſhed in the 58th vol. of Philoſophical tranſactions, it appears, the greateſt cold there, was on the third and fourth days of that month, when the mercury in the thermometer fell to 20 degrees. The greateſt height was on the 14th, when the mercury ſtood at 49 degrees; wind at S. W.

SECT. II.

ESSAYS ON AGRICULTURE.

An ESSAY on the cultivation of the VINE, and the making and preſerving of Wine, ſuited to the different climates in North-America. By the Hon. *Edward Antill*, Eſq; of New-Jerſey. Communicated to the Society

By *Charles Thomſon*, with the following Extract of a Letter to him.

DEAR SIR,

I HAVE at laſt, after many hard ſtruggles, and many a painful hour, labouring under a tedious diſorder, finiſhed the eſſay on the cultivation of the Vine, &c. which I now ſend you.

Nothing but the love of my country and the good of mankind could have tempted me to appear and expoſe myſelf to public view. I have, to the utmoſt of my ſkill and knowledge,

ledge, endeavoured to lay open and explain every part of this undertaking, yet new to America; though an undertaking as antient at leaſt as the days of Noah; and yet what ſeems ſtrange to tell, it is an art that has not yet arrived at perfection, but is ſtill viſibly capable of ſome eſſential improvements. That America ſhould give the finiſhing ſtroke at laſt to a work, that has been in hand above four thouſand years; and what is ſtill more ſtrange, a work every part of which, is an experiment, if attended to; I ſay that the completing of ſuch a work ſhould be left to the genius of America, no doubt would give the people of America a good deal of pleaſure. That this will be the caſe, I cannot yet take upon me to ſay; but I think there are ſome hints now offered, which if ſteadily purſued, and improved by eaſy experiments, the making of wines and the preſerving them, will ſoon arrive at greater perfection, than yet it has been done.

The ſucceſs and perfection of every undertaking depends upon ſetting out right: Indeed the people of America have greatly the advantage of the people of Europe, in things of this nature, becauſe we begin where they leave off, and we are free from the force of all their prejudices and erroneous cuſtoms; but then we muſt determinately act like men, and judge for ourſelves, and not implicitly follow them, without the uſe of our own reaſon: Let us then ſuppoſe that every art is capable of improvement, and let the people of America try the ſtrength of their own genius. They may hit on things, that have not been thought of before; for we yearly ſee, that the arts and ſciences too, meet with conſtant additional improvements; and why ſhould the people of America be ſecluded from the honour and pleaſure of being ſerviceable to mankind in their turn. We muſt expect to meet with all the diſcouragements, that the artifice of France, Spain and Portugal can give us; we ſhall be told, that our country is too new, our ſoil is not fit, and our climate is the reverſe of that of wine countries; beſides that without the help of experienced vignerons it will be impoſſible for us to make any hand of it; that as to books, they are ſo erroneous, *that there is no dependence upon them, and abundance of ſuch ſtuff. But let not the people of America be dupes to France, or any ſet of deſigning men.*

Why the people of America, that trade in wines, ſhould give oppoſition to the undertaking, I cannot conceive. They and their children will be dead and gone, before it can arrive to ſuch a pitch, as to interrupt their trade; beſides it muſt, when brought to perfection, be a double advantage to ſuch men; for it is well known, that the wine merchants, in all wine countries, gain more by wine than the people that make it; and their gain will ſtill be increaſed, when they come to ſend it home to the mother country.

The papers I ſend you are only a rough draught, as you will eaſily diſcover; I have not ſtrength to go over it again, to range all the parts under different heads, in order to reduce them to proper chapters for the eaſe of the reader; I muſt leave that to the printer, and to thoſe that direct the preſs.

I am, &c.

E. A.

Monmouth, New-Jerſey,
Shrewſbury, *May* 10 1769.

An Eſſay on the CULTIVATION *of the* VINE, *&c.*

THE vine, if conſidered in its full extent of pleaſure, profit and uſefulneſs to man, challenges, next to what affords us bread, the chief place among the vegetable creation; its fruit, when thoroughly ripe, is pleaſing to the eye, grateful to the taſte, comforting to the ſtomach, refreſhing to the body when eaten with caution and moderation, and greatly contributes to health. Its juices, when expreſſed and rightly fermented and purified according to art, partake of a noble ſpirit truly homogeneous and fit for the uſe of man. They gladden his heart, remove to to a diftance his troubles and cares, caufe him to forget his poverty and low eftate, and raife him to a level with the rich and great: They enliven his thoughts, exhilerate his fpirits, cheer his foul, and for a time make him as happy as his prefent condition is capable of. Wife and happy is the man, that fhuns excefs, that prudently avoids turning this cordial into a cup of poifon, and moderately enjoys the bleffing with a thankful heart.

Wine is a very confiderable branch of trade. The many advantages that muft arife to the Colonies from the making it, as well as to the mother country, are fo great and fo very well known, that I need not go about to defcribe them at large; to touch upon them is fufficient.

The planting of vineyards, the cultivation of vines, the making of wine, and cafks to preferve it, muft employ and give bread to a great number of people; the freight and a profitable remittance, muft enrich the merchant; and the being fupplied from the colonies with wine, in exchange for her manufactures, muft be a confiderable faving to Great-Britain.

I know full well, that this undertaking being new to my countrymen, the people of America, will meet many difcouraging fears and apprehenfions, left it may not fucceed. The fear of being pointed at or ridiculed, will hinder many: The apprehenfion of being at a certain expence, without the experience of a certain return, will hinder more from making the attempt; but let not thefe thoughts trouble you, nor make you afraid. You have a friend for your guide, who will not deceive you, nor miflead you: One, who by experience, knows, that the thing is practicable here, where the country is open and clear; one who looks upon you all his children, and with the fondnefs of an affectionate father will take you by the hand, and lead you with plainnefs and honeft fimplicity, through all the different operations, till you become mafters of the whole, and then with pleafure and delight will look on and fee you reap the profits, to your full fatisfaction, of all your expence and labour.

Whoever

Whoever confiders the general climate of North-America, the foil, the feafons, the ferenity and drynefs of the air, the length and intenfenefs of the heat, the fair and moderate weather, that generally prevails in the fall, when grapes are coming to maturity, and arrive at their greateft perfection; whoever compares the prefent ftate of the air, with what it was formerly, before the country was opened, cleared and drained, will find that, we are every year faft advancing to that pure and perfect temperament of air, fit for making the beft and richeft wines of every kind.

Such has been the bounty and goodnefs of heaven, that there are vines adapted to every country, to every region, from fifty degrees both north and fouth latitude down to the equator; and the countries beyond thefe may eafily be fuplied by traffic, fo that all the fons of men may partake of this general, this univerfal bleffing.

It is not every vine, that is fit for every country: Some are earlier, fome are later ripe; fome are tender and delicate, and will not ftand the feverity of winter, others are hardy and robuft, and will ftand any weather: Hereafter I fhall range them in proper and diftinct claffes, and adapt the different forts by name to the different climates in America, where they may be propagated with fafety and to the beft advantage.

A vine, from a ftick or cutting, begins to bear fruit the third year, the fourth year it bears more, and the fifth year you may make wine; and for your greater encouragement, from that time until it attains the full age of man, it increafes in value and yields a richer wine; and if from the beginning, it be carefully pruned, duly manured and properly cultivated, it will generoufly reward you for all your labour, expence and care, and will hold good above an hundred years, as moft writers affirm. But then it muft be tended by a careful and fteady hand. It will not bear to be flighted, or neglected. If you do not manure the ground and keep it in good heart, your vine will bear no fruit; if you neglect to cultivate the foil and keep it clean, your

your fruit will be knotty, and ſtarved, and will not come to maturity; if you ſuffer the ſtakes or props to fall, and your vine to ſprawl on the ground, the fruit will not ripen, but remain auſtere, and will not make good wine. Wine is too rich a juice to be made from a barren ſoil, or by lazy idle ſlovens. Such men ſhould never undertake a vineyard. They not only hurt themſelves, and bring the thing into diſcredit, but hinder others, who are fit for the undertaking, from making the attempt. If a vineyard does not ſucceed, the fault is in the man, not in the vine. It will flouriſh and proſper under a careful diligent hand; but it will degenerate and run wild under the hand of ſloth and idleneſs. A gentleman of Rome, who took great delight in vineyards, ſome of which he had raiſed with his own hands, wrote a very elegant piece upon the culture of vines, and in the moſt pathetic terms recommends it to the people of Italy, as the moſt profitable, as well as agreeable amuſing undertaking. Among many other encouragements, he tells them this ſtory: "Pavidius Veterenſis, a neighbour of my uncle, had a vineyard and two daughters. Upon the marriage of one of them, he gave with her as her dowry, one third of his vineyard; and then doubled his diligence, and cultivated the remainder ſo well, that it yielded him as much as the whole had done before: Upon the marriage of the other daughter, he gave with her one other third of his vineyard; and now having but one third part of the whole left; he ſo manured and cultivated it, that it yielded him full as much as the whole had done at firſt."

This ingenious author accuſes many of his countrymen of having begun this work with ſeeming reſolution, and of having carried it on for ſome time with aſſiduity, but before they had brought it to perfection, they flagged, and for want of ſteadineſs and a little longer perſeverance, loſt their money, their labour, and all their proſpects. At the time he proves to a demonſtration, from exact and minute calculations, the great advantages of vineyards notwithſtanding the great expence the Romans were at in buildings, incloſures,

ſures, workmen and magnificent works, and brings his own vineyards, which were well known, as proofs of all he had ſaid.

I ſhall take the liberty to conclude this introduction with a ſhort but pretty deſcription of the vine, which Cicero, in his beautiful tract upon old age, puts into the mouth of Cato.

The vine that naturally runs low, and cannot rear itſelf without a ſupport, is for this end provided with tendrils, by which, like ſo many hands, it lays hold on every thing it meets with, that may raiſe it, and by theſe aids it expands, and becomes ſo luxuriant, that to prevent its running out into uſeleſs wood, the dreſſer is obliged to prune off its ſuperfluous wandering branches; after which from the ſtanding joints, in the enſuing ſpring, the little bud called the gem, puſhes out the new ſhoot, wheron the tender young grape is formed; which gradually ſwelling by nouriſhment from the earth, is at firſt auſtere to the taſte, but guarded with leaves around, that it may neither want due warmth, nor ſuffer by too ſcorching rays, it ripens by the Sun's enlivening beams, and acquires that delicious ſweetneſs and beautiful form, that equally pleaſes both the taſte and the eye; and then enriches the world with that noble liquor, the advantages of which I need not name. Yet it is not the ſenſe of theſe, nor of all the advantages of huſbandry, that ſo nearly affect us, as the pleaſure I find in their culture alone; ſuch as ranging the vines and their ſupporting perches in exact and even rows, in arching and binding their tops, lopping off the woody and barren, and training the fruitful branches to ſupply every vacancy, and then contemplating the beauty and order with the proceſs of nature in the whole.

Of the planting and management of the Vine.

THE firſt thing neceſſary to a good vineyard is a proper plot or piece of ground. Its ſituation ſhould be high and dry, free from ſprings and a wet ſpewy ſoil. Its aſpect

pect or front ſhould be towards the ſouth and ſouth-eaſt. Though the ground be not a hill, yet if it be high, open and airy, and gradually aſcends towards the ſouth or ſouth-eaſt, it will do very well. If it be a fruitful hill, it will do better. But if it be a mountain, with a rich ſoil, it will be beſt of all; for the higher the vineyard, the richer the wine.

The ſoil moſt natural to a vineyard, and ſuch as produces the ſweeteſt grapes, and the richeſt ſtrongeſt wine, is a rich mould mixed with ſand. The newer and freſher the ground, the better; ſuch a ſoil may be found on a riſing ground and on ſome hills, but very ſeldom on the ſides of mountains; for here the ſoil is generally ſtiff and clayey, ſo ordered by Providence, as being leſs ſubject to be waſhed away by hard rains; but this ſtiff ſoil on the ſide of mountains differs greatly from clay grounds below; the winds and air, and the Sun's heat ſo dry and warm it, that it becomes a proper bed for vines, and renders them both prolific and productive of the richeſt wines.

A rich warm ſoil mixed with gravel, or a ſandy mould interſperſed with large ſtones, or with ſmall looſe rocks, are alſo very proper for a vineyard. Rocks and ſtones, if the ſoil be good, warm and dry, are no diſadvantage to vines. On the contrary, they reflect great heat to the fruit, and thereby contribute towards perfecting the wine, eſpecially if they are on riſing ground, on the declivity of a hill, or on the ſide of a mountain. It is true they are attended with ſome inconveniences. It is more difficult to keep ſuch a vineyard clean, to ſtake it well, to range the vines in proper order, and regular form, to dung the ground, and gather in the vintage. But then, theſe rocks and ſtones will make a good, cloſe, ſtrong, and laſting fence. On the ſides of hills and mountains they are abſolutely neceſſary to make low rough walls along the lower ſide of the vines, to preſerve the good ſoil from waſhing away. They ſerve alſo to keep the ground moiſt in hot dry times, when, but for them, the ſoil would be parched

up

up along ſuch ſteep grounds. In ſhort, there would be no ſuch thing as raiſing vineyards on ſuch grounds, were it not for rocks and ſtones. For as it is neceſſary to keep the ſoil looſe and mellow, it would all waſh away with hard rains, if not prevented by forming a kind of rough wall of ſtones along the lower ſide of each row of vines. Again, ſuch lands are cheap, being unfit for other purpoſes, and generally yielding but little timber or graſs. They may therefore be purchaſed by poor people, who could not afford to go to the price of good land. Laſtly, theſe ſteep hills and mountains always yield the richeſt wines, the value and price of which will compenſate for any extraordinary labour.

If the ground be worn and out of heart, it muſt be renewed and helped with dung, with freſh mould, with creek mud, with the rich ſoil that lodges along the ſides of brooks or rivers, or that ſettles in low places at the foot of hills or mountains, or by foddering cattle and ſheep upon it with good ſtore of ſtraw, ſalt hay, or corn-ſtalks, &c. or by penning ſuch cattle upon it and plowing all under it as deep as may be, till all be made ſufficiently rich, or by any other method, that ſhall beſt ſuit the owner.

If your ground be ſtiff, it may be mended by good ſtore of ſand, aſhes, ſoot, the rubbiſh and morter of old buildings, well pounded, eſpecially if ſuch morter be made of lime and ſand, by the duſt and ſmall coal of coal kilns, and the earth, that they are covered with when they are burnt, ſea ſand or fine gravel, and good ſtore of fowl's dung and ſheep's dung, or the old dung of neat cattle.

After your ground is brought into good heart, and has been deep ploughed or dug and well harrowed, ſo as to be quite mellow, it muſt be well ſecured with a good cloſe fence, ſuch as is fit to turn rambling boys, as well as cattle and hogs, for on this depends the ſucceſs of the whole.

The next ſtep to be taken, is to provide a ſufficient ſtock of vine cuttings, not only enough to plant the vineyard, but a ſmall nurſery too. If theſe cannot be had all at once, begin to lay up a year or two beforehand, and plant them in your nurfery in even rows, at four inches diftance, and the rows three feet afunder, that they may be howed and kept clean; and fcatter fome fhort ftraw and chaff along between the rows to keep the ground moift and the weeds down. Let the ground of your nurfery be in good heart, but by no means fo rich as the foil of your vineyard; if it is, when the plants are removed into the vineyard, they will pine and dwindle, and feldom flourifh and become fruitful. The reafon of planting the cuttings fo clofe in the nurfery is, to prevent their fhooting their roots too far into the ground, which would render them very difficult to take up without damaging the root, and more tedious to plant out.

Be not over fond of planting various forts of vines in your vineyard, if you mean to make good wine. The moft experienced Vignerons fay, that grapes of one fort make the beft wine; that if they are mixed, they hurt the wine, by keeping it conftantly upon the fret, by means of their different fermentations. Be that as it may, I fhould recommend this practice, for reafons that operate more ftrongly with me, which are, that the more fimple and pure wine is, the more perfect it is in kind. Three different wines may be all good in kind and very agreeable, whilft diftinct, but when mixed together become quite the reverfe, and the whole is fpoiled. If my vineyard contained one acre of ground, I fhould choofe to have but two forts of grapes in it, if I meant to make a profit of it by felling the wine, if it contained two acres, I would have four forts in it; and if it contained three or four acres, I fhould not choofe more. But if it contained fix, eight or ten acres, perhaps I might incline to have a greater variety; but then I fhould prefer thofe kinds that make the beft wines and fuch as do not come in at the fame time, from whence I fhould reap many advantages. Firft I fhould not be overhurried in the time of vintage, nor run the rifque of having fome fpoil upon my hands, whilft I was making up the reſt; again, if a ſeaſon proved unfavourable, and ſome were cut off by the inclemency of the weather, others, that were later ripe, might eſcape the injury. It is certainly beſt to plant each ſort in a diſtinct quarter by itſelf, if we mean to avoid confuſion, and to reap every advantage.

The next thing to be conſidered is the quality of the vines to be made choice of. This muſt be limited, and adapted to the climate where the vineyard is planted. The moſt hardy and earlieſt ripe, will beſt ſuit the moſt northern colonies, I mean thoſe of New-Hampſhire, Boſton, Rhode-Iſland and Connecticut. As to thoſe countries, that lie ſtill farther north, they are not yet ſufficiently cleared and open for the purpoſe. The vines proper for theſe countries are,

1. The black Auvernat,	These firſt four numbered make the beſt Burgundy.	The white Muſcadine,
2. The black Orleans,		The Muſcadella,
3. The blue Cluſter,		The Melie Blanc,
4. The Miller Grape,		The white Morillon,
The black Hamburgh,		The white Auvernat,
The red Hamburgh,		The grey Auvernat.

All theſe are ripe early in September.

All the foregoing ſorts will do very well for the three bread colonies, viz. New-York, New-Jerſey, Pennſylvania, and the three Lower Counties; I mean for the clear and open parts of theſe countries; to which may be added the following ſorts, which I recommend by way of trial, they being more tender, but ripen in September; they ſhould have the warmeſt birth in the vineyard.

The Chaſſelas Blanc, called the Royal Muſcadine,	The red Frontiniac,
The Malvois or Malmſey,	The black Liſbon,
The grey Frontiniac,	The white Liſbon,
	The Chaſſelas Noir.

All the forgoing ſorts will do very well for the colonies of Maryland, Virginia, and North-Carolina, to which I ſhall add the following ſorts, and recommend them for trial, but then they muſt have a warm place.

The

The white Frontiniac,
The malmfey Mufcat,
The claret Grape of Bourdeaux,
The white Oporto,
The black Oporto,
The black Damafk,
The Chicanti of Italy, which makes a rich wine much admired in Italy.

All the abovementioned forts will do well in South-Carolina, and in the colonies ftill farther fouth. To which I fhall add the following forts, as being ftill more tender and later ripe.

The raifin Mufcat,
The Alicant and Malaga Raifin Grape,
The red Mufcat of Alexandria,
The white Mufcat of Alexandria,
The gros Noir of Spain,
The St. Peter's Grape.

In many parts of Virginia, North and South-Carolina, and in Georgia, the foil is chiefly a hot dry fand, and what ftrength nature afforded has been exhaufted by tobacco, Indian corn, rice, &c. However thefe grounds, where they lie near to rivers and creeks, may eafily be recruited; for thefe rivers abound with rich mud, which is the beft kind of manure for fuch lands, and it would be no great expence to procure a fufficient quantity of it to cover a piece of ground large enough for a vineyard, efpecially if it be confidered, what a number of hands the gentlemen of thefe countries have, who might be employed at fuch times, when other bufinefs is not very urgent: But then this mud muft lie fome time upon the ground, before it be mixed with the foil, at leaft a fummer and a winter; for at firft it will bake very hard, and be very crude; but the winds, dews, rains and frofts, with the help of the Sun, will fweeten, mellow, and bring it into a proper temper. Then it muft be equally fpread and well mixed with the foil. Thus may the land be recruited, and kept in good heart, from time to time, and from a barren ufelefs piece of ground it may become profitable both to the owner and his country.

The nature and quality of the vines being confidered and made choice of to fuit the country you live in, the next thing neceffary to be known is, how to make choice of fuch parts of a vine, for cuttings to plant, as may be moft likely to grow and flourifh, and alfo to produce healthy and fruitful vines, on which the fuccefs and profits of a vineyard very much depend. Know then, that all parts of a vine are not equally good and fit for plants. If you have it in your choice, avoid all branches, that have not born fruit, all fuckers, nephews, lateral and fecondary branches, and efpecially the long running barren branches. Thefe different forts feldom produce fruitful vines. Choofe therefore, your cuttings from the teeming part of the vine, from among thofe branches that were fet apart for bearing fruit; and among thefe, choofe fuch as are fhort jointed, and have been moft fruitful the laft fummer, fo fhall you be fure to have fruitful and thrifty vines. Let them be cut down clofe to the old wood; for here the wood is ripeft and moft firm. The upper part of the fame branch is lefs ripe, and more loofe and fpungy, and more apt to fail, and very feldom makes fo firm and lafting a vine. However, where vines are fcarce, and men have not thefe advantages in their power, they muft do the beft they can. Thefe branches muft be trimmed and cleared from the nephews and the lateral or fecondary branches; but in doing this, great care muft be taken not to wound the buds or eyes, which a carelefs hand is very apt to do. If the bud be bruifed with the back of the knife, fo that the cotton that lies under the thin bark, that covers the bud, and is wifely intended to preferve it from the injuries of the weather, be rubbed off, the bud will perifh. Therefore as the buds lie clofe to thefe lateral branches, and are in fo much danger of being wounded, it is beft and fafeft to cut the branches off, a little above the height of the bud, that the little ftump or ftub left behind may be above the top of the bud, fo fhall the eye be left fecure, and run no rifque of being blinded.

The

Theſe branches being thus trimmed remain whole and at full length 'till the next April, which in the northern colonies, is the beſt time for planting. They ſhould be ſeparated from the mother plant, ſometime in September, or as ſoon as the vintage is over, that being the beſt time for the trimming of vines, becauſe the wounds which the mothers receive are healed up, and ſecurely cloſed from the ſeverity of the winter ſeaſon. If this work be left 'till February or March, the parent ſuffers by her freſh wounds in long rains, ſleets and froſts that follow; or if the weather be favourable, ſhe grows faint and exhauſted by exceſs of bleeding, and her eyes are drowned in her own blood.

The beſt way I have found for preſerving the cuttings through the winter, and which I therefore recommend for a general practice, is as follows. At or near the north weſt corner of your vineyard or garden, the fence being good and cloſe, let a ſmall trench be dug five or ſix inches deep and wide, and ſo long as may contain all your branches. In this plant them thick and cloſe with the but ends down, and fill up the trench, as you go, with the ground, that came out of it, and preſs it down well with your hand, all about the bottom of your branches; let the dirt riſe two or three inches above the ſurface of the ground, to prevent the water from ſettling about the vines, which would rot them. Between every ſort, drive down two ſtakes and fix a label to one of them to diſtinguiſh the vines from each other by their proper names. Before you plant your vines in this manner, drive down two or more crotches, according to the quantity of vines, at about three feet from the trench, and parallel with it, upon which poles are laid, to ſupport the upper part of the branches about twelve or fifteen inches from the ground. Thus they all lie ſloping without touching the ground, which preſerves them from growing mouldy and from rotting. The vines then are covered with ſtraw, laid lengthways upon them up and down a little beyond the trench, ſo that

that the water is carried off beyond the foot of the vines by this ſtraw roof; and yet the ſtraw muſt not be laid on too thick, leſt it continue moiſt too long, and occaſion mouldineſs. Acroſs the top, a pole is laid and acroſs the bottom, and faſtened down to prevent the ſtraw from blowing away. Thus they remained 'till ſpring.

In the beginning of April when you are ready for planting, the weather being moderate and calm, the froſt out of the ground, and nature teeming with freſh vegetation, then cut your branches for planting. If one cutting from every branch be ſufficient for your purpoſe, then cut the lower part about twelve or fourteen inches long. But as it is moſt likely, that you will not be ſo lucky, as to have enough of theſe, then do what neceſſity requires, and make two or three cuttings of every branch, not leſs than a foot long; and having a trench made ready, place them in it cloſe together, the but or lower end down, and cover them up with earth to the upper eye 'till you are ready to plant, carefully placing every ſort by themſelves, with a label denoting the kind. This direction is calculated for the three bread colonies. The more northern colonies will be a month later, and the more ſouthern colonies will be at leaſt a month, ſome two months earlier; they muſt conduct themſelves accordingly. To theſe laſt colonies, I would recommend the cuttings to be longer, that they may be planted deeper, the better to preſerve the vines from exceſſive heats and droughts.

Your ground as I ſaid before being well manured, and brought into good heart if old, or being naturally rich if new, and having been, at leaſt twice, deep ploughed and well harrowed the ſummer before, in the fall of the year it muſt be deep ploughed the third time, and always acroſs the hill or riſing ground, and let it lie rough juſt as it is ploughed, all winter, which will greatly prevent waſhing, and the froſts will mellow it and prepare it the better for vegetation.

In

In the Spring of the year, as ſoon as the ground is dry, let it be well harrowed both ways, with a ſharp iron tooth harrow laid down ſmooth and even; and take this caution along with you, which I now give once for all, never to meddle with the ground of your vineyard when it is wet, or even moiſt at top, nay, I would have you avoid as much as poſſible, walking in at ſuch a time. Your own experience will ſoon teach you, the reaſon of this caution. For you will find, that the lighter and more open and looſe the ſoil of a vineyard is kept, the more the vines will flouriſh, and the more fruitful they will prove.

When your ground is in proper order, provide a ſmall ſtake of four feet long for every vine; and begin to lay out your vineyard in the moſt regular manner the nature and ſhape of the ground will admit of. If you mean to plough and harrow your vineyard, with a ſmall ſingle horſe plough and a ſmall corn harrow, you muſt leave a border of ten or twelve feet on each ſide of every ſquare, to turn your horſe upon, leaſt he tramples upon and deſtroys the outſide vines. There will be no need of ſuch borders along the upper or lower ſide of the ſquares, unleſs you chooſe it for regularity's ſake; becauſe your vineyard ſhould never be ploughed up and down hill, but tranſverſely, unleſs you mean to have it gullied, and the rich ſoil waſhed away by hard rains.

The following method of laying out a vineyard, I think is as eaſy, as regular and as expeditious as any, for a long ſquare or a four ſquare piece of ground. Your ſquares being laid out, and having concluded how far your vines ſhall ſtand every way from one another, in which every man is to pleaſe himſelf; you ſtretch a line of a proper length, and ſtitch ſmall pieces of red, blue, green, or any other coloured cloth at ſuch diſtance from each other as you mean to plant your vines. I will ſuppoſe eight feet, becauſe upon the moſt mature deliberation, I think that the beſt diſtance for vines to ſtand at in this country, as I ſhall afterwards ſhew more fully.

The

The line being ready, ſtretch it along the head or upper part of your ſquare, ſo that a rag appears at each corner, drive down a ſtake at every rag: This done, move your line down to the lower ſide of the ſquare, which is oppoſite to the firſt, and ſtretch your line along that, having a rag at each corner, and drive down a ſtake at every rag: Then turn your line the other way up and down, and faſten your line to the upper and to the lower outſide ſtakes, ſo that a rag be at each ſtake, and drive down a ſtake at every rag, and ſo go on from ſtake to ſtake, till the whole be compleated. If you have been careful not to diſturb or move the line, when you drove down the ſtakes, and have driven them all on the ſame ſide of the line, your ſquare will be uniform, and the ſtakes near the ground, will range exactly every way.

If your vineyard be large enough to divide into four, ſix, or eight ſquares, or more, according to the different ſorts of grapes you deſign to have in it, and you are not pinched for room, you will find it very convenient on many accounts to have croſs walks of twelve feet, between the ſquares, not only to turn upon when ploughing, but for carting in of dung, and placing it handily for dunging the vines, which will be a great ſaving of labour, beſides being attended with many other advantages.

Having ſtaked your ground, which ought to be done when it is dry, becauſe it will ſave you a great deal of labour, in making it looſe and mellow again; and having as many vine cuttings as you can plant in half a day, ſoaking in rich dung water, in a pail, which ſerves beſt to keep the plants upright, the butt ends being down, dig holes at every ſtake larger or ſmaller, according to your own fantaſy and judgment: For it matters not, ſo they are deep enough to contain the plant. But here I muſt clear up a point, which has led many people into miſtakes and rendered this work more tedious, and that is the throwing into the holes, in which the vines are planted, rich mould mixed with old dung, thinking that this muſt be a great ad-

vantage

vantage to the vine. This is a great miſtake. For as ſoon as the vine ſhoots it roots, beyond this rich mixture, into the common ſoil, which is many degrees poorer and colder, the roots, as it were, recoil and ſhrink back at a coldneſs and poverty, they had not been uſed to, and the vegetation is ſtopped, and the plant dwindles into poverty and barreneſs; and if you examine the plant at bottom, you will find that inſtead of extending its roots to their uſual length, it has ſhot out a great number of ſmall fibres like threads, which extend no farther than the good mould and theſe being quite inſufficient to anſwer the demands of nature, the plant periſhes, or remains in an inactive and barren ſtate. Whereas, had the vine been planted in the common ſoil at firſt, it would have met with no alteration, no ſudden change to check its growth. This ſhews that the ſoil ſhould be well mixed; and let me tell you once for all, that the vine delights in a warm, comfortable, fruitful ſoil; but proves unfruitful and periſhes in a ſoil cold and barren. Yet a ſoil may be too rich, or made too rank by dung, and this extreme is alſo to be avoided. But to return to planting our vines, the holes being dug according to your mind, plant your vine, ſetting the foot forward from the ſtake, and bend it a little, without cracking the bark, and bring it gently up againſt the ſtake, ſo that one eye only remains above the ſurface of the ground. Let not the eye touch the ſtake, but look from it. Then mixing the ground well together, throw it in and preſs it gently about the vine, till the hole is almoſt full, and throw the reſt in lightly, without preſſing, ſo that it may riſe up to the eye of the vine, which ought to be about two inches above the common ſurface. By this means, the vine will be preſerved from drying winds and the hot Sun, till it begins to grow. Some place four or five paving ſtones about the foot of the vine, not ſo cloſe but that the roots may ſhoot out between them, and theſe they ſay, and I think with reaſon, condenſe the air in hot dry ſeaſons, and nouriſh the vine with moiſture, and cool and refreſh it when parched with exceſſive heats. In the northern colonies, the vines ſhould be planted on the ſouth ſide of the ſtakes, for the ſake of the Sun: In the ſouthern colonies, they ſhould be planted on the north ſide to avoid too great heat. The upper eye only ſhould ſhoot out branches, from which the head of the vine is formed. If any ſhoots ſhould riſe from below, which ſometimes is the caſe, the ſooner they are removed the better, theſe are called ſuckers, and very much exhauſt the vine. And thus you proceed till all be finiſhed.

When your vines are all planted, if you have any cuttings remaining, plant them in a nurſery or along the north ſide of your ſtakes, for you will have occaſion for them, as many of your vines will miſcarry, and the ſooner their places are ſupplyed the better. If ſome of your vines do not ſhoot till July, do not give them up, they may grow notwithſtanding. I have had many, that have not ſhot till Auguſt, and yet have done well. And here let me tell you that, the filling up all the vacancies, where the vines have failed or miſcarried, is abſolutely neceſſary to be done as ſoon as poſſible, either the fall after the vines were planted, with plants, if you have any growing in your nurſery, which are beſt planted as ſoon as the leaf is fallen; or the next ſpring, with cuttings, which is the beſt ſeaſon for planting them; for the latter having no root ſuffer greatly in the winter ſeaſon, and if planted in the fall, moſt of them periſh. If the vacancies ſhould by any means be neglected for three or four years, you will find it very difficult to raiſe thrifty and flouriſhing vines in ſuch places afterward; becauſe by this time, the neighbouring vines have ſhot their roots all round the ſpot, where the young vine is to be planted, and will ſo draw away the nouriſhment, and entangle the ſmall tender roots, that firſt ſhoot from it, that it will not be able to ſhoot forward and flouriſh. Some, for this reaſon, plant two cuttings in a hole, leaſt one ſhould miſcarry. To this the chief objection is, that hereby the regularity and uniformity of your vineyard is hurt, many of the vines ſtanding out of rank and file.

For

For a well regulated vineyard reſembles a fine regiment under proper and exact diſcipline. If ſome of your vines prove weak the firſt ſummer, and do not recover ſtrength the ſecond ſummer, though manured and cultivated well, root them out, for they very ſeldom are worth raiſing; and plant healthy vines in their ſtead, out of your nurſery; ſo ſhall you have a healthy, flouriſhing and well conſtituted vineyard.

By this time you ſee the neceſſity of having a ſupply of young vines from a nurſery, a circumſtance that is by no means to be neglected.

In digging up the plants from your nurſery, be careful to take them up without wounding or bruiſing the roots, and having a pail or ſmall tub, half full of rich dung water, put the plants, with the roots down, into that, ſo ſhall they be preſerved from the Sun and drying winds, which would ſoon parch and dry up theſe young tender roots and kill the vine. When you have dug up about a dozen or twenty plants, then proceed to planting, which muſt be done in the following manner. Your holes being dug deep enough and ſufficiently wide, for the roots to be ſpread in at full length, throw in ſome looſe earth, and ſpread it over the bottom of the hole, and fix in your plant near the ſtake, ſo high that the little branches riſe an inch or two above the ſurface of the ground. The roots, you will perceive, for the moſt part grow in rows, one above another. The upper roots of all, which are called the day roots, muſt be cut away; the under roots of all muſt then be ſpread at full length, and covered with earth, then the next muſt be ſerved in the ſame manner, and ſo on till all be regularly extended and covered. This is purſuing of nature, which in theſe caſes is generally the beſt director. So ſhall the earth be well ſettled about the roots, and the vines in the ſpring will grow and flouriſh, as if they had not been moved or tranſplanted. If a ſervant, or even a gardener be left to manage this work, they will be apt, as I have often ſeen, to ſet the plant in the hole, in a carelefs manner, with all the roots huddled together, and fo cover it with earth. This is fo contrary to the order of nature, and to common fenfe, that the difference is plainly feen without farther explanation; and indeed moft of the mifcarriages in life are are owing to inattention and careleffnefs.

Your vines being all planted as above directed, and the vine cuttings, with one eye only above ground, and that almoft covered with light earth, to preferve them from fuffering with heat and from drying winds 'till they begin to grow; this upper bud only will fhoot out branches, and the lower ones will throw out roots: And this is much better than to have two or three buds above ground, and branches growing from them all, which only ferve to weaken the vine, and to hinder the forming of a good head, which is the firft and chief point to be gained and well fecured.

We now proceed to the management of the vine in its infant ftate, upon which will very much depend the fuccefs of your vineyard.

There are but two ways of forming and managing of vines to advantage for vineyards, by ftakes, or efpaliers. In ancient times, it was common for vines to be wedded to trees, and they had the poplar, the afh, or the elm for their companions and fupports, but men foon difcovered the great inconveniency of following nature in this refpect. They found, that thefe trees were found difficult to raife in high dry grounds, where vines were proper to be planted; that when they did grow, their roots were very much in the way of the vines, and of working the land, and alfo drew away too much of the ftrength of the ground; and they mounted the fruit fo high, that it became very difficult and took up a great deal of time to gather it, for which reafons this method has long been laid afide. As for wall fruit, the vines that are fixed to walls muft be managed in the fame manner, as thofe which are defigned for efpaliers, that is, the head of the vine is at firft formed

formed about three feet from the ground. But this I ſhall particularly explain, when I treat of the management of vines for eſpaliers. I ſhall begin then with the proper culture of vines that are deſigned for ſtakes.

In this caſe the head of the vine is formed near the ſurface of the ground, as I have already more than once obſerved; and this method is now generally practiſed throughout wine countries, and indeed it is the only method proper for countries, where the froſts in winter are ſo hard as to hurt vines, by which means the next year's crop is deſtroyed. There is no way to prevent this, but by covering the vines in winter, which cannot well be done, when vines are fixed upon frames or eſpaliers, without great difficulty and labour, as well as danger to the vine.

The firſt ſummer after the vine is planted, you have nothing to do, but to tie up the little branches to the ſtakes with a ſoft band, as ſoon as they are grown about a foot or fifteen inches long, which will ſave them from being torn off by hard winds, which would endanger the vine. Beſides they grow the ſtronger and the better for it, and are out of the way of the hoe, the plough and the harrow. You are alſo to keep the ground clean and free from weeds and graſs; for they are great enemies to vines. If the ground be kept mellow and looſe, your vines will grow and flouriſh the better. If you have any litter, ſhort ſtraw and chaff, the ſhives of broken hemp or flax, the chaff of flax ſeed, the duſt and chaff of buckwheat, and the ſtraw trod fine with horſes when it is dry, any or all of theſe ſpread over your vineyard after it is hoed or ploughed and harrowed, will keep down the graſs and weeds, keep the ground moiſt and light, and will greatly preſerve the good ſoil from waſhing away. If this be done the firſt three or four years, it will greatly forward the vines, bring the ground into good heart, and finely prepare it to produce good crops, by keeping it looſe, airy and light, in which vines greatly delight.

In

In the month of September, when the leaf begins to wither and fall off, which is the beſt time for trimming of vines, as I have already obſerved, cut down all the branches, to one good bud each, and always remember that the lowermoſt bud next the old wood, is called the dead eye, and is never reckoned among the good buds. When your vines are thus trimmed, let a careful hand take away the dirt from the foot of the vine, about four inches down, and cut away all the upper roots that appear above that depth. Theſe are called day roots, and muſt be taken away every fall, the firſt three years. The beſt way is, not to cut them off cloſe to the body of the vine, but about a ſtraw's breadth from it, ſo ſhall they not be ſo apt to grow again. Theſe upper or day roots greatly weaken the vine, and hinder the lower roots from extending themſelves, and from firmly fixing themſelves below, on which greatly depend the ſtrength, firmneſs and durableneſs of the vine, and alſo its fruitfulneſs. Beſides by theſe roots running deep, the vine is preſerved from periſhing in long tedious droughts. Let the foot of the vine be left open, after the day roots are cut away, that it may dry and harden, till the hard froſts come. Then the holes are to be filled again, and the head of the vine covered with chaff and ſhort ſtraw mixed, or with bog hay, or ſalt hay, or with horſe litter, that is free from dung and graſs ſeeds; for theſe ſhould be carefully kept out of a vineyard, which will ſave the labour of rooting out the graſs that would ſpring from them. Some cover the head of the vine with the ground when they fill up the holes; but this is wrong, it greatly endangers the vine, as I have found by experience, for I have loſt many of them by this management, before I diſcovered the danger. The ground, in warm rains, moulds and rots the vine. For the ſame reaſon, ſuffer no dung to be among the ſtraw, hay, or horſe litter with which you cover your vines. The heat of the dung, in warm rains or muggy warm weather, will mould and rot them; the cooler and dryer they are kept, the better.

better. I have told you before, and I now repeat it, (becaufe it is a work that muft by no means be neglected,) when you trim your vines, if you find that any of them have mifcarried, which is very common, plant others in their room immediately, if you have any plants of the fame fort growing in your nurfery; if not, then do not delay to provide cuttings of the fame kind, and preferve them till fpring, as you were before directed, and plant them in the vacant places, that your vineyard may be full and complete as foon as poffible, fo fhall it grow and flourifh the better.

The fecond fummer you will find more branches fhooting from the heads of your vines, than did the firft fummer; and here the fkill of a Vigneron is neceffary for forming the head of a vine in the beft manner. Let the fhoots grow, till they are ten or twelve inches long, then choofe eight, that are fhort jointed and much of a fize, that grow on all fides of the vine, and with your finger ftrike off all the reft. If any one branch among the whole number, appears much more thrifty than the reft, you may perhaps be tempted to fave it; but let not your eye fpare it. It will only prove a thief and a robber. It will draw to itfelf the chief nourifhment of the vine, and ftarve the reft of the branches, and after all will bear but little fruit. The fhort jointed branches, prove the beft bearers, and thefe ftanding on all fides of the head, preferve the vine in full ftrength and vigor. For this reafon the rounder the head of the vine is formed, the better. If the branches be fuffered to grow from one fide of the head, the other fide fuffers greatly, and is apt to perifh.

This year there fhould be two ftakes to a vine, one on each fide, to faften the branches to, by this means they are fpread at a diftance from each other, and grow the ftronger and better; the Sun, air, and winds come to every part; the wood ripens well, and the buds fill, and they are the better prepared to become fruitful in due time. Whereas, when they are huddled altogether, and faftened up to one ftake,

ftake, they fuffer greatly for want of the Sun and air to dry them after rains, mifts and heavy dews; and in clofe muggy weather, they will mildew and rot. Let therefore the branches be tied up fingly to the ftakes on each fide, with a foft band, as foon as they are long enough, leaft they be torn off by hard winds, which would ruin the vine. I need not tell you again, that your vineyard is always to be kept clean and free from weeds and grafs; and the dryer the ground is, and the hotter the weather, the more effectually they are deftroyed, by hoeing, ploughing and harrowing. But remember never to meddle with your ground when it is wet, you do more hurt than good.

This fecond fummer your main branches fhould be fuffered to grow about five feet long, and then the ends of them muft be nipped off, in order to curb them, to keep them within proper bounds, and to hinder them from growing wild. The lateral or fecondary branches fhould be nipped off at the end, when they are about a foot long, the nephews alfo fhould be nipped off when they are about fix inches long. This is much better, than the taking all thefe fmaller branches clean away, which is the practice of fome, who are more nice than wife. For I have found, by experience, that, when thefe fecondary branches are clean taken away, the main branches fuffer; they grow flat, and appear diftorted; which plainly fhews, that nature is deprived of fomething, that is effentially neceffary to her well being. It is quite neceffary to nip off the ends of the main branches, when they are grown about five feet long. They grow the larger and ftronger, the wood ripens the better, the lower buds are well filled, and better prepared for the bearing of fruit. Befides it teaches the vines to become reconciled to a low and humble ftate, it curbs their pride and ambition, which is always to climb and mount up above every thing that is near them, and educates them to bear fruit within your reach. Some time after the tops of the main branches are nipped off, they will fhoot out a fecond time, and then they generally throw out, from

near

near the end, two branches inſtead of one; ſo prone is the vine to ſhoot and extend itſelf, theſe alſo muſt be nipped off; at the ſame time the lateral or ſecondary branches muſt be looked to and nipped off, if any of them are ſhooting out anew.

In the fall of the year, as ſoon as the leaf begins to wither and fall off, which happens earlier or later, according to the weather, cut the branches down again to one good bud each, and take away the earth round the heads of the vines, as before directed, and cut away the day roots, and manage them juſt in the ſame manner as you did the fall before. Now as ſome of your forward vines will bear fruit the third from the planting, which is the next year, and as it is natural for you to deſire fruit, and eſpecially to know what ſort of fruit, and how good, your different vines will bear; to ſatisfy your curioſity, I would adviſe you to ſet aſide two or three at moſt, of each ſort of your moſt thriving vines for that purpoſe, and inſtead of cutting down all their branches to one bud each, like the reſt, leave two branches on each of theſe vines, with two or three good buds each, which will ſhew ſome fruit to your ſatisfaction. But be perſuaded to prevent the reſt from bearing fruit till the fourth year, and the weaker vines till the fifth year, and your vineyard will make you ample ſatisfaction, for this piece of ſelf denial. For it greatly weakens a vine to bear fruit when ſo young; and however fond moſt men may be of their vines bearing much fruit, the overbearing of vines is allowed on all hands, to hurt them greatly. To prevent which, in wine countries, where it is common to leaſe out vineyards to huſbandmen, whom they call Vignerons, they have very ſtrict laws, obliging them to leave four, ſix, or eight bearing branches on a vine, according to the age of the vineyard, the ſtrength of the vines, and the goodneſs of the ſoil, and according to the cuſtom of different countries where good wines are held in repute, to prevent their hurting the vines, and the reputation of their wines. Theſe Vignerons are likewiſe

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obliged, after three fruitful years, if ſo many happen ſucceſſively, to let their vineyards reſt one year without bearing fruit, that they may have time to recruit and gather freſh ſtrength.

The third ſummer you are to manage your vines in the ſame manner you did the ſecond, tying up all the branches to the ſtakes, one above another; only of thoſe vines that are to bear fruit, the fruit bearing branches ſhould be tied up above the reſt, that the fruit may have the benefit of the Sun, the air and winds, all which are neceſſary, and conſpire to bring the fruit to maturity; and this ſhould always be the practice. This year a third ſtake is provided, which in the ſpring is drove down juſt on the north ſide of the vine, upon a line with the reſt, for order ſake. To this ſtake the branches that bear fruit, there being but few of them, will be beſt faſtened, becauſe there will be the more room for the branches of reſerve, which are to bear fruit the next year, to be diſtinctly faſtened to the ſide ſtakes. Theſe branches of reſerve are now of great importance to the owner, as the next crop will depend upon the right management of them. They are, therefore, to be carefully tied up at proper diſtances to the ſide ſtakes, that they may grow well, that the wood may ripen, and that the buds may be well filled. When they are grown about five feet long, the ends muſt be nipped off, the lateral branches kept ſhort, and the nephews reſtrained, if they grow too long, ſo ſhall the main branches appear full and round, and in a natural, healthy and flouriſhing ſtate; whereas, if they are all tied up to one ſtake, as is the practice with ſome people, the wood remains green and ſpungy, and does not ripen, the buds do not fill well; and where the band is, all the branches mildew and rot; which plainly ſhews the badneſs of ſuch management. As to the few vines that bear fruit this ſummer, let the fruit bearing branches be nipped off five joints above the fruit, and let the ſide branches and nephews be kept ſhort as above directed; ſo ſhall the fruit come to perfection.

In

In the fall of this third ſummer, preſerve two of the beſt ſhort jointed branches of reſerve, one on each ſide of the head of the vine, for bearing fruit the next year: The reſt cut down to one good bud each. If ſome of your vines be very ſtrong and flouriſhing, you may preſerve four branches for bearing fruit, but by no means more, one on each quarter of the vine, ſo ſhall they bear fruit the better. As to the branches on the few vines, that bore fruit this year, they muſt be cut down to one good bud each; for the ſame branch muſt never be ſuffered to bear fruit two years running, unleſs you fall ſhort of branches of reſerve, in that caſe you muſt do what neceſſity requires, and let the old branch bear a ſecond time, but they ſeldom or never bear ſo large cluſters, nor ſo fair fruit. On theſe vines, that bore fruit this year, not above two branches on each, ſhould be kept for bearing fruit the next year, ſo ſhall you preſerve their ſtrength from being exhauſted when young; they will laſt the longer, and bear fruit the more plentifully hereafter. The reſt of the management is the ſame with that of the laſt year; only ſome time in the latter end of November, or ſomewhat later, if the hard weather keeps off, a ſmall long trench on each ſide of the vine is dug with a hoe, and the branches that are kept for bearing fruit, are laid down gently into them, without forcing them, ſo as to crack them, or ſplit the bark, or ſtrain the wood too hard, and muſt be covered over with the earth. If any part appears above ground, it muſt be well covered with ſtraw, bog, or ſalt hay, and indeed if the whole that are buried were alſo covered in the ſame manner, with ſtraw, &c. it would be beſt; for the branches being of an elaſtic nature, they are very apt, upon the thawing of the ground, to riſe with their backs above the ground, and remain expoſed to the weather, ſo that your crop may be loſt notwithſtanding your trouble, which a ſmall covering of ſtraw or hay will prevent. If any of them ſhould be ſo ſtiff and ſtubborn as not to bend down, then bind ſtraw round them and the ſtake.

In

In the ſpring of the fourth year, the branches that have been preſerved for bearing fruit, muſt be carefully trained up to the ſide ſtakes, the higher the better; and the branches that ſhoot out from the head this ſpring, which are called branches of reſerve, and are deſigned to bear fruit the next ſucceeding year, muſt be tied up to the ſtakes below the fruit bearing branches, and one or two to the middle ſtake, if there is room, for often times the fruit bearing branches, occupy the middle as well as the ſide ſtakes, and eſpecially in a plentiful year. The management of the vine in its bearing ſtate, calls for a cloſe and particular attention. Some gentlemen, and thoſe who have written beſt upon this ſubject, recommend the taking away all the lateral or ſecondary branches and the nephews, cloſe to the body of the fruit bearing branch, and to leave only the main leaves of that branch, thinking, by this method, that all the nouriſhment of the vine is thrown into the fruit. They alſo order the top of the branch to be taken off, within three joints of the uppermoſt cluſter of grapes. Others again are for following nature, and ſuffer all the branches to extend themſelves as they will. Theſe I look upon to be, two extremes, and think that a middle way, is every way beſt, moſt rational and ſafeſt. The lateral branches, the leaves and nephews are ſuppoſed by naturaliſts to draw off and perſpire the crude and thin juices and to hinder them from entering and ſpoiling the fruit, and alſo ſerve as lungs for reſpiration; the circulation of the air through all the parts being neceſſary to vegetation, and for bringing the fruit to perfect maturity. That this is ſo, or how it is, I am not ſo well acquainted with the operations of nature, as to determine; but this I know, that when theſe ſmaller branches are taken clean away, the main branches inſtead of growing round, full and plump, which is their natural ſtate, become broad, flat and diſtorted, and have an unnatural appearance. Beſides theſe branches, when kept within proper bounds, ſerve to ſhade the fruit from the ſcorching rays of the Sun, and to ſcreen them from violent

lent winds, from hail and beating rains, from damps and fogs and cold nights dews, which are all injurious to the fruit, as well as the cold dry north-eaſt winds, and the cold driving north-eaſt ſtorms. But let not this lead us into the other extreme, for if the vine be left to herſelf, and all be ſuffered to grow, ſhe will run wild, and ruin all by her own exceſs. This is the method of managing vines when the head is formed near the ground, which is now practiſed in moſt vine countries in vineyards, (except ſome parts of France, where they are ſtill fond of eſpaliers.) and this method muſt be continued as long as the vines laſt, which moſt writers do affirm, will be above a hundred years. As to the management of vines in gardens, againſt walls, and for forming of ſhady places, and many other ways to pleaſe the humour and phantaſy of the owner, that is not to be regarded, it has no relation to vineyards.

Here I would propoſe a new method of managing vines, the heads of which are formed near the ground, by way of trial; I have not yet made the experiment, if it ſhould anſwer, it would ſave a good deal of trouble, and be more ſecure againſt the ſeverities of the weather; I have been told that it is the practice of ſome to cut all the branches down, and to truſt to new ſhoots for bearing of fruit; and I have read the ſame account in a treatiſe publiſhed by *James Mortimer*, Eſq; fellow of the royal ſociety, in the year 1707, but theſe accounts are ſo vague, ſo general and ſuperficial, without entering minutely into any particulars, that I could have no dependence upon them; nor could any man form a judgment of the manner of doing it. However from thence I have taken the hint, and ſhall now propoſe a method which may be worthy on trial. If the fall of the third year of the vine's age, inſtead of ſaving two or four branches for bearing fruit, cut down theſe to two buds each, and the reſt cut down to one bud each; the upper buds of theſe branches that have two buds, are deſigned to bear fruit, this next year, the lower buds and the buds of all the reſt are deſigned for fruit the year after,

and

and therefore if any fruit ſhould appear upon them, they muſt be taken away as ſoon as the cluſters appear; in the fall of the fourth year, cut all the branches that have born fruit clean away, and leave thoſe that did not bear fruit; and then according to the ſtrength of the vine, cut as many of theſe down to two buds, as you think your vine ought to bear, and cut the reſt down to one bud, always remembering that the branches that have but one bud, and the under bud of thoſe that have two, are to bear no fruit. When your vines come to be ſtrong and able to bear it, cut down all the branches to two buds, and then you will have eight bearing branches in one year, which are quite enough for the ſtrongeſt vines; however if you have a mind to ſtrain your vines, and to try how much they will bear, you may then cut as many branches as you think fit down to three buds, two of which may bear fruit, while the under buds are kept for branches of reſerve. In the fall, all the fruit bearing branches are cut clean away. If this method ſhould ſucceed to your mind, and you think it preferable to the method firſt laid down, I mean that of preſerving branches of reſerve to be laid down and covered in winter, which is the German method, and the general practice of the Rhine, &c. then in order to bring your older vines into this method, cut down the fruit bearing branches to one bud the firſt year, and the branches of reſerve you may cut down to two or three buds each, as you think your vines are able to bear it. In this you form your judgment, from the ſtrength of your vine, the goodneſs of your ſoil, the diſtance of your vines from one another, and the quantity of fruit they have born the three preceeding years: for vines, as well as men, muſt have time to reſt and recruit, if you mean them to laſt, and to return to their work with vigour.

Now for the covering of theſe vines in the winter ſeaſon, I would adviſe a handful of ſoft hay, that is free from graſs-ſeeds, to be laid on the head of the vine, and a ſlight box made of rough cedar boards, or of pine, (which any ſervant

ſervant may make, only let the top piece cover the whole,) be put over the head, which will be a ſafe and ſufficient covering. Otherwiſe a ſmall ſheaf of ſtraw, bound well round the ſtake, and the bottom brought handſomely all round the head of the vine, and ſecured by a band from blowing open, will do very well. The vines ſhould not be covered till hard weather is ready to ſet in, and they ſhould be dry when covered.

Before I proceed to the management of vines for the frame or eſpalier, it will be neceſſary to acquaint you with ſome things of a general nature, which you will find worthy of notice.

When vines are trimmed in the fall, which they ought to be as ſoon as the vintage is over, or as ſoon as the leaf withers and falls off, they ſeldom bleed, and never ſo as to hurt them. If vines have been neglected and not trimmed in the fall, and this work muſt be done in the ſpring, let it be done in February, if good weather happens, or early in March. If it be done later, they will bleed too much, and endanger the crop. Searing the wound, as ſoon as it is made, with a hot iron, it is ſaid, and I think with reaſon, will prevent the bleeding. In trimming, keep about two inches from the bud, or half way between bud and bud: ſo ſhall the upper bud that is left be free from danger. The rule is, to cut ſlopping upward, on the oppoſite ſide to the bud, that the ſlope may carry off the tears from the eye, but I never found this any kind of ſecurity to the eyes below. If therefore ſearing every wound with a hot iron be thought too much trouble, the only remedy, beſides that, which I have yet been able to diſcover, is, to waſh the branches that are wounded and bleed, and eſpecially the buds, with a rag dipped in warm water, without touching the wound, which in 8 or 10 days will ſtop of itſelf; the liquor forming a ſtiff jelly upon the wound, like coagulated blood, and drying by degrees, heals up the wound. The waſhing muſt be deferred till they have done bleeding. Unleſs this is done, the eyes below will be in danger of being blinded,

blinded. For fo glutinous is the fap, that it binds up the bud it reaches, fo that the leaves cannot open and unfold at the time of vegetation. In cutting off large limbs from old vines, it fometimes happens that ants fall upon the pith, eat their way in, and make a hollow, where the water fettles and rots it. In this cafe the remedy is, to cut fuch branches clofe down to where it is folid and green, and it will bark over and heal.

It is common for large buds to fhoot out two or three branches each. One only on each fhould be fuffered to grow; if you expect fruit on them, be not in a hurry to ftrike them off 'till you know which is moft fruitful, and fave that. Vines that are clofe planted in a vineyard, cannot be expected to bear fo much fruit, as fingle vines, or as thofe that are planted at a diftance. Their roots are too much confined, fo that they cannot gather nourifhment in fo fmall a compafs of ground, to fupport and bring to perfection a large quantity of fruit; and this is a fufficient reafon for reftraining them, and for limiting the number of bearing branches, if you mean to make good wine, to keep your vines in full vigour and to preferve them for many years. Befides the deficiency is fully made up, by a greater number of vines; and the planting them clofe, enables you the better to keep them low and within proper bounds.

Vines that bear black or red grapes generally fhoot forth a greater number of branches, and more vigorous than thofe that bear white grapes, and therefore the latter require more caution in trimming, and more care in the cultivation and management of the foil, that it be kept clean and in good heart.

When vines have been covered with earth during the winter feafon, let them not be uncovered in the fpring, till the hard frofts are over, and then let it be done in a fair, warm, drying day, that they may dry before night, for if they fhould freeze before they are dry, it would greatly hurt, if not ruin the crop.

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The head of the vine, properly ſpeaking, when it is formed near the ground, is compoſed of the but ends of the branches, that are cut down to one good bud each, which ought to be eight at leaſt in number. Theſe branches, the ſecond year of the vine's growth, ſhoot from the ſolid wood chiefly, and then is the critical time to prepare for forming a proper head to a vine; therefore preſerve eight of the beſt ſhort jointed branches, that grow on all ſides of the ſtock, and much of a ſize, and theſe muſt be carefully tied up ſingly to the ſtakes, that the buds may fill well, and that the wood may ripen, on which greatly depends the future ſucceſs of your vineyard, as this is the foundation of the whole. If more than eight branches have grown from the head, the reſt muſt be ſtruck off with the finger. If one of the branches outgrows the reſt and appears more flouriſhing, that in particular muſt be ſtruck off. For if ſuffered to grow, it will rob the reſt of their due proportion of nouriſhment, and ruin the vine. Eight branches are ſufficient for a thrifty young vine, four of which are intended for bearing fruit, when that time comes, and the other four are deſigned for branches of reſerve. The third year, which is the firſt year of the vine's bearing, the lowermoſt good bud on the bearing branches, will produce one or two cluſters of grapes each. The fourth year, two or three of the lowermoſt buds will bear fruit, and after that five or ſix of the lower buds will bear fruit, but ſeldom more; ſo ſhall you have five or ſix branches, growing from each bearing branch, producing fruit, which makes twenty or four and twenty bearing branches upon one vine, and each of theſe branches yielding two three or more cluſters, according to the fruitfulneſs of the year, and the due cultivation of your vineyard.

Nay if your vines are well choſen, as I have directed, and properly cultivated, and your ſoil kept clean and well improved, you ſhall, in a fruitful year, ſee ſome of the ſecondary branches and even the tendrils bearing fruit. This happened to ſome of my vines in the year 1767. I had four fucceffive crops hanging on feveral of my vines at one and the fame time, one under another, which I fhewed to feveral gentlemen, who admired, and were furprized at fuch a production: But I took away all but the firft crop, leaft my vines might be too much weakened by over bearing. I mention this to fhew what nature will do in a favourable year, under proper management. And here I muft remark, that the greater the vintage, the better the wine, but a meagre thin crop produces thin weak wines, which require dexterity and art to make them fit for ufe; but this I fhall inftruct you in, when I come to the making of wine.

In tranfplanting vines or trees of any kind, I have by long experience found, that removing them in the fall, after the leaf is fallen, is much furer and fafer, than doing it in the fpring. For if trees are well ftaked, fo as to ftand firm againft hard winds, the ground will be fo well packed about the roots, that they will grow in the fpring, as if they had not been removed, and are in no danger, if a dry feafon fhould happen, efpecially if fome horfe litter or old hay be thrown round them in the fpring, fo as not to touch the ftem. Whereas if they are removed in the fpring, and a drought fucceeds, before the ground be well fettled about the roots, many of them will mifcarry.

As vines are beft planted upon rifing grounds to prevent too much wet, and as it is neceffary to keep the foil loofe and mellow, it thereby becomes the more liable to wafhing away by hard rains, which muft be a great injury to a vineyard; now if by any means fo great an inconveniency might be avoided, it would be a great point gained, and therefore it very well deferves our attention: For it is no fmall coft and labour to renew the foil, that is fometimes carried off by fudden floods of rain. I have tried feveral ways to prevent this evil, fo as neither to injure the vines, nor hurt the crop. The following method, where a perfon has the conveniency, I find to be the moft effectual. Lay broad flat ftones, not exceeding two inches in thicknefs,

nefs, clofe along the lower fide of the vines, after the ground has been made loofe and mellow. Thefe ftones being broad, and not very heavy, do not prefs hard upon the roots of the vines, nor pack the ground too clofe. They reflect great heat up to the vine and fruit, which helps to bring it to full maturity; they preferve the foil from wafhing away, they keep the ground moift in the drieft times, and hinder too much wet from penetrating down to the roots near the head of the vine, which chiefly occafions the burfting of the grapes when they are near ripe, after a fhower of rain. To prevent this evil, is one reafon for cutting away the day roots, which extend themfelves along near the furface of the ground. But where fuch flat ftones are not eafy to be had, I would recommend fhort ftraw mixed with chaff, the fhives of flax and hemp, the chaff of flax-feed, which is alfo an excellent manure, old half rotted falt hay, or bog hay, free from grafs feeds, fpread thin between the rows; if it be fpread thick, it keeps the ground too long wet and cold in the fpring, which retards or keeps back the growth of the vines. Thefe I have experienced to be profitable, and very much to hinder the foil from wafhing away. On the fide of fteep grounds, of hills and mountains, ftones in proportion to the defcent, or logs of wood, where ftones are not to be had, muft be laid along the lower fide of the vines, to keep the foil from wafhing away, which otherwife it will do, to the great damage, if not the ruin of your vineyard, and therefore when you begin a vineyard, remember that this is one, and an effential part of the coft.

A vineyard will thrive the better, and the crops will be more fure, if it be well fcreened, by fome good fence, buildings, mountain, or thick copfe of wood at a fmall diftance, from thofe points that lie to the north of the eaft, and to the north of the north-weft; the winds from thofe quarters, in the fpring of the year, being very unfriendly to vines. But then a vineyard fhould be quite open to all the other points of the compafs. For vines delight much

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in an open, clear, pure warm air, free from cold damps, fogs, mifts, and from condenfed air, arifing from bogs, fwamps, and wet clay grounds, and from large tracts of neighbouring woods. The north-weft winds, indeed are rather advantageous to a vineyard: For although in America, they are extremely cold in winter, and occafion fevere frofts, yet as the vines are then covered, they do them no harm. Befides thofe winds are generally drying and feldom bring wet; in the fpring and fummer they are always cool, and I find by long experience that they are quite neceffary, to brace up, harden and confirm the leaves and tender new fhot branches of all trees and vegetables, which otherwife remain languid and weak.

There are three feafons when careful and experienced vignerons deny accefs to their vineyards, firft when the ground is wet, becaufe then the weight of a man preffes down and packs the earth too clofe and hard upon the roots of the vines. Secondly, when the vines are in bloffom, becaufe if they are then difturbed by handling, fhaking or rubbing againft them, the farina or fine duft that is formed on the bloffom, which impregnates or gives life to the fruit, is fhaken off and the fruit mifcarries. Thirdly, when the fruit grows ripe, becaufe the temptation is too ftrong to withftand, and people will pluck off the faireft ripeft grapes, which vignerons do fay is an injury to the whole bunch,; be that as it may, it certainly is a great injury to the owner, for the faireft ripeft grapes make the richeft and fineft flavoured wines.

I now pafs on to the management of vines upon efpaliers: But then you are to remember that, the training up of vines to thefe frames, is only fit for the fouthern or warmer climates, where the winter frofts are not fo fevere, as in our more northern regions; for as they are to ftand expofed to all weathers, the germ or bud, from which the grapes do fpring, are apt to be chilled and deftroyed by the feverity of a fharp feafon, and efpecially by moift fticking fnows freezing hard on the branches.

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The firſt year the young vines are trimmed and managed in the ſame manner you have been before directed.

The ſecond year when they always ſhoot forth a greater number of branches, is the time for making choice of the beſt branches for ſtandards. Set apart, therefore, two of the beſt ſhort jointed branches, on each vine, for that purpoſe, that you may be ſecure of one, in caſe the other ſhould fail, as theſe branches when young, are ſubject to many accidents: So ſhall you ſtand a fair chance of having fruitful vines; for all vignerons well know, that vines ſhoot forth more barren and unfruitful branches, then fruitful ones, therefore, as experience hath taught them, they always ſet apart ſhort jointed branches for bearers, becauſe theſe ſeldom fail yielding much fruit; all the reſt of the branches you ſtrike off with your finger: Again, would you ſtill more effectually avoid barren vines, if you have it in your power, chooſe your vine cuttings for planting, from fruitful vines; not only ſo, but chooſe fruit-bearing branches, that grow from the teeming part of the vine, that is as near the head and ſhoulders as poſſible, and then if you cultivate them well, you ſhall be ſure of having fruitful vines; and this, let me tell you, is gaining a very grand and eſſential point: I have here repeated this inſtruction, that you may not neglect it, nor miſs of ſo great an advantage.

Having thus choſen two branches for ſtandards, train them up as ſtraight as you can, one on each ſide of the ſtake: When they are grown about fifteen inches long, bind them gently with a ſoft band to the ſtake; for they are then yet very tender: And as they grow longer bind them a ſecond and a third time; and when they are grown up to the top of the ſtake, which muſt be five feet high, nip off the ends, and they will grow the thicker and ſtronger. When you have taken away the tops of the vine ſhe will try to recover herſelf, and will ſhoot out two branches at the top inſtead of one; but theſe you muſt alſo nip off, and keep ſhort, but take away none of the

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lateral branches or nephews till you come to trim them in the fall, only nip them off, to keep them within proper bounds. In the fall when the vine leaves begin to wither and fall, cut away one of these standards from each vine, close to the stock, leaving such as you best like, which is now out of danger, and trim away from her all the branches and nephews, and cut off her top within three feet and an half of the ground; leave four buds at the top, and cut off all the ends of the buds below them; all these wounds will be healed before the hard weather comes on, which should not be over severe where espaliers are used; the two upper buds will be the arms of the vine, the two lower buds will be the two shoulders, and just under these the vine is fastened to the espaliers, and is called the head of the vine. Now it requires the greatest skill of the most experienced vigneron to manage and cultivate vines thus educated and trained up to espaliers; and therefore they are more fit for gentlemen's gardens and the vineyards of rich men, who can afford the expence of these frames, and to employ vignerons to manage vines in this manner, in order to obtain the richest wines, than for common men and men of small fortunes, who must chiefly manage these affairs with their own hands, and for whose sakes I have taken the pains to write this treatise; but that I may do honor to the rich and great, and shew them that respect, which I think due to their distinction and high stations, I will proceed and give such instructions as shall answer their expectations; but then I must beg leave to guard them against pretenders to this art, for there are pedants, and not a few, among vine dressers, as well as among men of letters. The greatest difficulty, as experienced vignerons know, is so to manage a vine, as to keep her within the height and compass of a frame, and yet to cause her to bear fruit plentifully.

The third summer the espaliers being regularly set up six feet high, in a line with the vines, the posts being of some lasting wood as of red cedar, locust or of mulberry, which

which are cheapeſt in the end, or for want of theſe, of good thrifty cheſnut, that is not worm eaten; and being firmly fixed in the ground, in the middle ſpace between vine and vine, and the rails, being four in height, well nailed to the poſts, and placed on the north ſide of the vines, the lowermoſt about three feet from the ground, or juſt below the lowermoſt bud on the vine, the vine muſt be faſtened with a ſoft yet ſtrong band to a ſtake firmly fixed down near the foot of the vine, and faſtened to the frame, near the lower rail, the four buds riſing above it. When theſe buds ſhoot forth their branches, they muſt be regularly trained up to the rails above, and faſtened to them with a ſoft band; as ſoon as they are long enough to reach the firſt above them, they muſt be faſtened to that, and ſo to the next, &c. as they grow; and this muſt be done by a careful hand, becauſe theſe branches, at firſt, are very tender; if they ſhould be neglected, till they are grown longer before they are tied, they will be in great danger of being torn off by hard winds, to the great damage of the vine. When the branches are grown up to the top of the frame, the ends muſt be nipped off even with it, and when from the tops they ſhoot forth again, they muſt again be nipped off and kept down even with the frame, and this not ſo much for beauty and order ſake, but that they may be properly educated and taught to be humble and keep within the limits aſſigned them. The lateral branches and nephews alſo muſt be kept within proper bounds and not ſuffered to grow too long, for ſome of theſe ſide branches will ſteal away to a great length, and rob the vine of her ſtrength. If any fruit ſhould appear this third year, which may happen, let it be taken away, as ſoon as it appears, and your ſelf-denial ſhall be amply rewarded the ſucceeding year; For it greatly weakens a vine to bear fruit ſo young. Beſides not only the durableneſs, but the fruitfulneſs of vines, very much depends upon the proper culture of them when young.

In the fall of this third year, the lateral branches and nephews muſt be carfully cut away from the main branches,

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ſo as not to hurt, or rub againſt the lower buds, with the back of the knife, which is frequently done, by cutting off the branches too near the germ or bud. For if the thin bark, that covers the bud, be rubbed off, under which is a ſoft warm garment of cotton, to preſerve it from violent colds, the wet gets in, freezes and deſtroys the germ. The four main branches, that ſprung from the four buds, muſt now be cut down to two good buds each; the lower bud, next the old wood is never looked upon as a good bud, it is called a dead eye, or barren bud; becauſe it bears no fruit, at leaſt not the firſt year of its growth: And yet notwithſtanding you will be obliged ſometimes to make uſe of it, as I ſhall preſently ſhew. In cutting off the main branches, cut ſlanting upward, ſo that the wound appears in the ſhape of the nail of a man's finger, and let the ſlope be on the oppoſite ſide of the bud, that if it ſhould weep, the tears may drop free of the bud; this is the rule, but I have given my opinion on this precept before, to which I refer you. In cutting, approach not too near the bud, that is left, but keep at two inches diſtance from it, leaſt you endanger it, by letting in the cold air and wet upon it, before the wound can heal.

The chief point, in managing theſe vines, is, the providing branches of reſerve for recruiting the arms in ſuch manner, as to confine the vine within the compaſs of your frame; for if you raiſe new arms from the old ones, your vine will ſoon outſhoot the frame. You muſt, therefore, ſeek for new arms from the ſhoulders: If a branch grows in a proper place, any where between the arms and the head, and happens to be broken, clip it into a thumb, that is, cut it down to two or three good buds, as ſoon as you diſcover it, and this is called a keeper, and very well ſupplies the place of a branch of reſerve. Sometimes you will be glad to make uſe of the half ſtarved branch, that ſprings from the dead eye beforementioned; nay ſometimes you are drove to the neceſſity of nurſing up a ſmall bud of two leaves, or a knob or wart for that purpoſe; and when none

none of theſe are to be found, you muſt wound the vine in a proper place, ſomewhere about the ſhoulders, with a bodkin or ſharp pointed inſtrument, in two or three places, from whence it is uſual for a branch to ſhoot, if it be done ſometime in the ſpring: But if all ſhould fail, you then will be obliged to raiſe your frame higher, and make uſe of ſome of the branches, that grow out of the arms, the nearer to the ſhoulders, the better: But if you have been drove to this neceſſity before, and your frame has been already raiſed to a ſufficient height, there then remains no remedy but a deſperate one, ſince the diſeaſe is become deſperate, that is, to cut ſuch vines down even with the ground, and from theſe ſtumps freſh ſhoots will ſpring and bear ſome fruit, the ſecond year after, if a proper choice be made: They muſt be cut when you trim your vines.

If any fruit ſhould appear on any of the branches, that grow from the ſhoulders, which is often the caſe, let them be taken away as ſoon as they appear, for theſe being branches of reſerve, they are deſigned to bear fruit the ſucceeding year, the arms only are to bear fruit the preſent year: Theſe directions will ſerve for the fourth, the fifth, and the ſucceeding years.

In the fall of this third year, I have above directed you to cut the four main branches, that grew from the four buds, down to two good buds each, but this is deſigned for the ſtrong vines only; thoſe that are weak, muſt be cut down to one good bud, each branch, ſo ſhall they flouriſh and gather ſtrength the better, and if any fruit ſhould appear on the weak vines the fourth or even the fifth year, ſtrike them off as ſoon as they appear, and they will afterwards make you ample ſatisfaction for this prudent management of them when young and weak; and once for all be perſuaded not to overload young vines with fruit; if from a fondneſs to outdo your neighbour, you run into this error, your vines will pine and be at a ſtand, and will not recover for ſome years; and then your neighbour, who has cultivated his vines with more prudence and caution, will triumph in his turn, with greater reaſon, and with much greater advantages.

The fourth year when you trim your vines in the fall, you may cut the arms down to one good bud each, inſtead of taking them clean away, for the vines being yet young and low, theſe two buds will in a manner become part of the ſhoulders, being ſo near them; theſe will bear fruit the next, which is the fifth year; and then you can ſave the two lower buds, that grew on the branches that ſprung from the ſhoulder, for branches of reſerve, by taking away the fruit as ſoon as they appear, and theſe will bear fruit the year after; ſo ſhall you have four branches bearing fruit the fifth year, which is quite ſufficient.

The ſixth year you may have three good buds on each branch for bearing fruit, and the ſeventh year you may have four buds on each branch, which will make eight bearing branches, which are thought by the beſt judges to be quite ſufficient for the ſtrongeſt vines, if you mean to make good wine; and to this number vignerons are generally confined.

Vines that are deſigned for eſpaliers, muſt be planted further aſunder than thoſe, that are intended for ſtakes; for as they riſe much higher with the ſtem, they require more nouriſhment, and more room to extend their roots; ten feet is by no means too much: twelve would be better: Suetonius, a learned man, well known to men of letters, made this remark as he travelled through the wine countries, that the farther vines were planted from each other, the better he found the wine.

One general rule is neceſſary to be laid down, in order to give young vine-dreſſers, a clear idea of the nature and manner of trimming vines, which is very apt to puzzle young beginners; know then, that the young wood that grew this year, muſt be preſerved for bearing fruit the next year, and thoſe branches, that did not bear fruit, are better for the purpoſe, than thoſe that did bear fruit; and for this reaſon, you are above directed to ſtrike off, with your

your finger, the young clufters, as foon as they appear, from thofe branches, which you referve for bearing fruit the fucceeding year. When I mention a branch, I mean a main branch of young wood, not a fide or lateral branch, that grows upon thefe young main branches.

When the arms have born fruit, they are cut clean away in the fall of the year, as foon as the vintage is over, provided you have branches of referve, growing on the fhoulders, to fupply their places: But if you have been fo unlucky, as to have failed in thefe, notwithftanding all your attempts to procure them; you muft then do what neceffity requires, and cut the arms down to two, three, or four good buds each, according to the ftrength of the vine; but then remember, not to fuffer any fruit to grow on the branches, that fpring from the lower bud on each old arm, thefe being now abfolutely neceffary for branches of referve, in order to recruit the arms the next year. According to thefe rules you conftantly proceed with vines on efpaliers.

As fome of our fouthern colonies have a hot fandy foil, and are fubject to great heats and parching droughts, and thereby find it very difficult to raife and preferve vines, fo as to become fruitful; I fhall here offer fome thoughts and directions, which I imagine moft likely to fucceed in thefe parching hot countries; as I moft fincerely wifh comfort and happinefs to every colony on the continent and that the whole may become as beneficial as poffible to the mother country.

Firft then, I think it neceffary to fhade the young vines the firft two or three years, during the hot dry feafons, by driving down firmly in the ground, branches of trees thick fet with leaves, on the fouth fide of the vines; thefe are better than matts, or pieces of thatch work, as the air and winds can pafs more freely through them; it will alfo be neceffary to water thefe young vines twice a week, during the hot dry feafons, in the evening, that the water may have the whole night to foak down to the roots of the vines, to cool and refrefh them; the branches, in thefe hot countries, fhould not be tied up to ftakes, but fhould be fuffered to run on the

the ground to ſhade and keep it moiſt and cool. Theſe vines muſt be trimmed in the ſame manner, as thoſe which are deſigned for ſtakes, as ſoon as the leaf falls, or the vintage is over. The third year inſtead of driving ſtakes down to faſten up the branches to them, let ſhort crotches be drove down about ſix feet aſunder, and pretty ſtrong poles laid acroſs upon them, ſo that they may lie about fourteen inches from the ground, and ſo near to each other, that the branches of the vines may conveniently run upon the poles without dipping down and running upon the ground; if the ends of the vines ſhould run beyond the ſides of this bed of poles, they muſt be turned in and confined to their proper bed; becauſe it will be neceſſary to have a walk or path of two feet wide between bed and bed to regulate the vines, to cut away the luxriant ſuckers, that rob the vine and the bearing branches of their due nouriſhment, to gather in the vintage, and to trim the vines.

This bed of poles ſhould be ſo placed, as to extend three feet on each ſide of the row of vines, ſo that the rows of vines ſtanding eight feet aſunder, there will be a path of two feet between row and row for the neceſſary purpoſes before-mentioned. Particular care muſt be taken, not to take away too many branches from theſe vines, unleſs there ſhould happen an uncommon wet ſeaſon, nor to keep them too ſhort, becauſe they are deſigned to ſhade the ground as much as poſſible, in order to keep it cool and moiſt, which is neceſſary for the growth of the vine, and for bringing the fruit to perfection; but then in the beginning of Auguſt, or about a month before the different ſorts of fruits begin to grow ripe, each in their proper time, you ſhould take away the lateral branches and cut off the tops of the main branches, but this muſt be done, not all at once, but by degrees, ſome now, ſome then, and that according to the dryneſs or wetneſs of the ſeaſon, for this muſt be done to let in the Sun and the air, which, at this ſeaſon of the year, become neceſſary to bring the fruit to perfect maturity; the wetter the ſeaſon, at this latter part

part of the ſummer, the more branches muſt be taken away and the ſhorter the main branches muſt be cut, and if neceſſary moſt of the leaves muſt alſo be plucked off; the fruit will ripen the better, and make the richer wine, and all this may be done without any injury to the vines.

Here I would obſerve that the ſame management with regard to the thining the branches and the leaves at this ſeaſon of the year, is neceſſary for vines that are faſtened to ſtakes or eſpaliers, in order to meliorate and haſten on the full ripeneſs of the fruit; and remember that the longer white grapes hang on the vines, even after they are ripe, if the ſeaſon be dry, the richer wine they make. But it is otherwiſe with the black grapes; when they are full ripe, they muſt be gathered and made up into wine, if not, they rot and dry away ſuddenly, and periſh in leſs than a week.

The Portugueſe form the head of the vine near the ground, but whether through careleſſneſs, the love of eaſe, or the want of proper materials, I cannot determine, but they have a method peculiar to themſelves of managing their vines; they drive crotches into the ground, upon which they fix ſtrong poles, which lie about three feet from the ground, ſome more ſome leſs, according to the ſteepneſs of the hill, for their vineyards generally grow upon the ſides of hills and mountains. The branches of the vines, when grown long enough, they throw over the poles and faſten them; they trim them and nip off the ends of the branches according to art, and in the beginning of autumn, they cut away the lateral branches and nephews at different times and by degrees pluck away all ſuperfluous leaves, ſo that the fruit becomes much expoſed to the ſun, the air and winds, that they may arrive at full maturity. They then gather them, take away all the rotten and unripe fruit, throw them into the vat and tread them luſtily, ſinging all the while ſome Bachanalian ſongs, according to the Portugueſe dullneſs; and when they are ſufficiently trod, they take them out and preſs them as dry as they can; they then turn the huſks into the vat a ſecond

cond time, and although they appear quite dry, yet they trample them over ſo long that the very huſks ſeem to diſſolve into wine, this they preſs a ſecond time, and this is laid by for the richeſt Madeira wine; which in other countries is daſhed with water and made into a thin wine for common uſe.

If you mean to have plenty of grapes, your vineyard muſt be well dunged every three years, but hot dung muſt not be thrown near the ſtock of the vine; poor people who cannot come at ſo great a quantity of dung at a time, may dung one third of their vineyard every year; I ſhall now take notice of the different ſoils and dungs that are beſt and fit for vineyards; a vineyard planted on a piece of good ſtrong new ground needs no dung the firſt ſeven years. The beſt manure for a vineyard is ſuch as is warm and free from graſs ſeeds, for graſs is a great enemy to vines; Fowl's dung of every kind, except water fowl; ſoap aſhes, or other aſhes ſprinkled thinly between the rows of vines, but not too near them, for this manure is very hot and ſharp, and is beſt ſpread on the ground in the fall, that it may mix with the ſoil and be properly tempered before the heat of the next ſummer comes on, otherwiſe it would burn up the plants the rich ſoil that is waſhed down and ſettles along the ſides of brooks and rivers and in many low places along roads and high-ways, which poor and induſtrious people may eaſily come at; ſea ſand, mixed with common ſoil that might be taken up along the high ways, would make an excellent manure; in ſhort, ſand of every kind mixed in large proportions with good ſoil, is very comforting to vines, for thoſe vines produce the ſweeteſt and richeſt grapes, and the ſtrongeſt and beſt flavoured wines, that grow in rich ſandy ſoils: The morter of old buildings, that has been made of lime and ſand, pounded fine; the duſt of charcoal, the ſmall coal and the earth that the coal kilns are covered with when burnt; the ſoot of chimneys; the ſmall cinders and black dirt found about ſmith's ſhops, all theſe are excellent manure

manure for loomy or clay grounds to warm, to open and to dry them, and eſpecially if a large quantity of ſand, be mixed with it; creek mud, or the mud along the ſides of rivers thrown on in the fall, or thrown up and ſweetened all winter and laid on in the ſpring, is a rich manure for ſandy lands, or for clay and loomy lands if mixed with a good quantity of ſand. All warm rich untried earth is excellent, ſo is ſtreet dirt of cities. Come we now to what may be for the moſt part in every farmer's power to procure: And firſt it will be proper at certain ſeaſons of the year, when the graſs is free from ſeeds to pen his cattle and ſheep in ſome convenient place, where the dung will not waſh away, and as near to his vineyard or houſe as may be; into this pen let him throw his ſtraw of all kinds, that is free from graſs ſeeds, his buckwheat ſtraw, chaff and duſt, his old ſalt hay or bog hay; if he lives near to marſhes or ſalt meadows, let him cut good ſtore of reed, when it is near ripe, thatch, courſe three ſquare and ſedge, let it be dried and brought into the pen; then let him get rich black ſoil, that ſettles in low places and the bottom of ponds, that are dry or partly dry in ſummer, and what ſettles along the ſides of brooks and rivers, and throw theſe in, let him get good ſtore of leaves of every kind, and throw all the ſoap ſuds, chamberlye, the blood of beaſts, pork and beef pickle, cyder and beer emptyings, and greeſy diſh-water, the water that ſalt meat has been boiled in all theſe contribute greatly to make very rich manure.

The next beſt method for making good ſtore of manure is to throw moſt or all of the above materials into a pretty large hog pen; (if the hogs are fed with red clover, cut green, when it is about two thirds grown, and ſo on till the ſeed be grown but not ripe, this mowed twice or three times a day, and given to the hogs is an eaſy and cheap way of feeding them, and will make a rich manure,) hogs will champ with their mouths and trample with their ſharp pointed hoofs theſe materials, and make them fine

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in a ſhort time, and by rooting, will ſo tumble and mix them together, that they will ſoon rot and make good ſtore of manure. Then again, if corn ſtalks, huſks and cobs, ſuch as the cattle do not eat, be thrown into a hollow place, where they may be wet, alſo the chaff of flaxſeed, the ſhives and hurls of flax and hemp, where they will rot in a year's time, theſe make a good manure. Here let me remark, without giving offence to my dear countrymen, whoſe good I have always ſtudied, and whoſe intereſt I would willingly promote, that with a little more induſtry and application, and ſome eaſy and proper contrivances, take the whole country in general, I am pretty certain, that ten times the manure might be made and ſaved, that is made at preſent, and how much our old lands ſtand in need of it; every farmer very well knows; and give me leave farther to aſſert, that where a man has it in his power, and can employ a hand and team altogether in cutting and bringing together as many of the above materials, as can conveniently be had, at the year's end, he would find him by much the moſt profitable employed of any man and team upon his plantation: For I am clearly ot opinion that, ten acres of land well manured, will produce a much greater profit to the owner than forty acres of common old lands as they are now managed; the whole charge of manuring, tilling, and of the ſeed for ſowing, together with the fencing, reaping, threſhing, &c. being fairly calculated. For the ten acres will produce four good crops ſucceſſively, one of barley, then one of wheat, the next of oats, and the laſt of rye; and with a ſprinkling of dung, it may be laid down with red clover: The charge of ploughing for theſe four crops, amounts to no more than the charge for ploughing the forty acres for one crop, the expence of fencing the latter is much greater: The forty acres in the common way of working, lies fallow for three ſummers, and generally yields but very little graſs, the fourth ſummer it is ploughed again and yields no graſs at all; whereas on the plan propoſed, the ten acres in the fall af-

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ter the wheat and the rye will yield plenty of graſs. Pardon this digreſſion, I hope it will not be altogether unprofitable.

Grapes are delicious fruit and very tempting to people of every age and ſex, the rude and unthinking ſort will take all advantages of your abſence or neglect at the time of the fruit's beginning to grow ripe, to rob and pilfer; ſuch therefore muſt be carefully guarded againſt, by a good cloſe high fence without, and a ſmart watchful dog within, and eſpecially by the vigneron's appearing now and then with a gun in his hand walking about his vineyard in an evening, particularly when there are idle people without; this will effectually prevent any attempts, when they ſee what they apprehend to be ſo very dangerous.

But theſe are not the only enemies we have to fear and guard againſt, there are others which appear leſs formidable, and yet are full as deſtructive, namely birds: The robins are very numerous, and devour abundance of grapes; the beſt and moſt effectual method I ever diſcovered to get rid of theſe, was to deſtroy their food, that ripens about the time that the grapes do, which conſiſts of wild cherries and poke-berries chiefly; there are other ſmall berries which robins feed upon, but they chiefly grow in ſwamp and wet places, which are now generally cleared and deſtroyed. One year I cut down all the wild cherry trees on my plantation, and rooted up all the poke buſhes, and not a robin appeared near my vineyard till all my grapes were ripe and gathered; more than that, in order to ſave my Engliſh cherries, I made my boys go through my orchard twice when the robins had laid their eggs, and pull down their neſts, by this means they hatched their young ſo late, at which time they take away the fruit, that I ſaved my crop of cherries. The cat-bird and the thruſh are not ſo numerous, and therefore they are apt to be overlooked, and eſpecially as they give you a fine ſong for your fruit; but they are both ſly, cunning and very artful thieves, and devour grapes in great abundance, nothing that I have yet

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discovered, but a good gunner, will get the better of these: But then again wasps are great enemies to grapes, they pierce them in several places, with their sharp pointed bills, and that the fairest, ripest and most forward grapes, which make the best wine, these rot or dry away, which is a great loss to the owner; the best way I have yet met with, to destroy these pernicious vermin, is to hang up phials here and there, along the outward rows of vines, filled half full of water well sweetened with honey, melasses, or coarse black sugar, the mouth of the phial must be so wide as easily to receive a wasp into it, and not much wider, the wasps soon find out the melasses by its scent, and getting into the phial, are drowned in the sweetened water; another way I have discovered, which comes very near to the former, if it does not exceed it, which is to cover flat wide earthen pans, all over the bottom with honey or melasses without water, if there be three or four of these pans placed at a good distance, the whole length of the vineyard every wasp to leeward, that is within smell of them, will come to the feast, they will soon so entangle themselves in the melasses that, if you attend them, you may make it a deadly feast to almost all that come; when the wind comes from another quarter, place your pans along another part or side of your vineyard, that so the wind may blow from the vineyard to the place, from whence you would draw the wasps, and so go round till you have destroyed them all.

One circumstance I have omitted with regard to birds, and that is, if poles be stuck up here and there, near that quarter where the birds harbour and have their haunt, and small branches with three or four twigs on them, be fastened to the top of the pole, and the twigs well daubed over with birdlime, the birds will perch upon them, and will be so entangled by the bird-lime that if they are suffered to continue upon them some time, if they then get away, they will hardly return again that season: and as if they could communicate to each other their grievances and their

their dangers, few or none of the ſame ſpecies will come into the vineyard that ſeaſon.

The ſame grub, which is a ſhort ſmooth earth worm, that cuts off the Engliſh beans, &c. is very hurtful to young vines, often cuts off the choiceſt branches; if the earth were taken away round the foot of the vine, about two inches down, and ſome tar and hog's lard, mixed in equal quantities, were daubed round that part of the vine, I think, though I never have made the experiment, it would prevent the miſchief.

Vine fretters alſo are often injurious to vines; they are very ſmall animalculæ, or inſects, of what ſpecies, I have never examined, but they appear in great numbers, in mere cluſters, upon the young tender branches, upon the juice of which they feed; the only remedy I know, is to take away the branch with them upon it, and ſo deſtroy them bodily; but if the branch cannot be ſpared, they muſt be maſhed and rubbed off by a careful tender hand; if they are chiefly deſtroyed the firſt two or three years, they are not ſo numerous nor ſo troubleſome afterward.

It is common with gardeners and vignerons, who cannot bear to ſee a good piece of ground lie idle, to raiſe a crop of cabbages, colliflowers or brocoli, between vines when young. This is very wrong and very injurious to vineyards, for it not only cramps the growth of the vines, but robs the ſoil of thoſe rich ſalts and ſulphureous oils, which are neceſſary to bring the fruit to perfection when the vines begin to bear. The ſoil cannot be too freſh for a vineyard, provided it be not too rank, and therefore a freſh new ſoil, that has never been ploughed, at leaſt not in many years, is always recommended as moſt proper for a vineyard. A clean, light, warm, rich ſoil, that has a great mixture of ſand is beſt; a rank, heavy, ſtubborn ſoil is not good, it is apt to rot the vines, unleſs it lies high along the ſouth and ſouth-eaſt ſides of hills and mountains, the dryneſs of the ſituation and the intenſe heat of the ſun greatly alter ſuch a ſoil, and meliorate it, the they open, warm and ſweeten it, by drawing out its cold ſour bitter nature, and render it fit for the richeſt productions, ſo that here the ſtrongeſt and higheſt flavoured wines are made.

I have already mentioned the planting of vines at a proper diſtance, and in this I have exceeded the common diſtance practiſed in moſt wine countries; and that for reaſons which I ſhall preſently aſſign.

When I firſt undertook a vineyard, I can without the leaſt ſpark of vanity ſay, I did it for the good of my country, and from a principle of love to mankind; I conſidered that too many of the people of America were unhappily drawn into great exceſſes in the uſe of diſtilled ſpirituous liquors, which ruin their conſtitutions, and ſoon render them unfit for the ſervice of God and their country, as well as for that of their own family and friends. Wine on the contrary is a more homogeneous liquor, more wholeſome and much better adapted to the ſpirit, and conſtitution of man; and although men will run into exceſſes in the uſe of it, yet it works itſelf off better, and does not deſtroy the natural vital heat and animal ſpirits, in ſo great a degree and in ſo ſudden a manner, as fiery diſtilled liquors do; for theſe reaſons I went on, and endeavoured to make myſelf maſter of the ſubjeſt, and by many experiments to ſatisfy myſelf of the truth of things. I was determined not to take up with things upon truſt; for theſe things are generally conducted according to the uſage and cuſtom of our forefathers, whoſe method we follow with the ſame implicit faith, that too many do the religious tenets, cuſtoms and worſhip of their church, without examining into the nature, reaſonableneſs and ſoundneſs of them: But as reaſonable creatures and free agents, I think we have a right to examine things, to ſearch into the nature and reaſon of them, and to judge and act for ourſelves; and ought not to be tied down to arbitrary rules and rigid cuſtoms which have been laid down and eſtabliſhed in times of ignorance and ſuperſtition. To aſ-

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ſume then a perfect liberty in planting of vineyards and making of wines, as well as in all other parts of huſbandry, I ſhall now proceed to give ſuch reaſons for planting vines at a diſtance, as are obvious and clear to me from ſeveral experiments which I have made. If a vineyard lies on a ſloping ground and is not too ſteep to plough, the vines ſhould be planted eight feet from each other every way; the advantages of this manner of planting I think are many; with a ſingle horſe plough, having a foot fixed in the fore part of the beam, by way of gage, to prevent the plough from going ſo deep as to cut the roots of the vines; a man with the help of a careful boy to ride and guide the horſe, the horſe always ſuppoſed to be tame and under good government, may plough a full acre or more in a day, which is as much as ſix men will generally dig up with hoes, and is every way much better done, the furrows lying acroſs the deſcending ground, will very much prevent waſhing away by hard rains; the ground lies light hollow and looſe, by which means it readily receives all the benefit of the atmoſphere, the dews, the winds, and night air, the miſts and ſoft deſcending rains, which meliorate and impregnate it with nitre, volatile and fixed ſalts, and with oily and ſulphureous matter, fit for vegetation and the richeſt productions, and the Sun more effectually draws out the ſour and bitter nature of the ſoil, and by its genial heat prepares it for a plentiful production. After this it requires no more culture for twelve or fourteen days time, or more, according to the weather. If a drought ſucceeds the ploughing, it will need no other ſtirring 'till rain comes, provided thè ground turned up mellow and crumbly, which it will do if it was not wet when it was ploughed, which a judicious farmer will at all times carefully avoid, for nothing hurts a crop of any kind more than ploughing or harrowing ground when it is wet; Columella ſays, that it renders the ground carious, and that it will not recover a proper temper again that ſeaſon, and this I once found by woeful experience, which effectually cured me of ſtirring ground when wet,
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for any culture whatever. I ſay, that the ground will not want ſtirring again till rain comes, unleſs by the help of great dews the weeds ſhould appear, it muſt then be harrowed with a ſharp iron tooth harrow; which the ſame man, boy and horſe can manage; the man if careful and diligent, can with eaſe harrow three acres a day, and if this be repeated three, four or five days, after every rain, or upon the firſt appearance of weeds, they may with great eaſe be kept down: All then that is to be done with the hoe is, to keep the rows between the ploughings free from graſs and weeds, which are ſoon run over and the ground kept looſe and light, ſo as to let in the air, which is of great ſervice to vines; and the more mellow your ground the better it ſtands a drought; when the vines ſtand too near, the work muſt be done altogether by hand; this requires many more hands, which is very expenſive, the work is tedious and almoſt endleſs; the careleſs hard working man often ſtrikes too deep and wounds or cuts off the roots, the lazy and indolent will not ſtrike deep enough, beſides they all muſt trample down good part of what they dig, ſo that the ground cannot be left ſo looſe and light as by ploughing. Again, when the rows are at a good diſtance, the vines will not interlock nor ſhade one another, which is very pernicious, the wind and air will paſs freely through them, which are very refreſhing, and greatly help forward the growth, ripeneſs and ſweetneſs of the fruit; then the morning Sun, which is comforting and vivifying, will have free acceſs to every plant, will warm the ground, which grows cold by the abſence of the Sun, and by the night air; all will lie fairly open to the more exalted meridian Sun which by its heat brings forward the fruit to full maturity. Again, when the rows are at a proper diſtance each way, the roots of the vines will not ſo greatly interfere with each other; they will have more room to ſpread and extend themſelves, and collect more nouriſhment and food for themſelves and their offspring. Vines of four and five years old extend their roots ſix and eight feet from their ſtocks;

ſtocks; as for the root that ſhoots downward, nature, for the preſervation of the plant from exceſſive droughts, darts them down ſo far as to reach a moiſture below ſufficient to ſecure them from periſhing. If then in four or five years they extend their roots ſo far, how muſt they interfere and rob each other, when they are planted near, and eſpecially when they grow old, their roots then are ſo interwoven that they appear like a piece of net work; this, I think, ſhews, and plainly proves, that vines planted three, four, five, or even ſix feet apart, are quite too near, ſo that they greatly hurt each other and cannot produce ſo good wine. Again, when vines are planted at a proper diſtance, a wheel or a hand barrow may paſs freely through them, which will greatly facilitate the dunging of the ground and the gathering in of the vintage; or a horſe with panniers on each ſide, made flat on the ſide next his body, or a long ſquare baſket fixed on a hand-barrow and ſlung acroſs two hardy boys ſhoulders, would give diſpatch to either work. But farther, men of learning and obſervation ſay, that vines planted at a diſtance produce the beſt and richeſt wines, and to crown all, it is the opinion of men knowing and experienced in theſe things, that a vineyard planted at eight or ten feet diſtance each way, will produce as many grapes, as one planted within half that diſtance, though there be twice as many vines; that it will produce larger and finer grapes; will bring its fruit to greater perfection, and make better wine.

If a man be poor and cannot procure a horſe and a plough, or if his vineyard be ſmall and he chooſes to cultivate it with his own hands, or if his vineyard lies along the ſide of a ſteep hill or mountain and cannot be ploughed, in either caſe the German double pick, or ſarkling iron, is the beſt inſtrument for digging a vineyard; the ſhape you have in the margin: This inſtrument digs the ground with more eaſe than the hoe, and neither cuts nor wounds the roots. It is fixed on the handle like a hoe, and bends downward as that does.

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As ſtakes are a neceſſary article, and as on the choice of them depends very much their durableneſs, I ſhall mention ſome ſorts that are moſt likely to laſt and do the greateſt ſervice. Red cedar, locuſt, mulberry, thrifty cheſnut, that is free from worm holes, ſaſſafras, or the heart of oak, the heart of yellow pine, ſuch as grow in New-Jerſey in dry ſandy grounds, I am told will laſt long in ſome grounds. The ſtakes muſt be about an inch and a quarter ſquare, and not leſs, the biggeſt end muſt be ſharpened, they ſtand the firmer in the ground; if both ends were dipped in boiling tar, the head not above two inches, the lower end ſo deep as that the tar may appear above ground when the ſtake is drove down firm, this will greatly help to preſerve the ſtakes from rotting; the beſt way to ſave your ſtakes from being battered to pieces by driving is, to have a ſpike, with a long tapering ſocket, an inch and a half bore at top, with a long taper point, well ſteeled; the whole about fourteen inches long, with a ſtaff fixed in the ſocket four feet long, the whole ſhaped as in the margin: With this the holes for the ſtakes are made a foot deep, and with a ſtroke or two of a mallet, the ſtakes are firmly fixed, without being ſplit or battered. The ſtakes ſhould be ſix feet long, ſo as to ſtand five feet out of the ground, and ſhould be drove by a line and ſtand ſtrait.

The Roman frame, which ſerved inſtead of eſpaliers in antient times was plain, cheap and frugal, fit for farmers, and ſuch as every farmer can find, on his own plantation, without any other expence beſides his own labour: This ſhews the œconomy and prudence of that great and wiſe nation, whilſt they were a commonwealth. It conſiſted of ſtrong ſtakes or ſmall poſts fixed well in the ground in a ſtrait line ſix feet high, and three rows of poles tied faſt to them one above another, and fifteen inches apart, the upper pole being four, five or ſix feet from the ground, according to the age of the vine, over the upper pole the bearing branches were laid, looking toward the ſouth, and were faſtened to the pole ,and this they called precipitating a vine, a vine, when the branches were grown long enough, they were faftened to the middle pole, and then to the lowermoft, and when they came near the ground they were cut off. The branches were regularly difpofed fo as each might have the benefit of the Sun and air, by being faftened to ftakes drove down here and there, along the frame; they were trimmed and managed in other refpects, juft in the fame manner as thofe directed for efpaliers; and indeed from thefe frames the efpalier was taken.

The materials proper to make bands of, to bind the vines to the ftakes are, the fweet flag, otherwife called the calamus aromaticus. Thefe long flat leaves cut in June and dried in the fhade, and then bundled up and kept in a dry place for ufe do very well, but then they muft be made wet when you bind with them. The long flat leaves of reed, the rufhes and three fquare that grow in marfhy or meadow ground preferved and ufed in the fame manner do as well.

Having now gone through the neceffary directions for planting and managing vines for vineyards, I proceed to the making of wine, a fubject though fhort and eafy, yet calls for great nicety and exactnefs. The making, fermenting and preferving of wine is a myftery to the people of America, but when the methods of managing thefe things are brought to light and explained nothing appears more fimple and eafy; but before I proceed to this work, it will be neceffary to give fome directions about gathering the grapes, fince that work muft be done before we can make wine. As my countrymen are generally ftrangers to all thefe things, I hope they will bear with me, if fometimes I am more particular than to fome it may feem neceffary; fince I would willingly remove every obftacle out of the way, and communicate every the moft minute circumftance to thofe, who are altogether ftrangers to this new undertaking in America, fo that any man of common fenfe, that can read, may fafely undertake and go through with the whole affair fuccefsfully.

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I have already obferved, that the black grapes differ from the white in the manner of ripening, but whether your grapes be black or white, they muft be fully ripe before they are gathered, otherwife they will not make good wine; gather them in a fair day, when they are perfectly dry; take away all the rotten and unripe grapes from every clufter, for they fpoil the wine: If your vintage be large and you gather more grapes than you can mafh and prefs out in one day, let them be gathered without bruifing, for bruifed grapes foon contract an unfavory tafte and hurt the wine in proportion; if they are mafhed the fame day they are gathered, the bruifing will do no hurt; neverthelefs I would advife the gathering of them to be directed by fome grave difcreet perfon, for as this work is done generally by fervants and children, it is made matter of paftime and frolic, rather than prudent labour, and fo many grapes are torn off, and either bruifed or fcattered on the ground, to the no fmall damage of the owner, both in the lofs of fruit, and in hurting the wine, and thefe things fhould be impreffed on the minds of the gatherers before they begin, that every thing may be done regularly and in order, by which means more work will be done, and to much better purpofe.

The black grapes are beft known to be ripe, when here and there one of the forwardeft grapes begins to fhrivel and dry; then fet to and gather and make them up into wine as faft as you can.

If white frofts happen before fome of your grapes are fully ripe though very near it, fo as to want no farther feeding, you need be under no apprehenfions about them, let them ftill hang on the vines, they will grow ripe, rich and high flavoured nothwithftanding; but then they muft be gathered before the weather be fo hard as to freeze the grapes, for that will fpoil them; the light frofts that only kill the leaves do not hurt the fruit, unlefs it be fuch as are late ripe, thefe fhould be carefully covered from all frofts, they fhould grow againft walls or board fences front-

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ing the ſouth or ſouth-eaſt, and at night be covered with mats or frames thatched with ſtraw, which ſhould be ſo contrived as to be ſet up to cover the fruit or let down at pleaſure.

A pretty good judgement may be formed of the goodneſs or badneſs of your wine, and of a plentiful or thin vintage, by the ſeaſons of the year; if the ſpring and former part of the ſummer prove generally dry, with now and then moderate refreſhing rains, if the ſeaſon in Auguſt and September be hot and dry, if in the month of June the weather be calm, ſerene and dry, when the vine is in bloſſom, and the fruit is forming, your crop or vintage will be plentiful, and your wine rich and good: But if at the time of bloſſoming, the ſeaſon be wet and ſtormy, the winds high and bluſtering, if the ſpring be cold with much wet, and backward, if the latter part of ſummer and fall be ſtormy, raw and wet; your crop will be thin, and the wine ſmall and bad; when this happens, it will be neceſſary and for your advantage, to boil one half of the muſt, and to manage it as I ſhall hereafter direct you.

As the wine made from black grapes has a different management from that made of white grapes, I ſhall begin with the white; theſe then muſt be gathered as I mentioned before in a fair day, when the grapes are perfectly dry; and both the rotten and unripe grapes being carefully plucked off from every bunch, the cluſters are then thrown into the maſh vat, and two or three men, according to the quantity, having waſhed their feet and legs very clean in bran and water, get into the vat and trample and maſh the grapes thoroughly ſo that none eſcape, the more they are trampled and maſhed the better; about Paris they let the murk, that is the ſkins, ſtalks, muſt and all ſtand together in the vat eight and forty hours and then preſs it off, but in other parts of France they preſs off as ſoon as the grapes are maſhed: The laſt method I ſhould prefer, provided the huſks be trod over again in the Portugueſe manner, otherwiſe I ſhould prefer the firſt method practiſed by the people

people about Paris, for this reafon, becaufe there is a rich pulp that adheres to the fkin of the grape, which is not feparated by the firft treading; but by lying eight and forty hours in the murk, and the vat covered with fheets or blankets, which is the practice, a pretty ftrong fermentation has begun and continued fome time, which partly diffolves and partly loofens this rich pulp, that ftuck to the fkin, which then chiefly comes away by preffing; however I am of opinion that, the treading of thefe hufks after the fermentation, the muft having firft run off into the receiver, would do the work more effectually if they were well preffed after it. But then we muft take this caution along with us, that if vines are young, which always afford a thin weak wine, or if the feafons have been wet and bad, fo that the juices are not rich, in thofe cafes the muft fhould be boiled before any fermentation, in order to preferve the wine (as I fhall farther direct you when we come to the boiling of wines) in that cafe the Portuguefe method muft be purfued, becaufe the boiling of wine after the fermentation has begun, would entirely fpoil it; the fweet muft only, as it runs from the treading into the receiver, muft be boiled. The firft and fecond preffing being mixed together is put into hogfheads, which muft be filled within four inches of the bung, that it may have room to work and ferment, the cafks being placed in fome warm room or dry cellar. Then having a fmall fpile fixed in the middle of the head of the cafk, the third or fourth day, draw a little of the wine in a glafs, and if it be pretty fine, draw it off immediately into a clean dry well fcented cafk, the larger the better, fo you have wine enough to fill it, which you muft do within two inches of the bung, and ftop it clofe, leaving only the vent hole open for a fecond fermentation; after a few days it will work a fecond time, but not fo much as at the firft; if your wine be ftrong and good, which you may know by the age of your vineyard, and by the goodnefs of the feafons, it will be beft to leave the bung hole open for this fecond

working,

working, the wine will be the better: for ſtrong wines require a greater fermentation than weak wines, and the ſtopping of the bung hole, is a check upon the working, and prevents weak vines from ſpending themſelves too much, which muſt greatly hurt them; on the contrary if ſtrong wines have not a thorough working, they are apt to grow thick and ropy, which hurts them as much the other way; by this you may form a proper judgment what degree of fermentation is proper for the wine that is under working and govern yourſelf accordingly. Three or four days after the ſecond fermentation begins, which you muſt carefully watch by viſiting your wines every day, again try your wine in a glaſs, and if it be pretty fine, prepare a caſk ſweet and good, burn a good large brimſtone match in it, and as ſoon as the match is burnt out, whilſt the caſk is full of ſmoke, draw off the wine into it; now fill up your caſk to the brim, and bung it up tight and ſtop the vent hole; the ſmoke or the brimſtone will hinder any further fermentation; and this is called ſtumming: then make a morter of clay and horſe dung mixed up with ſtrong flaxſeed tea, and cover the bung and vent hole cloſe with it, and ſo let it ſtand till it is fit to ſell or to uſe.

When you firſt rack off your wine, if you have any old wine that is rich and good, of the ſame kind or colour, put four or ſix gallons of it, and two gallons of good brandy into your caſk (this quantity is ſufficient for an Engliſh hogſhead) and then rack off your wine into it for the firſt time, this will greatly ſtrengthen and preſerve your wine, and if your wine be weak, it will hinder too great a fermentation the ſecond time, and ſo preſerve the purer ſpirits from flying off.

When wine is in fermentation, all the groſs parts are thrown up to the top of the caſk, or veſſel that it ferments in, and there meeting the air, they undergo a very great change for the worſe, they contract a harſhneſs and become rancid. If then they are ſuffered to paſs down through the body of the wine, which they certainly will do, as ſoon

ſoon as the fermentation is over, they will communicate thoſe evil qualities to the wine, and it muſt be a ſtrong wine indeed that will ſtand ſuch a ſhock. It the wine be weak it will ſoon turn ſour; if the wine be ſtrong and has a ſufficient ſtock of native ſpirits to defend it from thoſe bad impreſſions, yet it will contract an unſavoury harſhneſs, which will not be removed for ſome time, nor will it be fit for drinking till age has ſmoothed and made it mellow. For this reaſon it is that you are to draw off your wine both times before the fermentation be quite over, and as to weak wines, they ſhould by no means work too much, either time, three days are quite ſufficient for each working; ſtrong wines ſhould work longer for the reaſon above aſſigned; they are better able to ſtand it, beſides it prevents ropineſs and they fine the ſooner and better for it.

I now paſs on to the making of red wines from the black grapes. Red wines have a different managment from the white; the whole of one or even two days treading or maſhing, (when the vintage is great) is thrown into a large vat, the muſt, ſtalks, ſkins and all, and ſtands in ſome warm dry place or cellar. The vat is covered cloſe with ſheets or blankets, or both, and thus it remains, according to cuſtom from four to ſeven or even ten days, according to the coldneſs or heat of the weather. This is done to obtain a ſtrong fermentation, in order to give a deeper colour to the wine, and this is the only end propoſed by it; the manager of this work, viſits the vat twice a day, and in a glaſs views the colour of the wine, and taſtes it; if the tincture be not deep enough to his mind, he knows by the taſte of the wine, whether it will ſtand a longer fermentation: if it will not, he contents himſelf with the colour it has and draws and preſſes it off, and fills it into caſks, leaving about two inches from the bung, for a ſecond fermentation. When the ſecond fermentation is over, which generally happens in four or five days, he then draws it off into clean well ſcented caſks, and adds to it ſix gallons

gallons of good old wine and two gallons of brandy to an Englifh hogfhead, which contains from 60 to 63 gallons. Where the fame kind of wine is not to be had, he makes ufe of port wine. He then fills the cafk quite full and bungs it up tight, leaving only the vent hole open to let out the generated air. Note, when I fay, where the fame kind of wine is not to be had he makes ufe of Portugal wines, this is mentioned for our practice, not that the French make ufe of fuch wines, for they always have wines enough of their own of the fame kind.

This management of red wines, which perhaps with little variation, is almoft as ancient as the making of wine in France, deferves fome attention and a clofe examination, in as much as I am fully perfuaded that it is capable of an effential improvement.

To underftand the nature of this affair rightly, we muft know that, befides the main pulp or core of the grape, which is white in black grapes as well as others, there fticks to the infide of the fkin, a confiderable body of rich pulp, which is perfectly red, of a deeper die in fome than in others. This pulp gives the colour to the grape, according to the lightnefs or deepnefs of its tincture: thus we fee fome grapes of a light red, fome of a full red and fome of a deep red, fome again are almoft black, fome quite black and fome of a fhining jett; this fame pulp alfo gives the tincture or colour to the wine, for the fame grape is capable of making white wine as well as red wine; if the main core which is firft trod out, be only ufed, the wine will be white; thus they make white Burgundy, &c. but if the red pulp be mixed with it, it makes it of a rich purple colour; as this is a clear cafe and lies expofed to every difcerning eye, the great point of improvement to be gained, is to diffolve or extract this rich pulp, without injuring the wine. That the prefent method is the beft and moft effectual to that purpofe, I can by no means think; the violent fermentation through which the wine is made to pafs, in order to procure the tincture, muft exhauft the fpirits ſpirits in a very great degree, and leave the body in a weak and languid ſtate, and ſubject it to harſhneſs, to turn eager or vapid in a ſhort time; theſe wines grow worſe not better by age; many inſtances of this kind we meet with in the French clarets, among which, where one hogſhead proves good, ſound and wholeſome, ten, not to ſay twenty, prove harſh, eager and diſagreeable: Theſe conſiderations lead me to think, that the preſent managment calls loudly for a reformation; one experiment I have made, and but one, which I ſhall offer with ſome farther thoughts to conſideration for farther improvement; but I moſt heartily recommend this affair to ſome public ſpirited and worthy philoſophers of the age, who by repeated experiments might bring to light this important ſecret, which when known would be very beneficial to the nation. The experiment I made was this, in a clean ſtone pot, wide and open, containing two gallons, I ſqueezed as many Burgundy grapes as nearly filled it, with the liquor and ſkins; the ſtalks I left out. It ſtood in a dry room covered with a coarſe dry towel four double, four days and nights fermenting, I then ſtrained it off and with my hands maſhed the ſkins very well, by this means I obtained a full deep tincture of that kind of purple that is peculiar to the Burgundy wine; I then left it to ferment, in a large caſe bottle, after the firſt and ſecond fermentations were over, I found about a quart of rich ſediment at the bottom and a pretty thick ſkin formed on the top, the ſmell was very pleaſant and truly vinous, the juſt indications of a ſound healthy wine. By this experiment I found that, three days fermentation, allowing the firſt day for heating, which is preparatory to fermentation, (the degrees of heat are mentioned by Boerhaave, Hoffman and others) was ſufficient to obtain a tincture, with the help of ſqueezing the ſkins a ſecond time, without injuring the wine, and I found what red pulp remained adhering to the ſkins, ſeparated from them very eaſily, and by the colour of the wine, before the ſecond ſqueezing, that the fermentation had diſſolved moſt of this pulp, or extracted

extracted a great part of its tincture; from the whole then, I think I have reason to conclude, that if the husks or skins, after four days lying in the murk, were taken out and thrown into the mash vat, and heartily trod over again, and especially if some of the must, or rather wine, for it is wine after fermentation, be now and then thrown over the husks, as they are trampling it in order to wash away the pulp, that a full tincture may be obtained, without torturing the wine, as the present manner is, and without running so great a risque of spoiling it.

As this is a very important point, upon the right management of which depends the goodness of the wine, and as a farther improvement is hereby designed, I have dwelt the longer upon the subject, and therefore hope it will not be looked upon, as a useless digression.

Wine made from young vineyards is always thin and weak, and so are wines from old vineyards, when the seasons have been cold, stormy and wet, and without some assistance, they will not hold sound long; now this is given two ways, either by the help of some old strong wine, one fourth part at least, and four gallons of brandy to an English hogshead, or if that is not in your power, then half of the must is to be boiled away to one half of its quantity, that is, if one half of your must contains forty gallons, that must be boiled away to twenty, this greatly enriches it, and makes it of the consistence of liquid honey. As soon as it is cool, mix it with the rest of the must, and let it ferment together, and then manage it as before directed of other wines; when your vineyard comes to be ten or twelve years old, it will yield much stronger wines.

The boiling of your must is managed in the following manner, which must be carefully attended to; your copper or kettle being well cleaned, rub the inside all over with a woollen rag dipped in sweet oil, which preserves the wine from contracting a nauseous, copper or brass taste; then throw in your must, and kindle a gentle fire under the copper with brush or small split wood, your copper

 standing

ſtanding ſo high, that the wood need not touch the bottom of it, when you put large wood under it to make it boil faſt; for if at any time your wood touches the bottom of your kettle or copper, the wine will be burned, which will ſpoil it; as the ſcum riſes skim it off, and gently raiſe your fire by ſlow degrees, ſtirring your muſt often from the bottom, and take off the ſcum as it riſes, till all be clear, than raiſe your fire by larger wood, and make it boil faſter and faſter, as it ſettles down or boils away, till one half be conſumed, being always careful and upon the watch that none of the wood touches the bottom of the copper; the muſt thus boiled away is called defrutum, or the rob of grapes. If you neglect to raiſe the ſediment from the bottom of the copper, it will burn and ſpoil the wine, for it turns bitter.

And now once for all I muſt caution every one, who attempts to make wine, to be ſtrictly careful to have all the veſſels and inſtruments made uſe of in this work, perfectly clean and ſweet; for if they have any ſour, unſavoury or offenſive ſmell, they will communicate it to the muſt and ſpoil the wine; and every thing that has an offenſive or diſagreeable ſmell, muſt be removed from the place where wine is made, and from the cellars where it is kept; the cellar ought to be dry and warm; for damps or wet hurt wines exceedingly. It muſt alſo be free from muſtineſs, and in good weather, the windows next the ſouth and weſt muſt be opened, to admit the warm dry air, which will prevent muſtineſs and dangerous damps.

Hogſheads well bound with iron are the only ſafe caſks for wine, if you truſt to old wine pipes, or to hogſheads with wooden hoops, it is ten to one but they deceive you; they conſtantly want repairing every year, but iron bound caſks will hold many years without any expence at all, ſo that in three years time they become by much the cheapeſt caſks; I mean for ſtanding caſks, out of which the wine is racked into other caſks for ſale; but then as ſoon as they are empty, the lees muſt be taken out and ſaved for diſtilling

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into brandy, and the ſame day the caſk muſt be filled with water, or elſe they will be deſtroyed by a ſmall worm, which will pierce it like a ſive.

Every man that has a vineyard ſhould have a ſtill and good worm, that he may diſtil all the lees, the husks and the ſcum into good brandy, which he will want for the preſervation of his wines, the ſame ſtill will do to make peach brandy and the ſpirits of cyder, which will ſoon pay for it. A ſtill that holds a barrel is quite large enough, unleſs your vineyard and orchards be very large indeed.

I now paſs on to the different management of wine after fermentation; one method I have already mentioned; ſome after the ſecond fermentation, leave the wine in the ſame cask upon the lees, and adding the old wine and brandy to it (for which they make room) they ſtop up the bung hole, and leave only the vent hole open to let out the generated air, till the month of March, filling up the cask from time to time as the wine ſubſides or waſtes, and then draw it off into a clean, well ſcented and well ſtummed cask, and ſtop all cloſe with morter.

Others again in the month of March, before they rack it off and ſtum it, roll the cask backward and forward in the cellar to mix the lees thoroughly with the wine, thinking thereby to communicate the ſtrength of the lees to the wine, and then let it ſtand and ſettle till it is fine, and rack it off into clean well ſtummed casks, and ſtop and plaiſter all upc loſe.

Here I think it proper to take notice, that the lees of ſtrong wines may be of advantage, and communicate ſome ſtrength to weak wines, that are racked off upon them, but it does not therefore follow, that all lees are beneficial to the wines that produce them; for, as I have already obſerved, the lees, in the time of fermentation, being thrown up to the top of the veſſel, there meet with the air, and being expoſed to it for four or five days, contract a harſh and rancid nature, if they do not grow quite ſour, and then ſubſiding, as ſoon as the fermentation is over, and ſettling to to the bottom of the cask, where they are left for the wine to feed upon, I leave it to any man to judge what kind of food this muſt be, and what manner of good it can communicate to the wine. But what ſhall we ſay, ſo rigid and arbitrary is cuſtom, that we even look upon it next to rebellion, to deviate or depart from the cuſtoms of our fathers. The cyder that has been made in America for above one hundred years paſt, has till very lately, been conſtantly ſpoiled by this ſame miſtake. Every man that makes cyder very well knows, how ſoon the pumice corrupts and grows ſour by being expoſed to the air, and yet no man in all that time ever prevented the pumice, after fermentation, from ſettling down through the whole body of cyder, but there left it to remain for his cyder to feed upon all winter, and indeed all the next ſummer too, if it laſted ſo long; with this additional advantage, that in the ſpring upon a freſh fermentation, the ſame body of pumice riſes again to the top of the cask and there contracts a ſtill greater acidity or rancid nature, and by ſinking down again through the body of liquor, communicates a ſtill higher degree of theſe rare qualities to it, and then the owner complains of the hardneſs of his cyder, and ſo does every body elſe that drinks of it; and yet this has ſo long remained without a remedy, becauſe our fathers did ſo.

From what experiments I have made, I am clearly of opinion that the fæces or lees which are left in wine or cyder is the true cauſe of their frequent fermentation; nature appears to be loaded with, and ſick of them, and like a man with a foul ſtomach, often ſtrains hard for a diſcharge, and the neglecting to eaſe and clear nature of this pernicious, this deſtructive load, is the chief cauſe of all the ill effects it produces. In this, the juice of the grape reſembles the blood, the vital juice of man, if by a foul ſtomach any quantity of crude, indigeſted or vitiated matter be thrown into the blood, it is preſently ſet into a ferment, which riſes and increaſes till either the matter be fully diſcharged, or the vital union be diſſolved; if the man

man recovers the ſhock, and gets the better of the mighty ſtruggle, yet how weak, how low and faint does he appear! Thus it fares with wines, the ſtrong bodied wines that are replete with ſpirits, often get the better of theſe ſtruggles, but I believe not without conſiderable loſs and damage; but the weaker wines generally ſink under them. It is from this idea of the thing, that I have all along ſo ſtrongly inſiſted upon the removal of the lees in the beginning, upon the firſt as well as the ſecond fermentation. I ſhould be greatly pleaſed if the ingenious and Reverend Dr. Hales, of Teddington in Great-Britain, would, by experiments, bring this matter into a clearer light; the world would be obliged by him, as they have already been, by a diſcovery which he was ſo good as to make not long ſince in a caſe that bears ſome relation to the preſent one; I ſhall tranſcribe it as it is related by the ingenious Mr. *Philip Miller*, in his Gardener's Dictionary: viz. "A great complaint I received from a curious gentleman in Italy, of the ſpoiling of their beſt and fineſt wines there; who ſays, ſuch is the nature of this country wines in general, (nor are the choiceſt Chianti's excepted) that at two ſeaſons of the year, viz. the beginning of June and September, the firſt, when the grapes are in bloſſom, and the other when they begin to ripen, ſome of the beſt wines are apt to change, eſpecially at the latter ſeaſon; not that they turn eager, but take a moſt unpleaſant taſte, like that of a rotten vine leaf, which renders them not only not fit for drinking, but alſo unfit for vinegar, this is called the ſeptembrine, and what is moſt ſtrange, one caſk drawn out of the ſame vat, ſhall be infected, and another remain perfectly good, and yet both have been kept in the ſame cellar. As this change happens not to wine in bottles, though that will turn eager, I am apt to attribute it to ſome fault in filling the caſks, which muſt always be kept full; which either by letting alone too long, till the decreaſe be too great, and the ſcum thereby being too much dilated, is ſubject to break, or elſe being broken by filling up the caſk, and being mixed with

with the wine, gives it that vile taſte: But then againſt this there is a ſtrong objection, i. e. that this defect only ſeizes the wine at a particular ſeaſon, viz. September, over which, if it gets, it will keep good many years: ſo that the caſe is worthy the inquiry of naturaliſts, ſince it is evident that moſt wines are more or leſs affected with this diſtemper, during the firſt year after making.

"Upon receiving this information from Italy, I conſulted the Revd. Dr. *Hales* of Teddington, who was then making ſeveral experiments on fermenting liquors, and received from him the curious ſolution of the cauſe of this change in wine, which I ſent over to my friend in Italy, who has tried the experiment, and it has accordingly anſwered his expectation, in preſerving the wine, he thus managed, perfectly good. He has alſo communicated the experiment to ſeveral vigneronsin Italy, who are repeating the ſame; which take in Dr. *Hales* own words, viz.

"From many experiments which I made the laſt ſummer, I find that all fermented liquors do generate air in large quantities, during the time of their fermentation; for from an experiment made on twelve cubic inches of Malaga raiſins, put into eighteen cubic inches of water the beginning of March, there were four hundered and eleven cubic inches of air generated by the middle of April; but afterward, when the fermentation was over, it reſorbed a great quantity of this air; and from forty two cubic inches of ale from the ton (which had fermented forty four hours before it was put into the bolt head) there were generated ſix hundred and thirty-nine cubic inches of air from the beginning of March to the middle of June, after which it reſorbed thirty-two cubic inches of the ſame air; from whence it is plain, that fermented liquors do generate air during the time of their fermentation, but afterwards they are in an imbibing ſtate, which may perhaps account for

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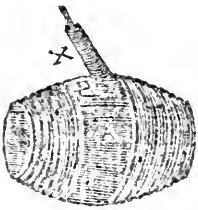
the alteration in the nice Italian wines,* for wine during the firſt year after making, continues fermenting more or leſs, during which time a great quantity of air is generated, until the cold in September puts a ſtop to it, after which it is in an imbibing ſtate, that is, it draws or ſucks in air; the air thus generated is of a rancid nature (as the Grotto del Canno) and will kill a living animal if put into it, ſo that if there be, during the fermentation, two quarts of this air, ſo rancid, pent up in the upper part of the caſk, when the cold ſtops the fermentation, the wine by abſorbing this air becomes foul, and acquires this rancid taſte; to prevent which I would propoſe the following experiment:

* Had Dr. Hales been aſked what he thought was the true cauſe of thoſe frequent fermentations, and was deſired to apply a remedy; I think he would have ſought for the cauſe, where it was to be found, and upon removing that, the effects would naturally have ceaſed; but being put upon the ſearch of ſecondary cauſes, cauſes far removed from the original, in order to prevent or cure the evil effects of them, he reſolved that difficulty, I do ſuppoſe in the beſt manner it could have been done, and with great ingenuity applied a remedy. And now, ſhould theſe pages fall within his ken, or ſome friendly letter comprehending my full meaning, the Doctor, as a true philoſopher, from a public benevolent ſpirit, would ſoon find out the true cauſe of theſe miſchiefs, and apply a remedy, truly ſpecific.

The gentleman in Italy, who makes the repreſentation to Mr. Miller ſays, "And what is moſt ſtrange, one caſk drawn out of the ſame vat, ſhall be infected, and another remain perfectly good;" in this caſe it is certain, that the firſt and ſecond caſk drawn out of the vat, and the third and fourth, if the vat be large, were drawn off fine and clear, being perfectly free from the fæces or lees below, but when the laſt caſk comes to be drawn, a good deal of the lees comes with it, and this is not much regarded, as the lees were ſuppoſed to nouriſh the wine; ſuppoſe the gentleman complaining had the firſt and the laſt caſk drawn out of the vat, and one of them ſpoiled, the other remained perfectly good, which ſhall we ſuppoſe to have been the caſk? That which was perfectly fine, or that which has the lees? Whoever will taſte the firſt and the laſt drawings, will find ſo ſenſible a difference in the wine, that I think he cannot be at a loſs to determine the queſtion.

Secluding the air from wine or cyder, is a great means of preſerving them long ſound and good; nature itſelf points this out to us; wine forms a ſcum upon the top to ſecure itſelf from the bad impreſſions of it, and we daily find that theſe liquors put into bottles, keep much better than when left in caſks; ſome think that ſtrong old Madeira is an exception to this rule, but I think it has not had a fair and impartial trial. That cyder drawn out of a barrel grows worſe and worſe as the air gets to it, every one is ſenſible of, whereas ſome of the ſame cyder bottled, remains good a long time, if well corked and roſined, as every body knows; and that this is the X caſe with common wines, no man will diſpute. For this reaſon the lining of the inſide of the caſks with roſin, as the Romans did with pitch, prepared as hereafter directed, would be a great means of preſerving wine, not only from the air but from great waſte; and the bung and vent-hole ſhould be well ſecured with clay and horſe dung: if you are under apprehenſions that the roſin will communicate a bad taſte to the wine; melt it, and waſh it with lye, and that will prevent it. The Doctor's method of keeping the caſks full is very ingenious and of great ſervice.

B The tubes, repreſented in the margin, perhaps may be a ſmall improvement upon his, this double tube is ſuppoſed to be made of pewter or tin, well ſoldered together; the ſmall tube enters the large one at bottom, below the wine, and does not break the ſcum that is on the top of the wine in the large tube; the large tube ſhould be well ſtopped with a good cloſe ſcrew head, and this muſt be opened when wine is poured in through the ſmall tube, and preſently ſtopped again, that the caſk may always be kept full, and to keep out the air.



ment: Suppofe the veffel A, filled with wine, in the bung-hole B, of this veffel I would have a glafs tube of two feet long and about two inches bore fixed with a pewter focket clofely cemented, fo that there may be no vacuities on the fides; and in this tube fhould be another of about half an inch bore, clofely fixed; the lower tube fhould be always kept about half full of wine, up to X, which will fupply the veffel, as the wine therein fhall wafte or fubfide, fo that there will be no room left in the upper part of the veffel to contain generated air, which will pafs off through the upper fmall tube, which muft always be left open for that purpofe; and the tube being fmall, there will be no danger of letting in too much air to the wine: As the wine in the large tube fhall fubfide, it may be replenifhed, by introducing a flender funnel through the fmall tube down to the fcum upon the furface of the wine in the large tube, fo as to prevent its being broken by the wines falling too violently upon it; this will be prevented by the wines being poured in gently with a fmall ftream. This experiment being tried with glafs tubes will give an opportunity to obferve what impreffion the different ftates of the air have upon the wine, by its rifing and falling in the tubes; and if it fucceeds it may be afterward done by wooden or metal tubes, which will not be fo fubject to break.

This curious experiment having fucceeded, where ever it has been tried, will be of great fervice in the management of wines; there being many ufeful hints to be taken from it; particularly with regard to fermenting wines; for fince we find that wines too long fermented (efpecially thofe which are made in cold countries) do feldom keep well; fo by letting them ftand in a cool place, the fermentation will be checked, which will render the wines foul, and fubject to turn eager; therefore great care fhould be taken to keep the wine in an equal temperature of air, which may be known by hanging a thermometer in the vault.

vault. But after the wine has paſſed its fermentation in the vat, and is drawn off into caſks, it will require ſomething to feed upon: And when the wine has remained one year upon the lees it is commonly drawn off into other veſſels, it will then alſo be proper for it to have ſomething to feed upon; about four pounds of the beſt Malaga raiſins picked clean and ſtoned, and thrown into each hogſhead, will be ſufficient and beſt for that purpoſe, more would be dangerous, by raiſing a new fermentation, which always hurts the wine more or leſs according to the greatneſs of it. As the wine will ſubſide by waſte as long as it continues in casks, it is the uſual method to fill them up from time to time, with ſome wine, as nearly like the ſame ſort as may be; for if it be of a different nature or much newer, ſuch as has not thoroughly fermented, it will often raiſe a new fermentation, which will endanger the wine: Therefore, if you have no ſuch proper wine, it will be beſt to throw in as many clean waſhed pebbles and well dried, as will raiſe up the wine to the bung: This I have known practiſed with ſucceſs." Thus far Mr. *Miller*.

Here I muſt beg leave to make ſome obſervations, which may either ſerve to throw a light upon this affair, or lay a foundation for farther experiments, in order to come at the truth, which in all caſes is worth purſuing, and eſpecially in this, where it has lain dormant for ſo many ages, and the diſcovery would be of great importance to the preſent deſign.

The principles of wine are an inflammable ſpirit, a phlegm or watry liquor, an acid ſalt or tartar, and a ſulphureous oily ſubſtance; wines therefore greatly differ in their taſte, ſmell and virtue, according to the various proportions and manner in which theſe principles are combined. Perhaps the difference of flavour, taſte, colour and body in wines may be owing as much to the time of gathering, manner of preſſing, the different degrees of fermentation, &c. as to any difference in the grapes themſelves; in Hungary, whence Tockay and ſome of the richeſt and higheſt flavoured wines do come, they are extremely curious in theſe reſpects; for their prime and moſt delicate wines, the grapes are ſuffered to continue on the vines till they are half dried by the heat of the ſun, and if the ſun's heat ſhould not prove ſufficient, they are dried by the gentle heat of a furnace. Wines that are thin may be improved by freezing, by this means the watry parts adhere to the caſk, and the ſtrong ſpirituous parts are left in a body, in the middle of the caſk, and being drawn off by themſelves, prove ſtrong and good, and will keep well. See *Hoffman*, and the celebrated Dr. *Stahl* on the ſubject; ſee alſo Dr. *Shaw's* comment on *Stahl*.

If theſe be the real principles, and ſome of the eſſential conſtituent parts of the grape, or if a proportionable quantity of nitre be allowed to come into the compoſition, which might perhaps be diſcovered by an accurate analyſis, it will not be hard to account for the fermentation; heat and air both are neceſſary to it; now theſe principles whilſt confined to the grape, are ſo diſpoſed by the wiſe Author of Nature as to be confined diſtinctly in their proper cells or tubical ramuſculi, and they are ſo cloſely ſecured by the covering of a ſkin, of ſuch a compact texture, like that of bladders of ſeveral kinds, that the air cannot come at them, but they are effectually ſecured againſt the impreſſions of it; if this, or ſomething like this be the caſe, then theſe principles remain in a neutral or inactive ſtate, whilſt thus confined to the fruit, but when the fruit comes to be maſhed, and theſe principles come in contact of each other, and are expoſed to the warm air, which is of a very active and elaſtic nature, the whole body, by degrees, is put into motion, the motion begets heat, and the heat increaſes the motion, (this heat and the increaſe of it is plainly diſcernable by the touch, 'till it increaſes to ſuch a degree, as according to *Boerhaave*, is neceſſary to a full fermentation. The heat then increaſing to a farther height, the fermentation gradually abates, and thus ends the firſt fermentation: By this operation a ſpirit is generated, and the mild, ſoft, luſcious juice of the grape, which

which is called muſt, is changed into a briſk, lively, inflammable ſpirit, which is then called wine; which has, if cloſely and attentively conſidered, a ſtrange and wonderful effect upon thoſe that drink it, according to their different diſpoſitions, humours and conſtitutions.

By the violent motion of this firſt fermentation, all the fæces or groſs parts are thrown up to the top of the veſſel, and this is a proper time, at the end of three, four or five days, according to the ſtrength of the wine, which is then pretty clear, to draw it off from thoſe groſſer parts; which will be done without loſs, and the lees muſt be preſerved for diſtilling into brandy. If this be neglected, this groſs body having been ſo long expoſed to the air, contracts a rancid nature, or turns ſour, and as ſoon as the fermentation is over, it gradually ſinks down to the bottom, and paſſing ſlowly through the body of the liquor, communicates thoſe evil qualities to it: This is ſo clearly diſcernible in cyder, which alſo is a tolerable good wine, when properly managed, that no man can be miſtaken in the caſe. Since I have taken this method with cyder, it has proved more like wine than common drink, but then I racked it off a ſecond and a third time, as ſoon as it appeared fine, and then ſtummed the cask that received it the laſttime: This cyder will keep ſound all ſummer in a cask, and grows ſtronger, and may be bottled at any time, it will ſoon ripen, and be very briſk when poured into a glaſs, and that without endangering the bottles ſo much, its briskneſs proceeding from ſpirit, and not from fermentation.

Weak wines will by no means bear ſo great a fermentation as ſtrong wines, let them therefore be drawn off after three days fermentation the firſt time, and adding two or three gallons of brandy, and five or ſix gallons of good old wine; ſtop up the bung, and leave only the vent hole open, and when the ſecond fermentation is juſt over, and when the wine is pretty fine, draw it off a ſecond time into a well ſtummed cask, fill it up to the brim, and ſtop all cloſe, and keep it ſo 'till you ſell or uſe it, and then bottle it.

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Some cuſtoms among the ancients, I think, are worthy of notice, and fit to be revived and retained by us; how many of them came to be laid aſide, when they appear ſo uſeful and beneficial, I cannot ſay, perhaps for reaſons which I am not able to diſcover: I ſhall here mention one, which I think pertinent to our preſent purpoſe, which was for the preſervation of their wines; they took a firkin, or eight gallons of pure clear tar, of the firſt cool running from the kiln; to this they added half as much good clean pitch pounded fine, and put it all into an iron pot, and melted it by a gentle fire; when hot they put to it four gallons of ſtrong lye (that is a lixivium of aſhes,) this they ſtirred altogether, at leaſt for half an hour very well, it was then left eight and forty hours for the tar and pitch to ſubſide, the lye was then poured off; the tar and pitch was heated till it melted a ſecond time, and four gallons of freſh lye were poured on, and ſtirred and managed as before; this was done a third time; they then took four gallons of ſea water, as ſalt as could be got, (for people who cannot eaſily come at the ſea water, a good clean brine, made of ſalt and water, may do as well) the tar and pitch being juſt melted, but not made too hot, they put the ſalt water to it, and ſtirred it very well, this was put in the ſun, and ſtood open all day, but covered at night to keep off the dews, and when it rained; this ſtood expoſed to the ſun till all the water was exhaled, and then it was put up for uſe. With this they payed or daubed over the caſk, into which they put the wine, in this manner: They took out one head of the caſk, and in the ſame manner as our coopers do, they heated the caſk thoroughly, and having ſome of the pitch and tar, (now more reſembling pitch alone) melted, they threw in as much as they thought would daub the caſk all over, and alſo the head that was taken out, they then took a broom and rubbed the pitch well over every part of the inſide of the caſk, ſo that no ſpot eſcaped, turning and winding the caſk about very briſkly; for this work muſt be done in hurry, leaſt the caſk and pitch

pitch cool, in which caſe the pitch grows ſo thick and hard as to refuſe to be ſpread: By this managment of the caſk, it was made perfectly tight, all the pores of the wood were ſtopped, the wine was preſerved from waſte, which wine merchants very well know is a great ſaving, and well deſerves the trouble and expence, and the ſpirits of the wine, which are always active, and ſtriving to fly off through every pore, are greatly preſerved, and the air without, which preſſes hard to inſinuate itſelf through every pore, is effectually prevented. If men that ſell rum, or any other ſpirituous liquors, could at firſt afford to have good iron bound casks, for conſtant ſtanding casks to keep their liquors in, and draw it off as they ſell it, they would ſoon find themſelves great gainers by this practice. I think roſin and turpentine well waſhed with lye in the ſame manner, would be ſweeter, and better anſwer all the purpoſes; or indeed roſin alone would do as well.

I ſhall now propoſe the managment of ſome ſmall quantities, in different manners, by way of experiments, in order, if poſſible, to arrive at ſome tolerable perfection in this new undertaking.

1ſt. Let a keg of four gallons be filled three-fourths with murk, that is, with the muſt and skins of black grapes, for making of red wine, (the skins having been well ſqueezed) before any fermentation; let the bung hole be ſtopped cloſe, and leave the vent hole open, to let out the generated air, and after the ſecond fermentation fill up the keg with old wine, and let the vent hole remain open, and let it ſtand ſo till February, then draw it off, and manage it as occaſion ſhall require; if it be clear, ſweet and good, bottle it, ſo ſhall you have pure genuine wine with its own peculiar flavour; if you find it thin and weak, you muſt help it as in other caſes.

2d. Let a keg of four gallons be filled with the wine that is drawn off, after the firſt fermentation is over, the keg having firſt been well ſtummed, ſtop all cloſe, and let it ſtand till February, if it then be fine bottle it, if not, ſtum a ſecond keg well, and draw it off, and ſtop all cloſe, and let it ſtand till the next winter; if it then be fine, bottle it; if not fine it down, and then bottle it for uſe: If, at the ſecond racking, you find it thin and weak, add ſome brandy and old wine to it.

3d. Let white grapes hang on the vine a month after the vintage is over, let others hang till they ſhrivel, make trial of theſe at different times; let them be maſhed as much as poſſible without breaking the grape ſtones, let them ſtand in the murk two, three, or four days, well covered with a blanket three or four double, then drain off the wine, and maſh the ſkins very well over a cullender the ſecond time; then ſtrain out the ſtones, waſhing the ſkins very well with the wine, till all the pulp, that ſticks to the inſide of the ſkins, be got off, fill your keg with this wine three-fourths, and fill up the reſt with good old wine, ſtop up the bung, leaving the vent hole open till the ſecond fermentation is over, then ſtop the vent hole, and let it ſtand till February: I think this wine will be good; but then in all theſe caſes the vent hole muſt now and then be juſt opened, to let out any generated air, leſt the keg be in danger of burſting. As ſoon as the air puffs out ſtop it again, that as little air as poſſible, may get in.

By varying theſe experiments, you may at laſt come at the moſt perfect way of making, fermenting and preſerving of wines: It is now ſaid, that wines cannot be preſerved without brandy, how then did the ancients preſerve them? I think they may be preſerved pure and perfect by their own ſtrength, when a vineyard comes to a proper age (which I will ſuppoſe to begin at twenty, and ſo laſt till ſeventy or eighty) if the grapes are ſuffered to hang on the vines till they are perfectly ripe; but people, partly from a fondneſs of getting done before their neighbours, and partly from a deſire of making a little more wine, and ſome from the apprehenſions of a rainy ſeaſon, hurry on this work before its time, and often, very often, become great ſufferers by it.

The

The reaſon for my being ſilent about vines that are natives of America, is, that I know but little of them, having but juſt entered upon a trial of them, when my very ill ſtate of health forbad me to proceed: From what little obſervation I have been able to make, I look upon them to be much more untractable than thoſe of Europe, they will undergo a hard ſtruggle indeed, before they will ſubmit to a low and humble ſtate, a ſtate of abject ſlavery: They are very hardy and will ſtand a frame, for they brave the ſevereſt ſtorms and winter blaſts, they ſhrink not at ſnow, ice, hail or rain; the wine they will make, I imagine from the auſterity of their taſte, will be ſtrong and maſculine.

The fox-grape, whoſe berries are large and round, is divided into three ſorts, the white, the dark red and the black; the berries grow but thin upon the bunches, which are plain without ſhoulders. They delight moſt in a rich ſandy lome, here they grow very large and the berries are ſweeteſt, but they will grow in any grounds, wet or dry; thoſe that grow on high dry grounds generally become white, and the colour alters to a dark red or black, according to the lowneſs and wetneſs of the ground; the ſituation I think muſt greatly affect the wine, in ſtrength goodneſs and colour; the berries are generally ripe the beginning of September, and when fully ripe they ſoon fall away; thus much I have obſerved as they grow wild. What alteration they may undergo, or how much they may be improved by proper ſoils and due cultivation I cannot ſay.

There is a ſmall black grape, a ſize bigger than the winter grape, that is ripe in September; it is pleaſant to eat, and makes a very pretty wine, which I have drank of, it was four years old, and ſeemed to be the better for its age; the colour was amber, owing to the want of knowing how to extract the tincture; this grape is ſeldom to be found; there is a vine of them near *John Taylor*, Eſq. at Middletown, Monmouth, and there are ſome of them in Mr. *Livingſton*'s vineyard at Piſcataqua in New-Jerſey. I think they are well worth propagating.

Th

The froſt or winter grape is known to every body, both the bunches and berries are ſmall, and yield but little juice, but the richneſs of the wine may make up for the ſmallneſs of the quantity; the taſte of the grape is auſtere till pretty hard froſts come, and then it takes a favourable turn and becomes very ſweet and agreeable; this vine ſhoots forth great numbers of ſlender branches, and might do very well for the ſouth and ſouth-eaſt ſides of a ſummer-houſe or cloſe walk, if all the uſeleſs and barren branches were cut away.

The vines of America are fit for ſtrong high eſpaliers, but if I miſtake not, he muſt watch them narrowly, muſt take away every unneceſſary and unprofitable branch, and trim them ſharp and cloſe, that means to keep them within bounds.

We ſee that the vines of this country have a covering of bark of ſo cloſe and firm a texture, that they ſtand all weathers without injury, they fear nothing but a froſt after they put forth the tender bud: We ſee that cold winds and winter blaſts have a great effect upon the human body, they brace up and confirm all the ſolids, harden and ſtrengthen the whole frame, and renders a man active, briſk and lively in all his motions: They have likewiſe a wonderful effect upon the brute creation; the covering of ſheep, cattle and horſes, in hot countries, is very thin and cool, remove them into a cold region, ſheep ſoon acquire a covering of wool, horſes and cattle a thick coat of hair. Why then ſhould not vines by being tranſplanted from a warm into a cold region, acquire a firmneſs and covering ſuitable to their new ſituation? I believe by a proper managment they may by degrees be inured to colder countries, but ſuch a hardineſs muſt not be ſuppoſed to be acquired all at once, but by being winter after winter, a little more and more expoſed to the ſeverities of the weather, they may in a few years, in a great meaſure, be reconciled to ſuch a climate as ours: But then I would have it remembered that, late ripe fruit will not do as yet to the northward

northward of the capes of Virginia; it is the early ripe fruits, that the bread colonies muſt propagate, 'till the climate becomes more temperate, by the country's being cleared further back; none that ripen after October will ſuit us at preſent, and the lateſt we raiſe, ſhould arrive at full maturity by the end of that month. In twenty years I make no doubt November will be as favourable a month as October is now.

Method of curing GRAPES for RAISINS.

JARR RAISINS or Raiſins of the Sun cured in the moſt perfect manner, ſo as to retain their full flavor, and keep long without candying, is done in the following manner:

Build a hurdle or ſtage two feet from the ground, or two feet high, and ſo long as to hold all the bunches you intend to cure at a time, ſo as to lie ſingle without touching each other, the bed of the ſtage is made of ſplit reeds, of willows, or any other ſhrub, that will lie level and ſmooth, and for want of ſuch it may be made of long rye ſtraw, the ends of which only has been threſhed. Then thatch two ſides a little longer than the ſtage, with ſmooth ſtraw, ſo cloſe as eaſily to turn off a ſhower of rain, and yet ſo light as to be fixed up upon the ſtage, and to be taken down at pleaſure, the ground under the ſtage muſt be covered with ſtraw to keep the damps from riſing, and to reflect heat: This being done prepare a lixivium of aſhes, that is, a lye, about half as ſtrong as that you make ſoap of which bears an egg; this you put into a broad ſhallow iron kettle, the quantity according to the number of grapes you intend to cure. Set it a boiling, and throw into it a handful or two of clean ſalt to four gallons of lye, and one pint of ſweet oil, or a pound and half of good ſweet butter; then having tied three or four bunches of the faireſt and full ripe grapes together, taking away the rotten, and all the unripe ones, and ſtirring firſt the oil or butter very well into the lye, the lye now boiling, you put as many bunches in as will near cover the ſurface, and let them ſcald pretty well, but not too much ſo as to be boiled; take them out gently into a wide flat cullender, without bruiſing, and lay them gently upon the ſtage, unbind them and lay every bunch ſingle by itſelf, ſo as not to touch each other; if your ſtage be large ſo that you ſcald a great many bunches to fill it, and before you have done, or near done, you have reaſon to believe that your oil or butter is expended, you throw in as much more as you think will finiſh your quantity, for this adds richneſs to the raiſins, and preſerves them long without candying; if you have hands to hold the bunches by the ſtrings whilſt they ſcald, it would be beſt, becauſe they would be handled without bruiſing, and indeed this is the deſign of tying ſo many bunches together, but if you are alone, or have but one hand with you, and cannot well hold bunches enough to cover the ſurface of the kettle, the beſt way would be to caſt the bunches in ſingle and to take them out with a ſlice or a ſkimmer. When your ſtage is full, about three hours after you have done, turn the bunches into a dry place on the ſtage, ſo that no wet may touch them, and that they may dry as ſoon as poſſible; before ſun ſet, at leaſt half an hour, ſet up your roof and cover them from dews and rain; the next morning as ſoon as the dews and damps are exhaled, uncover them, and turn them twice that day, and ſo on till they are pretty moderately dry, ſo as to be fit for keeping; then put them into jars with covers and plaſter them over with clay and horſe dung, and ſet them away in a dry cool place till you uſe or diſpoſe of them; but beware of damps: And obſerve that you are to begin this work in the wain of the moon, your grapes muſt be fully ripe and taken from the vines when quite dry. All fruits gathered in the wain of the moon will keep longer ſound and good, than thoſe gathered in the increaſe. Note alſo that theſe raiſins thus cured, are fit for princes, for the rich and great, and ought to fetch a good price, ſince no raiſins can be be more delicious. The common raiſins muſt be ſcalded the ſame way, and about the ſame time, and may be ſpread upon hurdles, laid on ſtraw on the ground, and hauled in under ſome ſhed or covering, at night, before ſun ſet, and brought out in the morning, and when dried put into ſmall caſks, ſuch as raiſins come in. The Malaga grape is eſteemed the fineſt for raiſins, but as the northern colonies, I mean the bread colonies, will not as yet produce them, they being too tender and too late ripe, we may however be ſupplied among ourſelves from the red Frontiniac, which is a very rich ſweet grape, is early ripe and makes very good raiſins.

And now to conclude the whole, as my countrymen are unacquainted with the utenſils that are neceſſary for making of wine, it is neceſſary that I ſay ſomething on that head.

Firſt then according to the ſize of your vineyard, you muſt have a number of cheap crooked knives, the ſhape of pruning knives, but a little more bending, to cut off the cluſters from the vines; for pulling them off, is very difficult, it is attended with great waſte of fruit, and is very deſtructive to the vines; you muſt alſo have a number of handy baſkets, to put the grapes into, as you cut them, and alſo a large wicker baſket or pannier, which is of a long ſquare form, fit to place on a good light hand-barrow, with leather ſtrops at each end to hang on the ſhoulders of two hardy boys, who may trot away with it to the maſh vat, as ſoon as it is full; or elſe it may be carried in a wheel-barrow, if hands are ſcarce, or you may have two panniers made fit to hang acroſs a horſe's back, being made flat on one ſide for that purpoſe. Then you will want a maſh vat big in proportion to your vineyard and the age of it, this muſt have a falſe bottom full of holes made with a twenty-penny gimblet, but not larger, leaſt the grapes get into them, it muſt lie upon a curve firmly fixed, about ſix inches above the true bottom; you will alſo want a receiver, which is a pretty large tub, placed

partly

partly under the mafh vat, to receive the muft as it runs from it; if your vineyard be large you will alfo want a kedlar, which is a large vat or ton, for fermenting the murk that you make red wines of, and perhaps for that of white wines, if you choofe to make wine of them after the manner of Paris. If your vineyard be not large the mafh vat may anfwer the purpofe. You will alfo want pails and dippers and a large funnel to ton with: A fmart clofe fcrew prefs, to go with one or two fcrews as you like beft, with a wicker frame and hair bag to fit it, and proper followers to prefs clean and dry, muft be had without fail; and laft of all good found ftrong iron bound butts or hogfheads, which are really cheapeft and the only cafks you can depend upon, what makes them far preferable to others, is, they are always tight, they want no trimming, only a little driving once a year, if they ftand empty any time and they laft good for many years, if they are well painted and dried till the fmell of the paint goes off, otherwife they would communicate that ill fmell to the wine. And here my dear countrymen I muft repeat to you what I have already endeavoured to inculcate, which is, that every thing muft be kept fweet and clean; if by careleffnefs, inattention or hurry of bufinefs, you fuffer your prefs or any of your veffels, your tubs or cafks to grow four or mufty, they will certainly ruin your wine, for nothing in nature is fooner tainted than muft or new made wine. And let me perfuade you to avoid one great error, which moft farmers run into, about their cyder, leaft that cuftom be put in practice alfo with wines; they put their cyder into frefh rum hogfheads, under the notion of preferving the cyder ftrong and good, but they deftroy the fine flavor of the apple, and inftead of an agreeable vinous liquor, your nofe is offended with a ftrong hogo, and you tafte nothing but the fumes of a rum hogfhead, fo that no gentleman, no man of tafte or delicacy, will buy it; now fhould you make the fame miftake with your wines, you would certainly fpoil them, were they otherwife never fo good, fo that no man would buy them. It

It has been the general opinion of makind that wines ought to have ſomething to feed upon, but this notion is very wrong, for moſt things that are put into wine raiſe a fermentation in a higher or lower degree; and it is agreed that every after fermentation hurts wine more or leſs; if wine be weak put in brandy and old ſtrong wine, theſe are the proper ſtrengtheners and preſervers of wine; ſtrong wine wants nothing but clean racking, and all wines ſhould be racked till they are fine. A double handful of clean coarſe ſalt may do good.

Perhaps I have not ſaid enough upon taking away day roots from vines the firſt three or four years of their age, but let me now tell you that, it is of great conſequence, and it is the chief means of preventing the grapes from burſting.

And now my dear children, countrymen and fellow-citizens, I have faithfully led you by the hand throughout this new undertaking; take my bleſſing and cordial advice along with it, be not drunken with wine wherein there is exceſs, but be ye rather filled with the ſpirit of wiſdom, for too much wine, like treacherous ſin, ruins and deſtroys the true happineſs of the ſoul. And may the God of wiſdom crown all your honeſt labours with ſucceſs, and give you a right underſtanding in all things.

The Method of curing FIGS; *by the ſame Gentleman.*

GATHER the fulleſt and plumpeſt figs when ripe and fit to eat, in a dry day, when the dew is off, and in the wain of the moon, ſpread them on the ſame hurdle you cure your raiſins upon, turn them twice a day and an hour before ſun ſet cover them from the dew, and from rain: When the figs are dry, they muſt be taken from the ſtage in the middle of a dry clear day, when they are yet warm with the heat of the ſun, and put them into earthen jars and preſs them down flat cloſe, putting a little dried fennel

fennel at the bottom and on the top, the cover of the jar muſt be daubed all round with clay and horſe dung and put away in a dry cool place where they will keep the year round ſound and good, or may be tranſported to any place abroad.

OBSERVATIONS *on the raiſing and dreſſing of* HEMP; *communicated to the* AMERICAN PHILOSOPHICAL SOCIETY, *by* EDWARD ANTIL, *Eſquire.*

HEMP is one of the moſt profitable productions the earth furniſhes in northern climates; as it employs a great number of poor people in a very advantageous manner, if its manufacture be carried on properly: It may alſo furniſh a ready remittance to the mother country, and become a reciprocal advantage to both; and therefore it becomes worthy of the ſerious attention of the different legiſlatures of the northern colonies, of every trading man, and of every man, who truly loves his country.

But as the people of America do not appear, from their preſent management, to be acquainted with the beſt and moſt profitable method of cultivating and managing this valuable plant, I beg leave to inform them of ſome things that may be of advantage to them.

Whoever would raiſe hemp properly and to advantage, ſhould ſet aſide two pieces of ground, of ſuch dimenſions each, as he ſhall be able to cultivate every year, and ſow the one whilſt he is manuring and preparing the other for the ſucceeding year's crop; the higher and dryer the ground the better, provided it be well dunged and made ſtrong and mellow; the ground ſhould not be too ſloping, leaſt the good ſoil be waſhed away with hard rains; if it droops toward the ſouth, ſo that it may have the full influence of the ſun, it will be an advantage; low, rich, warm, dry grounds will alſo produce good hemp; but wet land, though never ſo rich will by no means do. The ground being prepared and made very mellow, I now come to that part which

which muſt be particularly and exactly attended to, ſince the ſucceſs of the crop greatly depends upon it. Sometime in May, the ground being moiſt and in a vegetating ſtate, but by no means wet, it muſt be well ploughed, the furrows cloſe and even, the ſoil lying light and mellow it muſt be ſowed very even with two buſhels of ſeed upon one acre; a man with an iron tooth harrow follows the ſower, and harrows in the ſeed with two horſes without any balks, for the leſs the ground be trampled the better; if harrowing one way be not ſufficient to cover the ſeed, though it would be beſt if that could be done, it muſt be croſs harrowed. The ground being moiſt as I ſaid before, but by no means wet ſo as to clod, which would ruin the crop, the ſeed will all ſtart and come up together, which is a ſure ſign of a good crop, and nothing after that, but too much wet, will hurt it; for hemp thus come up, bids defiance to weeds and graſs of every kind; its growth is ſo quick and it ſo effectually ſhades the ground, that nothing below can riſe or ſhew its head, and it ſo preſerves all the moiſture below, that the hotter and dryer the weather the faſter it grows. Whereas if the ſeed be ſown, when the ground is dry, the ſeed that lies deepeſt where the moiſture is, will come up firſt, and theſe will ſhade and ſtarve thoſe that come after, by which means the firſt comers will be too large, and the laſt will be much too ſmall, ſo that the crop will be greatly damaged every way: So much depends upon this one circumſtance, of ſowing the ſeed when the ground is moiſt and fit to receive it: The crop thus rightly managed will ſtand as thick as very good wheat, and be from four to ſix feet high, according to the ſtrength of the ground; and the ſtems will not be thicker than a good wheat ſtraw; by this means the hemp will be the finer, it will yield the greater quantity, and it may be plucked from the ground like flax, which will be a very great ſaving: But if it be ſowed thin, that is one buſhel to an acre, which is the common practice, it grows large, the hemp is harſh and coarſe, and then it muſt be cut with hooks, which

which occaſions great waſte, for four or five inches juſt above ground is left, by way of ſtubble, which contains the beſt and heavieſt part of the hemp.

When the hemp has got its growth, and is fit to be plucked which you will know by the under leaves of the carle, or he hemp, turning yellow and falling off, the ſooner it is pulled the better; it muſt then be bound up with ſtraw bands, in ſingle band ſheaves, rather ſmall than large, and each ſheaf muſt be bound in two places; and the ſooner it is carried to the water to rot the better: Water rotted hemp, if it be rightly managed, is every way better than that which is rotted on the ground: there is leſs waſte in it, when it comes to be dreſſed; it looks brighter and fairer to the eye; it is eſteemed to be ſtronger and more durable, and it always fetches a better price; beſides it is much ſooner done, and it is rotted more even and alike, and with greater certainty and exactneſs. Many people in America are acquainted with the method of rotting hemp in water, but as many more are not yet acquainted with it, I ſhall, for their information, ſet down the method of doing it. Hemp may be rotted in ſtagnated or ſtanding water, ſuch as ponds, pools, or broad deep ditches, and in ſuch water it is generally four or five days and nights a rotting, and ſometimes longer, according to the heat or coolneſs of the weather; it may alſo be rotted in running water as in a brook or river; and in ſuch water three or four days and nights are ſufficient, according to the weather; to know whether the hemp be rotted enough in either caſe, take a middling handful, out of the middle row, and try with both your hands to ſnap it aſunder, if it breaks eaſy, it is rotted enough, but if it yet appears pretty ſtrong, it is not, and muſt lie longer, till it breaks with eaſe, and then it muſt be taken out and dried as ſoon as poſſible; in handling the ſheaves, take hold of the bands, and ſet them up an end againſt a fence, if one be near, or lay them down upon the graſs, for the water to drain off, and then unbind them carefully, open and ſpread them to dry thoroughly; then bind them up again and

and houſe them in a dry tight place: the reaſon of handling the hemp in this careful manner is, that when it is well rotted, whilſt it is wet the lint comes off with the leaſt touch, therefore if it be handled roughly, or if while it is wet it be thrown into a cart and carried to a diſtance to be unbound and dryed, it would be greatly hurt, and the owner would receive great damage by it, but when it is dry, it is handled with ſafety.

If the hemp be rotted in a brook or running water, the ſheaves muſt be laid acroſs the ſtream, for if they be laid down lengthways with the ſtream, the current of the water will waſh away the lint and ruin the hemp: It muſt be laid down heads and points, two, four, or ſix thick, according to the depth of the water and the quantity of hemp; if the bottom of the river be ſand, gravel, or mud, three good ſtrong ſtakes muſt be driven down at each end, above and below, and three long ſtrong poles muſt be laid on the hemp and faſtened well to the ſtakes, in ſuch manner as to force down the hemp under water, where it remains till it be rotted enough; though if a muddy ſtream could be avoided it would be beſt, becauſe it is apt to foul and ſtain the hemp. If the bottom of the ſtream be rocky or ſtony, ſo that ſtakes cannot be drove down to ſecure the hemp under water and from floating away, then a rough wall muſt be made at the lower end of the hemp, and along the ſide, to keep it in, and ſtrong poles or rails muſt be laid upon the top of the hemp, and pretty heavy ſtones upon them ſo as to ſink the hemp under water, where it muſt lie 'till it be rotted enough.

What hemp is intended for ſeed, ſhould be ſowed on a piece of ground for itſelf, which muſt be made very rich and ſtrong; it muſt be ſowed in ridges ſix feet wide, and the ſeed muſt be of the largeſt and beſt ſort and ſown very thin, at the rate of a peck upon an acre, or rather ſix quarts; for the thinner it is ſown, the more it branches, and the more ſeed it bears; it ſhould be ſown ſometime the middle of April, and then the ſeed will not be ripe, till ſome time after the other hemp is done with. If you have no convenient place to ſow your ſeed hemp by itſelf; then ſow a border of ſix feet wide along the north and weſt ſides of your hemp field; the reaſon of ſowing your ſeed hemp in ſuch narrow ridges or borders is that, when the carle or he hemp is ripe, and has ſhed its farina on the fimble or female hemp, by which the ſeed is impregnated, and the leaves of the carle hemp fall off and the ſtem grows yellow, you may eaſily ſtep in along the ſides, and pull up the carle hemp without hurting the female, which now begins to branch out, and looks of a deep green colour and very flouriſhing, and when the ſeeds begin to ripen, which is known by their falling out of their ſockets, you may all along both ſides bend down the plants and ſhake out the ſeed upon a cloth laid on the ground, for as they ripen they ſcatter upon being ſhaken by a hard wind, or otherwiſe; then it muſt be watched, and the fowls and yellow birds kept from it, for they are immoderately fond of the ſeed; as the firſt ripe ſeeds are the fulleſt and beſt, they are worthy of ſome pains to ſave them; and the beſt way to do that is, to bend down the plants all along, on each ſide of the border or ridge, as is ſaid above, and ſhake them over a cloth ſpread on the ground to receive the ſeed; if one ſide of the plant be rooted out of the ground by forcing it down to ſhake out the ſeed, there will be no damage, for the ſeed that remains will ripen notwithſtanding; and the plant muſt thus be ſhaken every two or three days, 'till all the ſeed be ripe and thus ſaved; and this is much better than pulling up the plants by the roots, and ſhaking them on a barn floor, and then ſetting them up againſt a fence, or the ſide of the barn, for the ſeed to ripen, and ſhaking them morning and evening on the barn floor; for by this method, which is the common practice, one third of the ſeed at leaſt never comes to maturity.

It is well known to every farmer, that in the three bread colonies at leaſt, the ſpring and ſummer ſeaſons are of late years

years become very dry; ſo that a crop of flax is become very precarious, ſcarcely one year in ſeven producing a good one: This is a conſtant complaint in the mouth of every huſbandman: Now hemp does not require half the rain that flax does; this is a circumſtance that is well worth the notice and attention of every farmer; and therefore by his raiſing hemp in the manner before directed, and by preparing it in the beſt manner for ſpinning and weaving into good cloth, he can with greater certainty ſupply all the neceſſary uſes of his family; and by ſelling the overplus, he can purchaſe ſuch things as his wife and daughters may think convenient on extraordinary occaſions. This however need not hinder him from raiſing ſome flax every year: But I think that it is more for his intereſt to fix his chief dependence upon his crop of hemp, as that is more ſure, and every way more profitable, the general run of ſeaſons conſidered. And let him not be diſguſted and think that I am about to perſuade him, his wife and daughters to wear oznabrigs, for I can aſſure him that I have ſeen dowlaſs, which is made of hemp, worth five and ſix ſhillings the yard, which no farmer need be aſhamed to wear.

I ſhall now endeavour to inſtruct the honeſt huſbandman in a few eaſy rules, for preparing his hemp, which he has raiſed and managed in the manner before directed.

Know then that the beſt preparation of hemp for the manufacturing of cloth is to render it as ſoft and as fine as poſſible, without leſſening its ſtrength, and the eaſieſt and cheapeſt way of doing that, is certainly the beſt. This is to be found out by a variety of trials and experiments; but till a better way be diſcovered, which I hope will not be long firſt, and with which I ſhould be greatly pleaſed; take the following method, which is the beſt I have yet been able to diſcover.

If you have a large wide kettle, that will take in your hemp at full length, it will be the better; but if your kettle be ſmall, then you muſt double your hemp, but without

out twiſting, only the ſmall ends of every hand muſt be twiſted a little, to keep them whole and from tangling; then firſt of all lay ſome ſmooth ſticks down in the bottom of the kettle, ſo as to lie acroſs one another, three or four layers, according to the bigneſs and deepneſs of your kettle; this is to keep the hemp from touching the liquor; then pour ſome lye of middling ſtrength, half as ſtrong as what you make ſoap of, gently into the kettle, ſo much as not to riſe up to the top of the ſticks, they being kept down to the bottom; then lay in the hemp each layer croſſing the other, ſo that the ſteem may riſe up through the whole body of the hemp, which done, cover your kettle as cloſe as you can, and hang it over a very gentle fire, and keep it ſimmering or ſtewing, but not boiling, ſo as to raiſe a ſteem for ſix or eight hours; then take it off, and let it ſtand covered till it be cool enough to handle; then take out the hemp, and wring it very carefully as dry as you well can, and hang it up out of the way of the wind, either in your garret or in your barn, ſhutting the doors, and there let it remain, turning it now and then till it be perfectly dry; then pack it up in ſome cloſe dry place, till you want to uſe it; but you will do well to viſit it now and then, leſt any part of it might be damp and rot. You muſt know, that wind and air weaken and rot hemp, flax and thread very much. Then at your leiſure, twiſt up ſome of the hands, as many as you intend for preſent uſe as hard as you can, and with a ſmart round ſmooth hand beetle, on a ſmooth ſtone beat and pound each hand by itſelf all over very well, turning it round from ſide to ſide, till every part be very well bruiſed; you then untwiſt it, and hatchel it, firſt through a coarſe, and then through a fine hatchel: And remember that hatcheling muſt be performed in the ſame manner, as a man would comb a fine head of hair, he begins at the ends below, and as that untangles, he riſes higher, till at laſt he reaches up to the crown of of his head. The firſt tow makes good ropes for the uſe of the plantation, the ſecond tow will make very good oznabrigs or coarſe ſheeting; and the hemp itſelf will make excellent linen. The ſame method of ſteeming ſoftens flax very much.

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OBSERVATIONS concerning the FLY-WEEVIL, *that destroys the wheat, with some useful discoveries and conclusions, concerning the propagation and progress of that pernicious insect, and the methods to be used to prevent the destruction of the grain by it.*

By Colonel LANDON CARTER, *of* Sabine-Hall, *Virginia; transmitted by Colonel* LEE. *Read, and ordered to be published, November* 15*th*, 1768.

IT is not in my power to oblige you with the paper that I some years ago published in our gazettes, upon this little destructive insect, called the moth or fly-weevil. However, as you are very earnest in your enquiries as to its particular nature, in order, if possible, to save so beneficial a commodity as wheat to America, which perhaps in a few years (unless such destructive insects do infest it) might become a kind of granary to most parts of Europe; I will from my diaries, put together those discoveries that led me to write that paper; and also what has since occurred to me in the attacks that our country has lately met with from those insects; for it is a certainty they continue amongst us, just as the season favours or not their propagation; although some will fancy they have their periods for coming and going away.

It is but something more than twenty-five years ago, that I heard any thing of such an insect that injured our wheat; but since then I have had frequent occasions to take great notice of it; and have had great reason to be very anxious to examine into the nature of that fly. It is with much propriety called a weevil, as it destroys the wheat even in our granaries, though it is not of the kind termed by naturalists the curculio, of which they have given a very long list; for it is not like a bug, it carries no cases for its wings; neither has it any feelers, with which the curculio is always distinguished; and perhaps (as I fancy it will turn out in the course of this letter that they never attack grain when hard) they really have no occasion for ſuch feelers. For from the make of it, to my judgment it appears an impoſſibility that it ſhould ever perforate into a hard grain, being furniſhed with nothing in nature, from the moſt minute examination by glaſſes, that could make ſuch a perforation; and ſeems indeed a fly itſelf, conſiſting of nothing ſenſible to the ſlighteſt touch with the finger, nor to the eye, aſſiſted with glaſſes, leaving only a little dry pale brown gloſſy duſt, on being ſqueezed.

Having obſerved the wheat from my Northumberland quarters, never affected by it; but conſtantly ſound and perfect, through many years that I have been obliged to keep it for my own uſe, even in the ſame granary with weevil-eaten wheat; I was, and am ſtill, inclined to conclude, the enemy is ſome how lodged in the grain before it grows hard. It might not have been then too late to have had that better proof of this, which I have ſince been able to get, by diſcovering little eggs and maggots half formed into flies in the grain. But as I had nothing particular at firſt to lead me to ſuch an examination, I waited till the next crop; and at all times, between day and dark in calm weather, during the ſeveral days of growth from the blooming time, till the livery or hardening ſtate of the grain, I viſited a field, if poſſible, to diſcover whether any of theſe flies appeared amongſt the heads of the wheat during the ſoft ſtate of the grain. Accordingly, in a pleaſant evening, after the ſun was down, and every thing ſerenely calm, I found the raſcals extremely buſy amongſt my ears, and really very numerous. I immediately incloſed ſome of them in a light looſe handkerchief; and by the magnifiers of my teleſcope, I took occaſion minutely to examine them.

They are a pale browniſh moth, with little trunks or bodies, ſome trifle ſhorter than their wings; and as ſome of their little bodies appeared bulging as if loaded, I applied the preſſure of a fine ſtraw upon them, and ſaw them ſquirt out, one after another, a number of little things which I took to be eggs, ſome more, ſome leſs; ſome emitted

emitted fifteen or twenty of them, and others appeared extremely lank in their little trunks, which I could not make difcharge any thing like an egg. Whether they had done this in the field before, or were of the male kind, I could not tell, but from this difcovery I find in my diary, many years ago, this conclufion, "that there need not be above two or three flies to an ear of corn, to lay eggs enough to deftroy the greateft crop."

I muft obferve, at that time, that the bloom or farina of the ears had for fome days difappeared, and the grain was nearly filling, though in a kind of milky ftate; and at fuch a time the hufks or capfules are generally fufficiently open to admit the entrance of fuch flies; for I imagine, that as nature certainly intends that farina to impregnate the grain, and as that could only be done by its falling into the capfule, fhe muft neceffarily favour fuch a procefs by opening the mouths of thofe veffels.

Some agree with me, that the fly does not perforate the grain, but they fay it lays its eggs upon the top of the hufk, and when they are hatched into maggots, thofe eat through the hufk into the grain; but I muft think fuch a fuggeftion certainly liable to many objections, even in the pea, from whence fuch gentlemen have drawn their arguments: The egg of that bug, they tell us, is laid upon the back of the pod, next the pea; and from thence it hatches, and eats through the pod into the pea. The fettling of fuch a point feems to be of little confequence, but to juftify nature or providence in the wifdom as well as perfection of its modes. Can it then be prefumed that an infect fhould, by particular inftinct, be directed to depofit its eggs for its fpecies into a proper nidus, which fhould be alfo a pabulum for the young as that egg hatches, and yet that they fhould only be permitted to do this upon the outfide of the coat of the nidus, from whence it may be liable to be removed by numberlefs accidents? For where one egg only is laid, the vifcus matter that might furround it, cannot reafonably be thought a cement fufficient for a grain or hufk in actual growth,

growth, as it might be with a number of eggs ſtudded together on a leaf, or round a twig, according to the nature of ſome flies. Again, ſhould even ſo ſmall a viſcous matter confine the egg to the outſide of the pod or huſk, againſt many accidents, yet what can we ſuppoſe will preſerve the maggot, juſt hatched, from thoſe accidents, when it lies on the outſide, on the back of the pod, or huſk? Beſides, I muſt think I have diſcovered an egg as well as a maggot under the ſkin of the pea, without any viſible lead to it, which muſt be a conviction it is not a maggot 'till it is hatched in the pea; therefore it ſeems reaſonable that the parent of that bug, perforates the pod, and then into the pea, in its tender and ſoft ſtate.

I wiſh then ſuch a ſuggeſtion may not have ariſen from the callous ſpeck that may be obſerved, with which nature cloſes up the wound made in the pod, by the parent of that bug. But how is this buſineſs of the worms eating through the huſk of the wheat, and then the grain, 'till they come out in a fly, a little above the germ, at the other end of the grain, to be thus conſtantly performed, if the egg only is laid upon the end of the huſk? For we clearly ſee thoſe eggs do not all hatch at once; and after the wheat is thraſhed out, in which operation, to be ſure, it muſt endure a pretty rough uſage (effect that buſineſs as you will) how can it run ſo many chances, without being diſlodged or deſtroyed? I may further aſk, what ſhould ſupport the maggot from its hatching, 'till it gets through the huſk into the grain? We ſee in moſt other ſpecies of inſects, the worm, maggot, or catterpillar, begins to eat as ſoon as it can twiſt about, and certainly the huſk cannot be the firſt pabulum intended by nature for this maggot. Beſides, from the obſerved tenderneſs of ſuch maggots, if they are not well preſerved from ſcorching ſun beams, wind, or rain, they muſt be ſubjected to various deſtructions, if the egg can be ſuppoſed to be hatched but in the grain; and it could not in any wiſe be the intention of nature, that they ſhould be deſtroyed by their own miſconduct; for we diſcover,

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in other inſtances, that her tenderneſs to flies, which propagate by eggs, directs them to depoſit their eggs on the under ſide of leaves, that are a good ſecurity againſt the force of ſun beams and weather; and as ſoon as they hatch, thoſe leaves become the immediate food for thoſe maggots, worms or catterpillars.

The ſame arguments muſt hold good againſt the eggs being laid on the end of the grain; and it is no new thing to advance that hundreds of buſhels have been carried very fair to every eye, from the barn or treading floor, into the granary; where, if thrown into a heap, the collected warmth vivifies the egg, and, in proportion to the growth of the maggot within the grain, the warmth is increaſed; and even whilſt the middle or lower parts of the heap ſhall be alive, and ready to fly away, the upper parts ſhall be quite fair, and yet nevertheleſs hatch even at ſome diſtant day, with a proper warmth, if not periſhed by any coldneſs or other exceſs in weather, or by art: I ſay then, in ſuch a length of time before hatching, the odds are greatly againſt the egg or worm's ſticking to the grain till it hatches or eats in.

Theſe things being conſidered, I thought that I had advanced far enough in inveſtigating this point, to be convinced the evil was effected by laying the egg in the grain, and in the ſoft ſtate of it; and that thoſe obſervations, ſaid to be made of the egg being laid on the huſk, or on the outſide of the grain, were inaccurate, and eſpouſed without a due conſideration. But, in order to make it as clear to others as myſelf, I muſt here beg leave to aſſert, that I have diſtinctly ſeen with my glaſſes the egg in the grain of wheat, at the upper end of it, beneath the ſkin, and round it a ſmall yellow ſtain, as if the milky ſubſtance had received a tincture from the egg; and as a further confirming circumſtance that theſe eggs are laid in the ſoft ſtate of the grain, I find in my diary, that many years ago I viſited a field of one of my neighbours, who having been extremely late in his harveſt, in very warm and temperate

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weather, had his wheat all eaten out; the flies were crawling out of the ears, and this whilſt the wheat was ſtanding.

Again, that the conviction may be as full as poſſible, it is an indiſputable certainty, that this maggot eats from the upper end of the grain, as it ſtands in its huſk, down to the lower end, and comes out in a fly a little above the germ. Now to ſuppoſe that theſe eggs are laid conſtantly upon that end of the grain, is to believe this fly capable of diſtinguiſhing ſuch particular end, in every confuſed direction that the grain may be thrown into after it is thraſhed out; and therefore the notion of the fly's laying its egg upon the outſide of the grain, and that egg's never being diſlodged, and the maggot's hatching upon that end, and eating into the grain, without being removed from that particular end, muſt be an abſurdity of the firſt magnitude. In the huſk indeed the fly might find that certain end of the grain, becauſe in that it always lies in its proper direction, and it is reaſonable to conclude that inſtinct would ſerve a fly for ſuch a purpoſe; but then this cannot remove the abſurdity before taken notice of, that of laying its egg upon that end of the grain conſtantly, as well before as after it is thraſhed.

Nature, I may ſay, from the minuteneſs of her ways in effecting her intended purpoſes, is frequently out of the comprehenſion of man, and although his microſcopical improvements upon viſion have helped him to many diſcoveries, numerous are the things that ſeem ſtill to remain as a ſecret to him. We can ſee in ſome flies their immediate changes from the firſt proceſs of propagation, quite through their periods of life; and from thence we are inclined to pronounce a rational hiſtory of their continuance, brood after brood: Yet in ſome flies, though we can carry them through all theſe ſeveral changes, there are certain phænomena not to be accounted for; particularly, how the length of time between their changes into flies, and their laying their eggs for the continuance of their ſpecies,

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is employed by them. This defect we generally supply by conjecture, that the time is spent in some torpid state: But there are some discoveries as to certain insects, that make it extremely difficult to suppose such a state; and if we regard what naturalists tell us of some of the moth flies, and indeed our own observations upon them, "that after they become a fly, they never attempt any kind of sustenance, but are seemingly solely employed in the business of fecundation, and the females in particular, in depositing their eggs for a new brood," we shall be puzzled to account how insects, that never eat after their change into a fly, can exist through so long a period as a great part of the fall, and generally of a long winter, till the period of the soft state of the new grain; and to what shelter they can retire from such a series of weather, generally too severe for such tender forms. We may imagine some intermediate brood, but what shall we fancy to be the nidus or food to bring them to this fly weevil again, ready for that new period of softness in the succeeding crop of grain? From hence, perhaps, it is that some gentlemen have grown fond of the opinion, of their eating out of one grain, and then flying to another grain, and laying their eggs upon the ends of them, for a new brood; but as even weevil eaten wheat is generally consumed one way or another, long before the kerning of the new crop, the difficulty (by such a supposition) will have many long months to contend with. Therefore others tell us, they lie about in barns, &c. However, the standing crop eaten up, before taken notice of, is with me sufficient to confute such a solution of that difficulty: And I might add my own strong fumigations of my barn and granary (though enough to destroy a world of insects) have been unsuccessful, with respect to this fly weevil, in the new crop.

I must here step aside to inform you, that though my wheat would, when weevil eaten, pretty generally come up in the field, yet when I was obliged to sow it, if I did not double the usual quantity (which the season always go-

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verned me in) the ground would be ſcanty, and extremely beggared for want of ſeed. I readily concluded the cauſe of this to be, that the grain was too much eaten (that is) the maggot was too far advanced in it, and therefore ſuch grains periſhed; and indeed for ſatisfaction in this point, I twice tried, after waſhing the grain, and drying the light chaffy ſtuff that ſwam at top, to ſow thoſe grains, and conſtantly found all that I could ſqueeze flat with my fingers, never ſprouted, ſow them how I would. This, I hope, will be looked upon as a very good anſwer to both of thoſe haſty aſſertions, that ſuch wheat will nevertheleſs grow when ſown, and likewiſe make a tolerable flour; for grind it how you will, I muſt be bold to ſay, it can produce no flour at all; and the flour imagined to be got from weevil eaten wheat, is only from ſuch grains of it that have eſcaped the weevil, or are but half eaten, perhaps by the maggot's not having run it's courſe in nature before it was deſtroyed; which is the preſumed cauſe of that prodigious clammineſs in bread, from wheat that has the weevil in it, as the moiſture of the maggots continues in the flour; but in biſcuits that clammineſs may be dried up, by the heat of the oven, as thoſe cakes are generally very thin.

The author of the Complete Body of Huſbandry, vol. IV. page 347, of the octavo edition, ſpeaks of a fly in England, that ſometimes attacks the wheat in it's ſoft ſtate; and calls it a ſmall black fly, not bigger than a large pin's head. He ſays they faſten on the ear in numbers, eat into the corn, and lay their eggs, which hatch into maggots, and devour part, and ſpoil the reſt of the grain.—He further ſays, the fly may be diſlodged whilſt it crawls on the ear, for they are ſo tender, that a very little force will deſtroy them, and that they only appear in dry years, for rains in any quantity deſtroy them; and from thence recommends the Iriſh method of rope hauling the wheat in dewy mornings, to bruſh the fly off, which will then be deſtroyed.

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I cannot readily agree with him here; for certainly as the fly got to the ear before, it is reaſonable to think it could, after falling off, crawl up again, unleſs the fall could be ſuppoſed to cruſh ſo ſmall an animal as a pin head. Therefore I was perſuaded, unleſs the diſturbance of rope-hauling was conſtantly given, the fly would return again ſo often, as to make it a tedious work of many days, at leaſt every morning and evening, from the caſting of the bloom, to the hardening of the grain. I have ſince fancied, that by the ſame author's method of fumigating turnips, juſt come up, in his 3d. vol. page 348, with orpiment, every here and there, thrown about on live coals, to windward of a wheat field, in a gently moving air, the prodigious thick foggy ſmoke raiſed by that drug, might kill the moth-fly, as he ſays it will do the turnip-fly, without injuring the turnips, even in vegetation. I ſay, I imagined the doing this pretty often in the wheat field might be of ſervice; for though orpiment is of an arſenical nature, as I found it ſo ſtrongly recommended, and have alſo read, that though poiſonous, it had been ſucceſsfully preſcribed to be worn round children's necks, as a deſtroyer of worms; I at firſt thought that might do: Yet as fire often renders things (really ſafe and innocent when crude) very noxious, there might be a poſſibility of danger in it; and reading of many bad ſymptoms occaſioned by it to the ſhot caſters, who uſe it to increaſe the fluidity of their lead, that it may run quicker or more certainly into globules, I could not think (upon better reaſoning) to make uſe of ſuch an experiment.

My end in all this enquiry, was to prevent the deſtruction made in wheat, by deſtroying this inſect in its egg; and I imagined I had foundation enough to conduct me to that point, from the accounts given of hatching in Egypt, and what we may collect with certainty from *Du Reaumer*'s elaborate treatiſe upon raiſing fowls; beſides many little family obſervations, that correſponded with the common ſenſe of things. Experience ſhews, that a fowl greaſed (as they ſometimes are under the wings to kill the lice)

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can never hatch an egg. I alſo remember a lady, curious in turkeys, in order to produce a forward brood, ſet her hens in her ſmoke-houſe, whilſt her meat was hanging, but the eggs did not produce one pout; and it was diſcovered that the hens had been greaſed by the accidental drippings of the meat.

As theſe diſcoveries ſquared with the French method of preſerving eggs, by tallowing them over, founded certainly upon the principle of keeping out the air, which would otherwiſe give them, in long voyages, a noxious and diſagreeable taſte of ſtaleneſs; I thought I might conclude, that beſides warmth, air was eſſential to the vivifying or hatching an egg; and the hen-houſe wives confirm me in it, by their conſtant obſervation, that hens, &c. not only turn their eggs, but leave their neſts, at proper periods; and thoſe that hatch well, cool themſelves frequently with water, whilſt others perpetually brooding (if they do not die themſelves) addle their eggs.

Upon theſe two principles then of heat and air, I thought myſelf pretty certain of effecting the deſtruction of theſe eggs in the grain; and therefore I endeavoured to hit upon ſuch a method for their deſtruction, which ſhould be attended with the leaſt labour and expence. Too much warmth, or too little, or an entire excluſion of the air, muſt do the buſineſs—Could it be conſiſtent with the prudence of a farmer to thraſh out his grain as ſoon as reaped, to be ſure a drying kiln might be ſo conſtructed as to deſtroy theſe eggs, by communicating too much warmth; but as there are many reaſons for a farmer (beſides his other neceſſary buſineſs) not to thraſh out his grain ſo ſoon, leſt he introduce the other inconveniency to his crop of muſtineſs and bad ſcent, I was obliged to bend my thoughts wholly to the excluſion of the air; for wheat, I know, will contract a degree of warmth in the mow, which is oftentimes of great ſervice to plump out the grain, by ſomething like an after circulation in the ſtraw; and to increaſe that degree of warmth, ſo as to deſtroy the eggs of the weevil, might be a means to mould the ſtraw, and ſunk the grain; therefore I ſay, I fell ſolely upon the excluſion of the air as much as poſſible; and this I was happy enough in effecting with great ſucceſs to my crop for many years, till my old age and infirmity prevented my attending my ſervants whilſt they were purſuing my directions; and not till then had I the leaſt reaſon to complain, whilſt others were eaten up in their crops; but villainy and negligence are ſuch concomitants in ſervitude, that I have been again deſtroyed, plainly to be accounted for from the viſible abuſe of my conſtant directions. The method I have taken is this.

I reap as early as I poſſibly can, reſpecting the dryneſs of the grain, as well as the ſtraw, which would otherwiſe ſunk it: At leaſt two feet quite round the mow I leave a vacancy, which is to be well trod with ſoft hay, or beaten ſtraw; therefore I keep perſons conſtantly treading down thoſe margins as the mow riſes; and when I reach the eves of my barn, I lay on and tread down a very thick covering of the ſame ſtraw or hay, and weighed it well down at top. Had I not found this effectual, I would have gone to the expence of filling in and plaiſtering my barn, being convinced that the excluſion of air, as much as poſſible, could be the only effectual method of killing thoſe eggs, which as they are ſo very ſmall before hatching, could not give the leaſt diſagreeableneſs in either look, taſte, or quality, in the flour. This method I publiſhed many years ago; and many gentlemen have aſſured me, they have practiſed it ever ſince, and continue to do ſo now with the greateſt ſucceſs. The farmer that chuſes to try, if he ſuffers nothing to prevent an early harveſt, will I am perſuaded, confeſs the juſtice of what I have ſuggeſted; but if, by any means, he ſhould be late in his harveſt, and the temperature of the weather ſhould be ſuited to the principles of hatching; or if he ſhould be too early in beating out his grain, it cannot then be of any real ſervice, but by accident, as the miſchief may be done in the field,

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and an egg not deſtroyed in the mow, may hatch in the granary.

You muſt here permit me to tell you, I have conſtantly laughed at all thoſe ridiculous noſtrums of brining, &c. to prevent this injury of the weevil, as well as that other deſtructive evil called the ruſt. They may be of ſervice to quicken the vegetation of the grain; and it is reaſonable to conclude they will deſtroy all vermin that lie in the ground when it is ſown; but that this brine, or any other ſolution, can remain and paſs through the courſe of circulation, in a very long ſeries of winter months, and preſerve its virtue to the kerning time of the grain, ſo as to prevent theſe flies from invading it, or indeed to check or correct the corroſive moiſture of particular airs, which produce ruſt, is an abſurdity below the dignity of a rational man; notwithſtanding many writers have given into it. I always looked upon thoſe gentlemen, as forgetful of the philoſophy upon which they ſet out within the firſt parts of their works; and I ſuppoſe to make a book of bulk, they ſtuff in the errors of old and obſtinate farmers, from one century almoſt to another. I remember I had an aſs of that kind, and for the ſake of conviction, I indulged his project of ſteeping and brining; and went ſo far as to leave him a parcel of wheat which he might put up or mow as he pleaſed; and though his obſtinacy would not ſuffer him to be convinced, I was, to my coſt, whilſt the reſt of my grain, conducted by my direction, was good and uſeful. Quickſilver, we are lately told, will circulate with the juices of a plant in vegetation, without injury to it, and it has been ſucceſsfully applied that way to kill the ſlugs and ſnails on wall fruit; yet if the difficulty of inſerting it, or impregnating wheat with it, before ſowing, could be got over, I cannot ſuffer myſelf to embrace any perſuaſion, that the virtue or ſubtility of the quickſilver could continue ſo many months in the wheat, by any kind of innate quality, in ſuch a long ſtage of growth, through a very bad winter. Therefore even that diſcovery, in my opinion, has not removed

moved the abſurdity hinted at. I have mentioned the ruſt, as preſumptively occaſioned by ſome corroſive quality in the air; and though it is out of my preſent ſubject, I will juſt hint that *Du Pratz*, in his hiſtory of Louiſiana, takes notice of ſuch a deſtructive obſtruction to the raiſing of wheat in that country, though he does not call it by any name that conveys an idea of ruſt. He ſpeaks of it as a brown red pearly drop, found at the lower joint of the ſtalk, which, in a ſhort time, pervades the whole ſtalk upwards, and periſhes the grain: As this is pretty ſimilar to what we diſcover here, it may not be amiſs to look upon it as a corroſive ſubſtance, communicated by the air; and I do believe it will be found to be the better opinion, upon a more accurate inveſtigation; for I have long been ſatisfied, that the aſcenſion of the juices are thereby prevented; and the ruſty duſt ſeems to be nothing more than thoſe juices oozing out of thoſe corroded parts, or wounded pores, that turn to that colour on drying; however I muſt declare, I never yet diſcovered *Du Pratz*'s brown red drop on any wheat of mine, notwithſtanding it has ſometimes been deſtroyed with the ruſt. This rubigo was a diſorder obſerved in wheat of very ancient date, and the writers, from one to the other, recommend preventing it by brining, &c. as before; ſome indeed juſt hint at the truth, by calling it by the general term a blight; but why they ſhould think of curing blights by an application before ſowing, is a curious myſtery, it ſhould ſeem as if ſuch men fancied, that the poſſible conſtitutions of air can as eaſily be prevented by their brine, as it can be kept out, or exhauſted by an air pump. Some, indeed, impute both weevil and ruſt to certain ſoils; but as wiſer men than I, have ſeen cauſe to complain of the abſurdities that have been adopted by writers that were good philoſophers in other matters, I ſhall not give myſelf any trouble to endeavour at an exploſion of ſuch an opinion, well knowing that all lands, where air and moth can come, may be, and are ſubject to thoſe evils, when they are about; and indeed every ſort of wheat

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that I have tried, has been attacked by them both; but from barley and rye's conſtantly eſcaping the weevil, I am at preſent perſwaded their protection happens only from their beards or awns; therefore a long bearded wheat would be worth propagating for a trial, as I never heard the bread made from ſuch ever objected to, nor indeed its increaſe complained of. This I ſay, believing that thoſe gentlemen who tell us that bearded wheat has been deſtroyed by the fly weevil, are ſome how miſtaken, from the improbability of the fly's getting into the capſules through thoſe awns. They give for a reaſon, that the awn in wheat never ſticks to the grain, as it does in barley; but as I never ſaw rye the leaſt affected by the fly, which is of a ſimilar growth with a grain of wheat, and has no awn growing to it, though the huſk has; I muſt conclude it may be ſtill ſome miſtake in the aſſerter; for certainly thoſe awns, even on the huſk, if any thing long, muſt embarraſs the fly, and prevent his miſchievous purpoſe.

Having thus, my good friend, endeavoured to comply with your requeſt, it remains that I ſhould make ſome apology for the length of it; but if we conſider enquiries into nature muſt be more or leſs prolix, according to the helps that can be got, you poſſibly will think any endeavour to be ſhorter, might have left my own concluſion leſs clear and intelligible. I know not how convincing my arguments may be, but you have my free leave to make uſe of them as you pleaſe; and I ſhall be glad, through your means, to read any thing that may ſhew wherein I am miſtaken. I am, dear SIR,

Your very reſpectful humble ſervant,
LANDON CARTER.

SABINE-HALL,
July 23, 1768.

Same SUBJECT, *by the* COMMITTEE *of* HUSBANDRY.

AN enquiry into the means whereby the injury of wheat in America from flies, may be leſſened or prevented, is attended with difficulties and uncertainty here; becauſe the

the members of the committee are at a diſtance from the immediate ſeats of obſervation, and cannot obtain that accurate knowledge of facts, which is requiſite to inſure the principles they adopt from errors. However, this is not thought a ſufficient objection to their doing all in their power towards putting ſo intereſting a reſearch on a plan of inveſtigation, and furniſhing gentlemen, of learning and leiſure, in the places where the miſchief prevails, with hints that may ſerve as a baſis to ſuch a ſeries of obſervations and experiments, as may probably be productive of the deſired diſcovery.

It is ſaid the injury of wheat from flies began in North-Carolina, about forty years paſt, where it has been difficult to preſerve it ever ſince, unleſs in ſpring houſes, or other cool places; and that the Indian corn of that country being of a ſoft and tender quality, is alſo liable to be injured by the ſame inſects, but may be preſerved from them, by keeping the cob covered with the under leaves of the huſk.

That theſe miſchievous flies have extended gradually from Carolina into Virginia, Maryland, and the Lower Counties on Delaware; to the laſt of which places they did not arrive 'till ſeven years ago, and had not yet penetrated into Pennſylvania, or paſſed the Delaware. That in the tranſit they have been principally confined to low level moiſt lands; and when they have been found in high dry lands, they have been but few in number, and did not remain longer than one ſeaſon. From whence we may rationally infer, that the high dry lands do not afford them equal conveniencies for ſubſiſtance and propagation, that the low level moiſt lands do, where many things conſpire to make all grain raiſed in them, of a ſoft ſpungy quality, and peculiarly adapted to become the food and neſts of tender inſects; and therefore thoſe are the places in which ſuch inſects will abound, and the wheat raiſed in them, is the only kind which they can pierce and injure. The truth or falſehood of this inference may readily be aſcertained,

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by experiments with different kinds of grain, put into a fly-infected granary. The following pertinent experiment is ſaid to have been often tried. Put three parcels of Indian corn into a place with fly-bitten wheat; let one parcel be of the firſt kind on the cob, and covered with the huſk; a ſecond of the hard flinty grains; and the third of the ſoft tender grains, both the latter ſhelled; the firſt and ſecond will be injured, whilſt the third is worm eaten in the ſame manner as wheat.

The accounts we have of theſe flies are various; but the moſt probable is, that they are whitiſh butterflies or moths, which reſt in the day, and are active in the night. They appear to be of the ſame kind with thoſe that do the like miſchief in Europe, which a gentleman of Angumois deſcribes to Mr. Duhamel, in the following manner:

"The great loſs, ſays he, we have ſuffered in our corn, and eſpecially in our wheat, for ſeventeen or eighteen years paſt, has put us on making ſtrict enquiry into the cauſes of a corruption with which our grain is infected. The common opinion is, that when the corn is in the bloom, that is to ſay, in the month of June, ſmall white butterflies lay their eggs in the flowers. When the grain is ripe, the eggs are incloſed in it, and as ſoon as the corn is laid up to be kept, it is found to ferment. This fermentation raiſes an heat, which hatches the eggs, whence little worms proceed, which are transformed into chryſalides, and theſe are afterwards metamorphoſed into grey butterflies or moths."

This proceſs of the flies in Europe, conforms with the obſervations of many gentlemen in America, ſome of whom aſſert, they have ſeen the perforations in the milky grains in the field, and in the dry grains of wheat, into which the flies had put their eggs. This is the leſs to be queſtioned, ſince it is the well known manner by which plumbs, cherries and fruit trees are injured by other inſects.

It is ſaid the moſt conſiderable injury done to the wheat by flies in America, is after it is reaped and laid up, which the

the gentleman in Angumois does not mention to happen in Europe. For a few days after the chryſalides are metamorphoſed into flies, theſe flies copulate, and impregnate more ſound grains of wheat with their eggs, which again produce worms, chryſalides, and new parent flies; whereby the number of worms is ſucceſſively multiplied, and the miſchief increaſed during the warm weather, but ceaſes in cold, and returns again in the ſpring. The ſpring flies are ſuppoſed to proceed from worms, hatched at that time in eggs, preſerved in the grain through the winter; becauſe they are preceded by worms, are ſhort lived, and never ſeen 'till the ſeaſon is become warm; and becauſe very cold winters have been obſerved to leſſen the number of flies the enſuing ſummer, which is ſuppoſed to be from the eggs being frozen, and deſtroyed in the grain. The gardeners in Europe preſerve their fruit trees, and fruit, by carefully deſtroying the neſts of thoſe inſects which injure them, and when the eggs of inſects are depoſited in any known place, or thing, it certainly would not be impracticable to prevent any miſchief ariſing from them.—Therefore in this enquiry it may be uſeful to know, how and where the wheat fly is preſerved; if in the wheat, it may be diſcovered by the following experiments. Expoſe to ſevere froſt a quanty of wheat, that had been fly injured in the fall; afterwards put this wheat, and an equal quantity of the ſame parcel, that had not been froſted, into different veſſels, and keep them a due time in the degree of warmth requiſite to hatch the eggs. If the facts are as above ſuppoſed, living worms will be found in the latter, but not in the former.

The eggs of theſe flies have ſometimes hatched, when the ſeaſons have been extreme hot and moiſt, in the corn ſtanding in the field. But this rarely happens 'till after it is ſtacked or houſed, and a fermentation enſues.

The common method of preſerving wheat from harveſt till it is threſhed, eſpecially in places moſt ſubject to the flies, is in ſtacks in the field. Theſe ſtacks afford a remarkable

markable phænomenon; for the fouth fide of them, which is more immediately expofed to the rays of the fun, become foon heated, and hatch the eggs contained in the grains of wheat from the furface to about eighteen inches in depth, whilft no worms or flies are found deeper, or on the north fide. If the degree of heat which hatches the eggs in the fouth fide of the ftack, and the degree in the north fide, which preferves them without hatching, were afcertained by a thermometer, it would lead us to a means of preferving the grain, either by keeping it cool, and thereby preventing the hatching of the eggs, or heating it, fo as to corrupt them, without injuring the corn; for the difference of warmth in which eggs may be preferved, hatched, or corrupted, is but fmall; "93 degrees of heat in 21 days gives growth to the chick in an hen's egg, from a little fpeck into a perfect animal body; but the fame egg would be rendered unfit for producing a chick by a greater degree of heat, fcarcely enduring 100 degrees without prejudice and a much lefs degree than 93, would not fuffice for hatching it." The degrees requifite to hatch the eggs of thefe flies, to prevent their hatching, or to corrupt them, might readily be known, by putting the fame kind of fly-injured wheat in different open veffels, and keeping them in different degrees of warmth, making 93, or the warmth of the prolific part of the ftock, the medium ftandard.

Another experiment, of great importance, in this enquiry, fhould be made at the fame time, to difcover whether the eggs of thefe flies can be hatched, or the worms exift, without the frequent acceffion of frefh air: This may be made, by tying a bladder clofe over a veffel, containing the above kind of wheat, and keeping it in the degree of warmth that will hatch the eggs; and if the eggs in the open veffel hatch whilft thofe in the covered one do not (which, philofophy teaches us, will probably be the cafe) it proves that fecuring the fheaves of corn from the accefs of frefh air, by covering them clofe in ftacks or barns, with hay or ftraw, &c. and keeping the threfhed grain in tight

tight caſks or granaries, will be an effectual preſervative of the wheat from the injury of flies. It likewiſe proves, what is very uſeful to be known, that fly-injured wheat in the holds of large veſſels, or in deep bulk in granaries, will not receive further damage from inſects, but on thoſe ſurfaces which are expoſed to the acceſſion of freſh air.

The following experiment on peaſe, is an encouragement to attempt the preſervation of wheat, by excluding air from it. Take any quantity of Engliſh peaſe intended for ſeed, divide them into two parts, put one in an open veſſel, keep the other in a veſſel well corked; that parcel to which the air has had admiſſion, will be worm eaten in the ſpring, whilſt the other remains ſound, and untouched by inſects.

It would be a great point gained, to deſtroy all theſe flies in granaries and mills, by poiſon vapour, if it could be eaſily done. But Mr. *Duhamel* ſays no other vapour, but that from burning ſulphur, which is injurious to the grain, will do it. This aſſertion is extraordinary, and the truth of it is to be doubted, ſince all other inſects are readily killed by vapours of various kinds. "If bones of animals, or hartſhorn, are laid on an open fire, in a room where the ſmoke is confined, it will kill all the bugs, fleas and flies in that room: But the leaſt nauſeous, and yet the moſt deadly vapours, are from the ſuffocation of fire: thus the ſpirits of charcoal, confined in a cloſe room, kills the ſtrongeſt animals in a ſhort time;" and therefore it may rationally be expected, that a pot of theſe coals fired, in a cloſe granary, could not fail of deſtroying the flies in it in one night: However, there is no determining this matter *a priori* becauſe of the difference in reſpiration between animals and inſects; the former taking in air by the noſtrils, and the latter by a perforation in the abdomen. But if the fumes of burning charcoal be inoffenſive to the flies, it is probable that filling the room with a thick, pungent, oleaginous ſmoke, ſuch as ariſes from burning the ſtems of tobacco, would ſoon deſtroy them, by clogging the

the air paſſages in the ſame manner as oil, which applied to the ſides of inſects, kills them immediately. Both theſe experiments may be eaſily tried, and if they fail, others ſuggeſted.

Wheat being now in bloom, and the flies probably very buſy in impregnating the tender grains with their eggs, all that can be done this ſeaſon is, to prevent the hatching of thoſe eggs, by threſhing out the corn as ſoon as poſſible, and drying it in kilns or the hot ſun, and keeping it afterwards in tight veſſels, or deep bulk in cloſe granaries: If it ſhould heat in the veſſels, it might be readily cooled, and kept ſo, by ventilating it an hour once a week, with a pair of common houſe bellows, according to Dr. *Hale*'s direction.

It ſhould not be ſtirred in bulk, if it can be avoided, that it may quickly encruſt upon the top, and exclude the air.

If it is not convenient to threſh it out early, the ſheaves ſhould be defended from the acceſſion of air, as before propoſed, till late in winter, and afterwards kept in bulk, or tight veſſels, to attempt the prevention of ſpring flies; for which purpoſe the wheat ſhould be threſhed out before ſpring.

If the ſtalks of wheat have not been preſerved from the injury of the flies, the injured part ſhould be threſhed ſeparately, and the wheat uſed immediately, or deſtroyed, or the eggs in it prevented from hatching: When flies appear in granaries, they ſhould be killed immediately, to prevent their doing further miſchief.

But as all theſe things require additional labour and expence, it is much to be wiſhed the injury could be totally prevented; and which, it is reaſonable to expect, may be attained ſolely by a proper change of ſeed grain annually; that is, to ſow the low moiſt lands with hard, dry, flinty wheat, of high mountains lands, inſtead of their own product. For it is well known to naturaliſts, that the quality of fruit, grain and vegetables, depends on the climate and

and ſoil: The apples of a Newtown pippin tree, growing in New-York and Virginia, have ſcarcely a reſemblance in taſte. The vine from which Burgundy wine is made in Burgundy, when tranſplanted into Champaigne, produces Champaigne wine, and the Champaigne vine, tranſplanted into Burgundy, makes Burgundy wine. Beans and peaſe from England, planted in America, ſoon dwindle much from the originals; and the alteration that ſoils and climates produce on wheat is ſo well known, that all careful farmers in Europe change their ſeed-grain often; this is ſo remarkable in America, it is obſerved, that the red flinty wheat which grows in the ſtrong mountainous lands, when ſowed in low moiſt places, undergoes a gradual change for four years, and then becomes light coloured, thin ſkinned, and of a ſoft texture; and that this wheat ſowed in the high lands, takes the ſame time to recover its natural colour and quality. Therefore if the injury of wheat from flies depends on the ſoft quality it contracts by its growth in moiſt low lands, a proper annual change of ſeed-grain, will alone prove an eaſy and certain remedy againſt the preſent deſtructive and alarming evil amongſt us.

Obſervations on the native SILKS WORMS *of North-America, by Mr.* MOSES BARTRAM. *Read before the Society, March* 11, 1768,

I HAD, for a long time, a deſire to know, if ſome of the wild ſilk worms of North-America could, with proper care, be propagated to advantage; accordingly, in March, 1766, I made an excurſion along the banks of Schuylkill, in ſearch of ſome pods or cocoons, in which the worms ſpin themſelves up and lie concealed all the winter, in the nymph ſtate, preparing for a change in the ſpring, namely, from an aurelia to a fly.

I was ſo lucky as to find five cocoons that had live ſound nymphæ in them. Theſe five I placed in my garret oppoſite to a window, that fronted the ſun riſing. I did this, that the warmth of the ſun might forward their coming out.

May 10. One of the flies came out; but the window happening to be left open it made its eſcape.

May 13. One of my pods produced a large brown fly, beautifully ſpotted, next day two more of them produced each a fly.

May 17. One of the flies, which came out of a large looſe pod, began to lay eggs. On the 22d, the other two, which were males, grew very weak and feeble and unable to fly. Next day one of them died, and the day following the other died; the female fly all this time continuing to lay eggs; on the 24th at night ſhe alſo died, having laid near three hundred eggs. *May* 31, my laſt pod produced a large female fly, of the brown kind like the reſt. But there being no male I could expect no increaſe from it. *June* 3d, ſhe began to lay eggs and continued ſome days: On the 8th ſhe died, having laid upwards of two hundred eggs. Theſe which my laſt fly laid looked at firſt large and full, but in a few days they began to ſhrivel and be indented in the middle, as did all the reſt. However, I folded them all up in ſeparate papers and laid them by, to ſee if any would hatch the ſpring following.

The male fly is leſs than the female, but his colours are brighter and more beautiful.

In the ſpring of the year 1767, I examined the eggs, and found them all dry, and not likely to produce worms; from whence I concluded they had not been impregnated by the males. This was a diſappointment to me. But being ſtill of opinion, that they might be propagated, I determined to make another trial with more caution and circumſpection. Accordingly, I ſet out in ſearch of cocoons, and gathered ſeveral of them both from the ſwamps and upland. Thoſe from the ſwamps I got chiefly off the alder; thoſe from the upland, off the wild crab-tree, and the viburnum or black haw buſhes. Theſe

Theſe pods I placed as I had the others, before my garret window, where the ſun might ſhine on them, as ſoon as it aroſe, and a great part of the forenoon. When I expected the flies were near coming out, I tacked coarſe cloths up againſt the windows on the inſide, not only to darken the room, but alſo for the flies to ſettle on, and to prevent them, in attempting to make their eſcape, from beating their legs and wings to pieces againſt the glaſs, which I found to be the caſe laſt year, and which it is probable, prevented their copulating.

May 16. Three of my cocoons produced each a fine large fly of the brown kind, the ſame as thoſe of laſt year. The two following days two more flies made their appearance, and one of the eldeſt began to lay eggs, which not being impregnated, dried up and yielded no increaſe.

May 19. One of the males that came out on the 16th, copulated with the female that was produced on the 18th. They continued together about twenty-four hours; a common caſe with moſt of the inſect tribe, which lay a great number of eggs at once. And ſomething ſimilar may be obſerved in ſome other animals.

May 22. This female fly began to lay eggs which looked plump and fine. Though I had now ſeveral flies, yet this was the only one from which I had increaſe.

June 2. The laſt of my flies died, all expiring regularly as they came out. The period of their exiſtence is ſhort, ſeldom exceeding nine or ten days, though ſome of the females lived to the age of fourteen or fifteen, as I found by one I had laſt year.

June 3. The eggs that were impregnated began to hatch and produce worms, to which I preſented for food the leaves of our common mulberry; but they did not ſeem fond of them. I laid before them ſeveral other kinds of vegetables, and obſerved that they ſeemed beſt pleaſed with the alder.

June 4th, 5th, and 6th. The eggs continued hatching and producing young worms.

June 8.

June 8. Thoſe firſt hatched left off feeding, ſhrunk up ſhort, and ſeemed motionleſs. I imagined they were ſick and changed their food, trying almoſt every kind of vegetable, in hopes of finding ſomething that would agree with them better; but all to no purpoſe. Having killed ſeveral in ſhifting them from one kind of food to another, while the reſt ſtill continued in the ſame torpid ſtate, notwithſtanding all I could do, I thought all my hopes of raiſing them were fruſtrated and concluded they would periſh.

June 9. I was agreeably ſurpriſed to ſee the little animals, that I had given over as dead, creeping out of their old ſkins, and appearing much larger and more beautiful than before. Finding themſelves diſengaged, in a little time they turned about and fell to devouring their old coat, which ſeemed a delicious repaſt to them; after which they reſted about twelve hours, and then began to feed on leaves as formerly with great eagerneſs.

June 15. The eldeſt worms again left off feeding, ſhrunk up very ſhort, and appeared fixed on the leaves almoſt motionleſs. In this ſituation they continued until the 17th, on which day, after appearing to be very violently convulſed for near half an hour, they threw off another ſkin, which they eat as before, and then reſting about twelve hours, fell to their uſual food.

June 20. One of my worms, that had juſt diſengaged itſelf from it's old covering, whilſt it yet remained weak, was deſtroyed by a kind of bug armed with a long bill, with which it pierced the ſide of the worm, and ſucked out it's vitals. This bug, which I fancy, I muſt have brought in with the leaves, I take to be a common enemy to the ſilk worm in it's tender ſtate. It's bill is ſo long, that it can ſtand at ſome diſtance from the worm, and with its weapon wound it, notwithſtanding the bunches of hair or briſtles, in form of a pencil, with which the worm is covered, and which are it's principal defence.

June 23. My oldeſt worms left off feeding, ſhrunk up, and on the 25th, threw off their third covering, which they devoured, and after reſting the uſual time, returned to feed as before.

July 2.

July 2. They left off feeding the fourth time, and on the 5th parted with their fourth covering, after eating which, and refting as ufual, they continued to feed on the leaves.

It is remarkable every change they undergo adds frefh beauty to the worms, and in every new drefs, they appear with more gaudy colours and lively ftreaks.

July 22. Two of my oldeft worms left off feeding and began to wander about in fearch of a proper place to fpin. Thereupon I got fticks, in which I fixed a number of pegs for the greater conveniency of the worms; though they can fpin in any place, where they have or can form an angle for their webs. After wandering about fome time, they fixed at laft and began to fpin in a curious manner.

July 23. Two left off feeding; thefe I placed on the racks I had made, which I fixed in glafs bottles to prevent the worms from getting off: For I found they were apt to ramble greatly before they could fix on a place to their liking, if they were not fuffered to fpin among the leaves they feed on; in which cafe they begin to fpin foon after they leave off feeding. But I did not like to fuffer this, as they feemed fond of drawing bits of twigs and leaves into their nefts, which muft obftruct the unwinding the filk. One of them fpun on the rack, the other got to the window and fpun in the angle of that.

July 24. Five left off feeding; and having wandered about all night, began early next morning to fpin. In like manner the reft of my worms, as faft as they arrived at a ftate of maturity, daily applied themfelves to fpinning or wrapping themfelves up in cocoons.

Auguft 10. The laft worm left off feeding, and like the reft wrapped itfelf up, in which ftate I expect they will all remain, until *May* next, when each of them, I hope, will produce a beautiful fly.

It feems ftrange there fhould be an interval of no lefs than nineteen days between the time the firft and laft worm began to fpin, though they were all hatched within three

or

or four days of one another, which was nearly the ſame ſpace of time the parent fly was laying the egg. Whether this was owing to the weakneſs or ſtrength of the vital principle in ſome more than in others, or whether to the ſhifting their food, or to their being frightened, and thereby prevented from feeding, I cannot tell. Farther experiments may poſſibly explain the matter.

The method I took to raiſe theſe worms, with the leaſt trouble to myſelf, as I live in town, and conſequently had to bring food for them out of the country, was as follows: I filled ſeveral bottles with water; in theſe bottles I placed branches of ſuch vegetables as the worms feed on. I placed the bottles ſo near each other, that when any of their food withered, the worms might crawl to what was freſh. By this means I kept their food freſh for near a week. I always kept the bottles full of water, whereby the worms were ſupplied with drink, which ſeems neceſſary for them. Without it they will not feed kindly. They commonly crawled down two or three times a day, drank heartily, then returned to feeding. The leaves of the apple tree ſeemed as agreeable to the worms as any I tried; and they anſwered beſt, as they kept freſh in the water longer than any other.

From ſundry experiments, I found the worms averſe to changing their food. On whatever they firſt begin to feed, they keep to it.

If any ſhould incline to propagate theſe worms, I would propoſe the following method. Let long narrow troughs be made, with a number of notches along the edges. In the bottom of the troughs, on the outſide, let pieces of ſtraight wood be fixed, ſo that the branches, on which the worms are to feed, may lie in the notches, and their ends be fixed under the piece of wood at the bottom. This would keep them ſteady, and lying thus inclined, they would more freely imbibe the water for the refreſhment of the leaves. The dung of the worms would fall clear of the troughs, and the water thereby be clean for their drink.

The

The troughs ſhould be always kept full of water, and placed in a ſhade, ſecure from the violence of wind, which might ſhake down the worms; but not too much confined, becauſe a little air is agreeable to them. Through a hole in the bottom of the trough, the water might be let out every two or three days, and the troughs filled again with freſh water, which by this means would continue ſweet and clean.

By this method, I am perſuaded, they might be raiſed to advantage, and perhaps, in time, become no contemptible branch of commerce. They appear to me much eaſier raiſed than the *Italian* or foreign ſilk worms. I did not looſe one by ſickneſs. They hatch ſo late in the ſpring that they are not ſubject to be hurt by the froſt. Neither lightenings nor thunder diſturb them, as they are ſaid to do foreign worms. And as they lie ſo long in their chryſalis ſtate, the cocoons may be unwinded at leiſure hours in the enſuing winter. One thing more in their favour is that one of their cocoons will weigh more then four of the foreign worms; and, of conſequence, it may be preſumed, will yield a proportionable greater quantity of ſilk. Theſe properties, not to mention their being natives, and therefore accuſtomed to our climate, and the variety of vegetables, on which they feed, muſt render them much more promiſing than the eaſtern or foreign worms, and, it is to be hoped, will induce ſome who have leiſure to make further trials of them. Any time before the middle of *May* will do to collect them. Now is the time to collect the cocoons, and with a little pains a ſufficient number of them may be found in almoſt any ſwamp or level piece of land, to make a beginning.

I would adviſe them to prepare boxes, in the following manner: They may be of any convenient length, about ſix inches deep, and four or five wide; without a bottom, and inſtead of a cloſe cover for the top, let there be ſtrips of wood nailed on, ſo cloſe to each other as not to admit the worms crawling through. Let there, alſo, be ſeveral holes

holes in one, or both ſides, big enough for the worms to be put in at, as they want to ſpin, and then ſtopped up. The inſide ſhould be waſhed with a ſolution of gum Arabic, or cherry tree gum. The boxes may ſtand on any flat place to prevent the worms getting out; and when the ſilk is to be unwound, by immerſing the boxes in warm water the cocoons may be taken out without breaking the threads of ſilk.

A MEMOIR on the DISTILLATION *of* PERSIMONS, *by Mr.* ISAAC BARTRAM.

THIS Society having propoſed at one of their meetings in November laſt, that a trial ſhould be made for drawing a ſpirit from the fermented juice of the *Perſimon*, I was appointed to make the experiment.

The ſeaſon being then ſo far advanced, I apprehended it was too late; but being ſtill urged by the Society to make the eſſay, I purchaſed about half a buſhel of the fruit in the month of December, which was ſo much damaged by the froſt and rain, that I almoſt deſpaired of ſucceſs; the proper time for gathering it being in the month of October.

I however proceeded in the following manner:

I cauſed the perſimons to be well maſhed, and put them in a five gallon keg, to which I added two gallons of water, and about two pennies worth of yeſt, in order to promote a fermentation. This being completed, I committed the whole to the ſtill, and drawed therefrom near half a gallon of proof ſpirit, of an agreeable flavor.

From the ſucceſs of this experiment, I think it may be concluded, that the perſimon may be rendered very beneficial to thoſe who have many of them growing on their plantations, and that they are worthy of the public attention, as many advantages may be reaped from the cultivation of the trees; ſome of which I ſhall hint in the courſe of this paper.

To

To thoſe who would undertake to collect large quantities of this fruit for diſtillation, I would recommend the following proceſs.

Let a number of empty hogſheads, in proportion to the quantity of fruit, be provided; take out one of the heads of each, and in the other let a hole be bored, at about four inches from the chimb, into which fix a plug, which may be occaſionally taken out from the lower end, when the caſks are fixed upon truſſels, at a ſmall diſtance from the ground. In theſe caſks, over the holes, lay a number of ſmall ſticks, covered with ſtraw, about two or three inches thick, to prevent the pulp from choaking them.

Your hogſheads being thus prepared, fill one of them half full with perſimons, which have been well maſhed; add water until it ariſe within one third of the top; then cover the caſk with the head that had been taken out, and let it ſtand about nine days; by this time the pulpy or feculent part of the fruit will be ſeparated by the act of fermentation; you are then to draw off the liquor, by the hole in the bottom of the hogſhead, and put it in a tight caſk, cloſely bunged up, to prevent a ſecond fermentation, whereby your liquor would become acid, and be rendered unfit for the ſtill.

Having thus extracted the more vinous parts from the firſt hogſhead, let as much water be added as before, which muſt be well ſtirred, and mixed with the pulp, thereby to procure the whole ſtrength of the fruit.

A ſecond hogſhead is then to be charged half full of fruit, well maſhed as the firſt, and inſtead of pure water, fill it two thirds full with the ſecond extract of the firſt hogſhead, leaving it to ferment, as before directed. This fermentation being perfected, draw off the liquor, and let it be bunged up cloſe. The third hogſhead is to be treated as the ſecond, and in like manner every ſucceeding caſk.—After you have in this manner converted all your fruit into a fermented liquor, let it be kept at leaſt one month before it is diſtilled, if it can be preſerved without danger of it's becoming ſour; for I have obſerved that vinous ſpirits, drawn from new fermented liquors, are not equal in flavor to thoſe which have been meliorated by age.

The perſimon tree is of a quick growth, and yields great quantities of fruit in a few years after it is planted. The wood is hard, has a fine cloſe grain, and may be applied to many mechanical purpoſes; it burns well, and its aſhes contain a very large proportion of ſalts.

Theſe trees grow ſpontaneouſly near all our tide water rivers, and ſucceed in almoſt any kind of ſoil. They thrive beſt when planted in an open place. I would therefore recommend, that they ſhould be fixed at about ten feet apart, round the fields, by which means they would be no incumbrance, but contribute to the ſupport of the fences, as they would ſerve for live poſts. The leaves ſoon rot, and become good manure, inſomuch that it is remarkable that graſs grows better under theſe trees, than any other.

Every farmer who has fifty acres of land, might plant three hundred trees round his fields; which being diſpoſed as before directed, would be a great addition to the beauty of his farm.

Let us ſuppoſe each full grown tree will produce two buſhels of fruit upon an average (ſome I have ſeen bear thrice that quantity.) From a farm then of fifty acres ſix hundred buſhels of fruit might be gathered; and as from the foregoing experiment a buſhel is found to yield a gallon of wholeſome and very agreeable ſpirit, every farmer having that number of trees, might make ſix hundred gallons of liquor as good as rum.

The expences attending the proceſs we will ſuppoſe to amount to one half of the value of the liquor when diſtilled, which admitting to be worth but two ſhillings per gallon, will leave a profit of thirty pounds per annum; a ſum equal to the intereſt of a farm that would coſt five hundred pounds.

Were we to extend this calculation to what every fifty acres of cultivated land in this province only would produce, we we ſhould find that we might ſoon become independent of the Weſt-Indies, for the expenſive article of rum, and thereby yearly ſave many thouſand pounds to this colony.

A valuable gum exudes from this tree; for the collecting of which, the Society eſtabliſhed in London for promoting arts and manufactures, offered a premium of twenty pounds ſterl. for the greateſt quantity, not leſs than fifty pounds weight that ſhould be collected from the perſimon tree, in any of the Britiſh colonies in America, and imported from thence into the port of London, between the firſt of April, 1762, and the firſt of April, 1763. And for the next greateſt quantity, not leſs than twenty-five pounds weight, a premium of ten pounds ſterling.

I have alſo been informed, that an excellent beer is made of perſimons in ſome of the ſouthern provinces.

Hence it will appear, that the cultivation of the perſimon tree is an object worthy the attention of our farmers, as it promiſes great profit to themſelves, and a ſtill greater advantage to the community in general.

A letter from Doctor OTTO *to Doctor* BOND, *gives the following account of an* Oil, *made from the ſeeds of the common large* SUN-FLOWER, *viz*

"THE oil is made much in the ſame manner as the linſeed oil with fire, only that the huſk is taken off before it is pounded and preſſed; tho' I think it would be much better if it had been drawn cold. One buſhel of the ſeed, in the manner this was made, yields about three quarts of oil: What quantity of oil one acre of land will produce, I cannot aſſert at preſent; however, there is a ſpot of land planted, and the ſeed now ripening, the contents whereof we will meaſure, and alſo the produce, and I will inform you of the reſult. It is frequently uſed by our brethren, inſtead of ſweet oil, for ſallad, and, with a ſmall addition of the ſweet oil, ſerves very well for that purpoſe."

Upon

Upon examining ſome of the oil which was ſent by Dr. *Otto*, it was found thin, clear, and agreeable to the taſte. And the committee are of opinion, that this oil will ſupply the place of olive oil for the above, and many other purpoſes, and may therefore be looked upon as a valuable diſcovery to America.

Dr. *Bond*, at the ſame time, produced a ſample of oil, made from the cotton ſeeds, and ſent by the ſame gentleman, of which he gives this account: This is the ol. bombac. or oil of cotton ſeed, made in the ſame manner as the above, one buſhel and a half of which yield nine pints of oil, and I have been informed it is ſucceſsfully uſed in the Weſt-Indies for the cholic,

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An Eſſay on the expreſſing of OIL, from SUN-FLOWER SEED, &c. By Dr. J. MORGAN.

THE grinding of the ſun-flower ſeeds, and expreſſing of oil from the ſame, is a manufacture, which, as far as can be yet learned was firſt begun among the Moravian brethren at Bethlehem, and reflects honor upon them, whilſt it affords the public a new ſubſtance, very beneficial in a variety of purpoſes, but more eſpecially, as it may ſerve for a ſallad oil, and for other uſes of diet and medicine, in the place of olive oil.

From experiments already made at Bethlehem, it is found that a buſhel of the ſun-flower ſeed will yield, on expreſſion, near a gallon of mild oil. The gentlemen, who is appointed by the community there to ſuperintend their mills, deſigns, as we are informed, to purſue a further courſe of experiments on this ſubject, the reſult of which, we hope, will be communicated to this ſociety.

Our correſpondent at Lancaſter informs the ſociety, that ſome perſons in the neighbourhood of that place, have alſo expreſſed a quantity of oil from the ſeeds of the ſunflower. His account is as follows.

“ The

" The perſon, who has raiſed the greateſt quantity of the ſun-flowers with us, informs me, that one hundred plants, ſet about three feet diſtance from each other, in the ſame manner Indian corn is commonly planted will produce one buſhel of ſeed, without any other trouble, than that of putting the ſeed into the ground, from which he thinks one gallon of oil may be made. I obſerved the land, on which he planted the ſun-flowers, to be of the middling ſort, and that he took no pains to hill them, or even to looſen the ground about them, which from my own obſervation on ſome planted in a neighbour's garden, I take to be of conſiderable uſe.

" As the ſun-flower is a plant of great increaſe, and requires much nouriſhment, hilling does not ſeem ſo good a method as that of ſetting the ſeed or plant in a hole, and when the plant is about a yard high, to throw in the mould round the ſtalk, ſo that the ſurface of the ground may be even about it. By an eſtimate made it appears, that one acre of land will yield to the planter between forty and fifty buſhels of ſeed, which will produce as many gallons of oil. The proceſs for making or extracting the oil is the ſame as that of making linſeed oil, which I make no doubt the Society is acquainted with, and therefore ſhall not trouble you with it."

The ſucceſs attending the trials already made, give the greateſt encouragement to proſecute this uſeful diſcovery. And as the ſeeds of the ſun-flower are at this time nearly ripe, and in a proper ſtate for extracting the oil from them, it may be of ſervice to lay theſe facts before the public. Such as may have an inclination to make trials on this ſubject, and are not at preſent furniſhed with a ſufficient quantity of ſeed for preſſing out an oil, may now ſupply themſelves with enough to plant for making experiments the enſuing year.

For the information of thoſe, who have both opportunity and inclination to extend the enquiry, and render this a valuable branch of buſineſs, but are not acquainted with the

the general principles upon which oil is obtained, by expreſſion from vegetable ſubſtances, it may be proper to obſerve, that the kernels of fruits, ſuch as walnuts, hickory nuts, filberts, almonds, peaches, &c. and the ſeeds of many plants, as muſtard, rape, poppy, flax, ſun-flower, &c. contain a large portion of mild oil. In order to obtain the oil, the kernels or ſeeds are commonly rubbed to powder, or ground in mills. They are then put into a ſtrong bag, made of canvas or woollen cloth, and committed to a preſs between iron plates, by which the oil is ſqueezed out, and is received or conducted into a proper veſſel to collect it. The plates of the preſs are often heated, either in boiling water, or before the fire. Many heat the maſh itſelf in a large iron pot, ſtirring it about with a ſtick or piece of wood, to prevent it's burning, which, when it happens, greatly injures the oil, and gives it a burnt ſmell and taſte, or diſpoſes it to become rancid in a ſhort time. When the oil is drawn without the aſſiſtance of heat, it is known by the name of cold drawn oil, and is more valuable, than when heat is uſed, but it is not obtained in the ſame quantity. It is milder, and may be kept longer without ſpoiling.

In a cold ſeaſon of the year, a certain degree of heat is abſolutely neceſſary. But if the oil is deſigned for aliment or medicine, the plates of the preſs ſhould be heated in boiling water only. When the oil is intended for other uſes, the plates may be made hotter, as heat expedites the ſeparation of the oil, and gives a greater produce, but then care ſhould be taken not to injure the ſubject by burning.

Sometimes the ſubject, when ground, appears almoſt like a dry powder. It is then ſaid to be meagre, and requires to be expoſed to the vapours of boiling water, which is done either by tying it up in a bag, or putting it into a ſieve, and placing it over the ſteam. By this impregnation, it will yeld it's oil more readily, and in greater quantity. The oil may be eaſily freed from any water that may happen to be preſſed out with it, as a ſpontaneous ſeparation between them will take place on ſtanding for ſome time.

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For the encouragement of thofe who may chufe to improve this fubject, it may be proper to obferve, that all the oils, from whatever vegetable fubftances they are drawn, when obtained by expreffion with due caution, agree in their general qualities, and are conftantly mild, even though they are obtained from very acrid fubftances. Thus the expreffed oil of muftard feed is, when frefh, as mild as that of olives, and the bitter almond, or peach kernel, affords an oil, by expreffion, as mild as that of fweet almonds. It is upon this principle, that the fun-flower oil may prove equally valuable with the beft Florence oil, for diet or medicine. For every expreffed oil, when pure and frefh, is void of acrimony, and free from any particular tafte or fmell.

Befides the mild oil juft mentioned, fome fubftances contain another kind of oil, called it's effential oil, a part of which may be drawn off with the mild expreffed oil, fo called, and impart it's fmell or tafte to that oil. It is called effential oil, from it's yielding the particular odour of the vegetable, or part of the plant, from which it was obtained; it is pungent to the tafte, and foluble in fpirits of wine, which the other is not. They may therefore be eafily diftinguifhed from each other.

The oil of fweet almonds, and the oil of olives, being pure unctuous expreffed oils, not foluble in fpirits of wine, but mild to the tafte, and void of odour, very foft, emolient and lenitive, are chiefly ufed in medicine and diet. And the reafon why the oil of olives, in particular, is preferred, is becaufe it is lefs expenfive, and will keep a much longer time without becoming rancid.

Perhaps, on trial, the fun-flower feeds may be found to contain an oil that will anfwer the like good purpofes with the falad and medicinal oil, now in ufe. If fo, it will have this advantage over that of almonds or olives, that it is a native of the country, may be always had frefh, and at a fmall expence, Whereas the others are the produce of diftant countries, bear a high price, and are often adulterated on

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that account; or being kept a long time, they lose their mild quality, and become rancid and acrimonious.

The practicableness of getting oil among ourselves at a moderate expence, and the importance of using it fresh, together with the probable uses of sun-flower oil for varnishes, for the basis of ointments, and for mixing of paints, as well as other purposes to be answered by oils in general, claim our attention to this subject, and encourage further trials of the like kind.

Before we quit this subject, it may not be amiss to mention, that castor oil is justly celebrated for it's medicinal qualities: The plant, from the seeds of which it is got, may be easily cultivated in this country, and the increase of it is very great in a short time; might it not then be worth the attention of our farmers to propagate this plant, for the sake of it's oil? We would just suggest, that perhaps it might be worth while to try whether the seeds of sumach, with which this country abounds, or of the mullen, which grows in old fields, and bears a great quantity of seed, would not yield by expression, a valuable oil for medicine, or other purposes.

Mr. JOHN MOREL's *Letter, with a keg of* BENE SEED. *Read before the Society, May* 20, 1769.

SAVANNAH, 5th May, 1769.

To Mr. CHARLES THOMPSON, *Secretary of the American Philosophical Society, at Philadelphia.*

SIR,

I SEND you a small keg of Bene or Bene Seed, which you will please to present to your Society for their inspection. This seed makes oil equal in quality to Florence, and some say preferable. Some say one hundred weight of seed will produce ninety pounds of oil, others say less, be that as it will, it certainly makes very fine oil, and produces

duces amazingly. If it is put to the trial, care ſhould be taken to have the preſs well cleaned, ſo as leave no tincture from what may have been already preſſed; in my opinion, this is an article of conſequence, and I believe it will grow in Philadelphia. The way to ſow it is in holes about three feet aſunder, dropping in each hole about ten grains; when it comes up, thin it to three or four of the moſt promiſing, the ſeeds will appear in pods about September, and ſhould, when full grown, and before dry, be gathered in. The method is as follows: As ſoon as you perceive about three-fourths or four-fifths of the pods riſe on the ſtalk, and the lower pods begin to loſe their ſeeds, it is then time to take it in; for after that, as much as ripens one day a top, ſo much falls out of the pod at bottom, you take a ſharp hatchet bill or ſome ſuch weapon, and with it cut off the ſtock twelve to eighteen inches below any of the ſeed, holding the ſtock with the left hand; and when cut, a ſecond perſon receives it, keeping it upright, till he has his load, for if you turn it downwards the ripe ſeed will fall out of the pods, you may immediately carry it into a barn, and ſet it upright on a cloſe floor till you perceive all the pods fully dry and open. (You may, if you chuſe, leave it in the field, which muſt be the caſe if a large quantity is planted,) then threſh it, and run it through a proper ſieve, and it is fit for uſe.

I am quite unacquainted with the method of expreſſing the oil, but I believe if it is deſigned for table uſe, nothing ſhould be done to the ſeed, as it might give it an ill taſte. The lighter and dryer the ſoil is in which it is planted, the better.

I am,

Dear SIR,

Your moſt humble Servant,

JOHN MOREL.

A Letter from Mr. HENRY HOLLINGSWORTH, *to the American Philosophical Society, held at Philadelphia, &c. Read before the Society, 17th of February, 1769.*

GENTLEMEN,

THE laudable design with which you seem actuated to promote the good of your country, and the earnest desire you have expressed in the public papers, to be informed of whatever may tend to that purpose, induce me to lay before you such experiments as I have made and found effectual to destroy the wild garlic, with which the country is in many places infected, and which is very pernicious to the grain. If what I offer, shall meet with your approbation, and be judged worthy the attention of the public, you are at liberty to communicate it in such a way as you shall think most proper. For my own part I shall think myself happy if my experience may, by your means, be made useful to my country.

In 1753, I fallowed and sowed with wheat, a field of about 50 acres, the greatest part of which was very full of garlic; I fallowed in May, stirred in August, and sowed in September. In April 1754, I perceived the wheat much choaked with garlic, and at harvest found in many parts of the field almost every tenth head was garlic, which rendered the wheat unfit for use, until by immersing it in tubs of water the garlic (which floats) was separated from it. But though the wheat, if carefully dried, receives little injury from this immersion, yet the trouble attending it is so great, as to discourage farmers from raising large crops. In April 1755, I planted the same field with Indian-corn, and had a good crop. In April 1756, I sowed the same field with oats, in August I ploughed down the oat stubble; and in September sowed a crop of wheat. In April 1757, I was agreeably surprized at seeing but very little garlic, and that small and dwindling; and at harvest there was scarce a head to be found, except along the side of the fences. The success of this culture, which was merely

merely accidental, and done without any view of deſtroying the garlic, induced me to try the following experiment.

In April 1758, having fixed on a field for my next fall crop, which had produced Indian-corn the year before, and was equally full of garlic with that I mentioned before; I ſowed part of it with oats, the other part I fallowed in June, and ſtirred in Auguſt, at which time I plowed in the out ſtubble, as before, and ſowed the whole in September, cauſing the ſame ridge to paſs through part of the ſtubble and part of the fallowed land. In April 1759, there was a very perceivable difference. The ſtubble part was green with wheat, but the fallowed part was of a bluiſh colour, occaſioned by the quantity of garlic, and at harveſt was full of large heads, while in the ſtubble part there was not one to be found.

Since that I have continued to ſow oats in the garlicky lands deſigned for wheat, and find I have ſucceeded ſo well in deſtroying the garlic, that after three years culture in that way, the lands may be fallowed and ſown with wheat in the uſual manner, without any danger from that noxious plant.

Several of my neighbours have purſued the ſame method and find it anſwers. As the advantage of a crop of oats is more than equal to the difference between fallow and ſtubble ground wheat (where the land is tolerably good) I would recommend it to all who are troubled with garlic to make a trial. The only diſadvantage will be the impoveriſhing their lands, which, if they have manure, may be eaſily remedied. At the ſame time, I would obſerve, that the ſtubble which is ploughed down ſerves for a manure, and nearly repairs the waſte occaſioned by the crop of oats.

If it be aſked why oats deſtroy garlic, I muſt confeſs I am unable to reſolve the queſtion. Perhaps ploughing the land in the month of April, when the greateſt part of the oil of the root or clove is in the ſhoot, and turning it under at that time, deſtroys the roots more effectually than at any other feafon, and the moving the oats, which is the method purfued by us, deftroys the heads that would otherwife come to feed later in the year. Poffibly the fame tillage in the fame feafon without fowing oats, might anfwer the end propofed. But having never made the experiment I can fay nothing certain on that head.

I am, &c.

H. HOLLINGSWORTH.

Head of Elk, Nov. 30, 1768

Extract of a letter from Mr. PETER MILLER, *of* Ephratah, *to Mr.* CHARLES THOMSON, *on the time of fowing* PEASE, *fo as to preferve the crop from being worm-eaten.*

"THE peafe I fend you the fample of are the produce of laft fummer. Their feed was very much worm-eaten, but as the crop produced from them was no way infected, it is evident that their fafety depended entirely on the time of fowing; which is about the 10th of June, new ftile. This hath been confirmed to me by a farmer of a long experience.

"The beft method would be to begin fowing towards the latter end of May, and continue for a few weeks, fowing fome each week, or at the diftance of three or four days, in order to difcover whether the worm does not come from fowing in an improper feafon. Some Albany peafe might likewife be tried as feed; all which I recommend to the prudent confideration of your fociety. For, if you could make any fure difcovery for the ufe of the country, the public would be greatly indebted to you.

"Peafe were heretofore very plenty in Pennfylvania: I knew one farmer in Oley who raifed fixty bufhels at a crop, and I did not hear that they were damaged at that time by the worm. I muft not forget to tell you, that as the peafe I have fent you are of an excellent kind, and very

very ſcarce here, you will be careful to propogate their ſpecies. As to the lentiles which are ſent, the time of ſowing them is early in the ſpring, and moſt commonly with oats."

N. B. It is recommended to ſuch as ſhall make experiments of ſowing peaſe late, in order to have a crop free from the worm, that they would keep an account of the times of ſowing, and the effect thereof, in regard to their crops.

An eaſy METHOD *of preſerving* SUBJECTS *in* SPIRITS. *By Mr.* LEWIS NICOLA.

PERSONS curious in preſerving ſpecimens for natural hiſtory are often diſappointed by the evaporation of the ſpirits, which occeſions the loſs of the ſubject intended to be preſerved, or they muſt be very careful in often examining their bottles, or putting ſpirits in ſuch as they have occaſion for a freſh ſupply, which, in a large collection requires much time, trouble and expence. This induced M. *de Reaumur* to try many experiments, in order to obviate this inconvenience; which he gave to the public in a long diſſertation, inſerted in the Memoirs of the Royal Academy of Sciences, for the year 1746, after mentioning his different trials, he recommends two methods.

The firſt is, to get bottles with glaſs ſtoppers of a conic form in the part that enters the neck of the bottle, and broad and flat at the other end. When the ſpirits and ſpecimen, ſupported by a piece of wire, are put in, a little mercury muſt be thrown into the bottle, and the ſtopper fixed in it's place, and ſecured by a piece of bladder or leather tied round it and the neck of the bottle; the whole muſt be reverſed and placed on the broad end of the ſtopper, which occaſions the mercury to ſettle between the neck of the bottle and ſtopper, and obſtructs the evaporation of the ſpirits by the only paſſage through which the fine

fine parts could fly off. He ſays, nut oil, thickened to the conſiſtence of honey, by a long expoſure to the air which will give it weight ſufficient to ſink in a weak ſpirit, may ſupply the place of mercury.

The ſecond method is, for bottles that have not glaſs ſtoppers for which he recommends a layer, of about two lines thickneſs on the inſide of the bladder, which is to cover the mouth of the bottle, of nut oil prepared as before directed, and when the bladder is well tied on, the bottle may be reverſed without any hazard, but great care muſt be had to wipe the edge of the bottle very dry, that the oil may adhere to it in every part. As many bottles will not ſtand on their mouths, Mr. *de Reaumur* directs their being placed in wooden cups, turned with a broad bottom and a hollow, ſufficient to receive the neck of the bottle.

Theſe two methods, though well calculated to anſwer the end propoſed, have ſome inconveniencies. In the firſt the bottles muſt be deſignedly made for this uſe and of flint, that the ſtoppers may be ground into them, which, with the coſt of the mercury, is a conſiderable expence, beſides the difficulty perſons at a diſtance from a glaſs houſe will find, in procuring them. In the ſecond, preparing oil, ſo that it may thicken to conſiſtence of honey, is a work of years, the operations may be much ſhortened, by putting the oil about two lines thickneſs in leaden veſſels, as that metal has a conſiderable effect on the oil, which may by this means be ſufficiently prepared in three or four months.

After ſeveral experiments, I found two methods free from the above inconveniencies, and which I have great reaſon to think will anſwer the purpoſe fully from four or five years experience.

The firſt method has ſome affinity with Mr. *de Reaumur*'s and is as follows. When the ſubject and ſpirits are put into the bottle, carefully wipe the inſide of the neck and edge till quite dry, prepare ſome thin putty, of the conſiſtence of ſoft ointment, and put a coat of it about a line or two thick on the ſide of the bladder or leather, which

which is to be next to the bottle, and tie it tightly about the neck, place the bottle with the mouth downward in a ſmall wooden cup, and fill it with melted tallow, or tallow mixed with wax, until all the bladder or leather cover is buried in it, and the tallow adheres to the ſides of the neck; this will effectually prevent the fine parts of the ſpirits from flying off. Great care muſt be taken to have the edge of the bottle very dry, and if rubbed with a feather, dipped in oil, it will be better, and in filling the cup, to have the tallow no hotter than is barely neceſſary to make it fluid.

The ſecond method is, after the ſpecimen and ſpirits are put into the bottle, dry the inſide of the neck and edge thoroughly, and anoint them with a feather dipped in oil, ſtop the bottle with a cork well fitted and ſteeped in oil, till it has imbibed as much as it can contain, cover the cork and edge of the bottle with a layer of putty prepared as directed above, and tie a piece of ſoft leather or bladder over the whole.

Olive, or any other fat oil, is to be preferred to ſuch as dry eaſily; I would alſo recommend the uſe of ſpirits of a moderate ſtrength, as thoſe that are very ſtrong burn up and diſcolour the ſpecimens, particularly ſuch as have fine colours. Theſe two methods have the advantage of Mr. *de Reaumur*'s, in the ſmallneſs of the expence and eaſineſs to procure the materials. For ſpecimens that it will not be neceſſary at times to take out of the bottles I would recommend the firſt method, as more obſtacles are oppoſed to the evaporation than in the ſecond, beſides the cup, the coſt of which is very trifling, puts the bottle in leſs danger of being overſet and broken, than moſt bottles are when ſtanding on their bottoms.

A Letter from Bethlehem, dated 23d, July, 1769. With a Receipt for making CURRANT WINE. Read before the Society.

DEAR SIR,

ESTEEMING it a duty incumbent on the members of civil ſociety, to communicate every uſeful diſcovery they conceive the public may be benefited by, I take the liberty of ſending you the incloſed receipt for making *currant-wine*, which, for a good number of years, has been ſucceſsfully carried on in this place.

From its cheapneſs (which I imagine cannot ſtand the maker in more than ſix-pence a quart); from the eaſy culture of the ſhrub, and the conſideration of their never failing to bear; it is thought the inhabitants of this province may be generally induced to fall into the way of making it, whereby, perhaps in time to come, the great importation of the inferior ſorts, and I fear, before they come into the hands of the retailer, bad wines may be greatly leſſened, if not wholly prevented, and a wholeſome liquor as the currant wine, if well made, and of proper age, really is, introduced in their ſtead, which I need not add would be a great ſaving to the province.

The currant buſh, though a ſhrub that grows almoſt ſpontaneouſly, requires nevertheleſs ſome dreſſing; in regard to which the following directions may be of ſervice.

Plant them round the quarters in your garden, that they may have the benefit of the dung and culture annually beſtowed thereon, which will conſtantly make the berries large, and the juice rich.

The red currant is preferable to the white, as yielding richer juice, and in much greater quantity.

Take the moſt luxuriant ſlips or ſhoots of a year's growth, ſet them in the ground about eight inches deep, and not leſs than twenty-four diſtant from each other; theſe never fail of taking root, and generally begin to bear in two years. For the reſt, let them from time to time be treated as eſpaliers, (but not againſt a wall) obſerving to keep the roots.

roots, efpecially in the fpring of the year, free from fuckers and grafs.

This treatment is the more neceffary, in that the goodnefs of the wine in a great degree depends on their having the full benefit of the fun and air, to maturate and give the berries a proper balfamic quality, by exhaling a due proportion of their acid watry particles.

The RECEIPT *for making* CURRANT WINE.

GATHER your currants when full ripe, which will commonly be about the middle of July; break them well in a tub or vat (we have a mill conftructed for the purpofe, confifting of a hopper, fixed upon two lignum vitæ rollers), prefs and meafure your juice, add two thirds water, and to each gallon of that mixture (*i. e.* juice and water) put 3 lb. of Mufcovado fugar, (the cleaner and drier the better, very coarfe fugar, firft clarified will do equally well) ftir it well 'till the fugar is quite diffolved, and then tun it up. If you can poffibly prevent it, let not your juice ftand over night, as it fhould not ferment before mixture.

Obferve, that your cafks be fweet and clean, and fuch that never have had either beer or cyder in them, and if new, let them be firft well feafoned.

Do not fill your cafks too full, otherwife they will work out at the bung, which is by no means good for the wine; rather make a proportionable quantity over and above, that after drawing off the wine, you may have a fufficiency to fill up the cafks.

Lay the bung lightly on the hole, to prevent the flies, &c. from creeping in. In three weeks or a month after making, the bung hole may be ftopped up, leaving only the vent hole open 'till it has fully done working, which generally is about the latter end of October. It may then be racked off into other clean cafks, if you pleafe, but experience feems to favour the letting the wine ftand on the lees 'till fpring, as it thereby attains a ftronger body, and is by that means in great meafure divefted of that fweet luſcious taſte, peculiar to made wine; nay, if it is not wanted for preſent conſumption, it may, without any damage, ſtand two years on the lees.

When you draw off the wine, bore a hole an inch at leaſt above the tap hole, a little to the ſide of it, that it may run clear off the lees. The lees may either be diſtilled, which will yield a fine ſpirit, or filtered through a Hippocrates's ſleeve, and returned again into the caſk. Some put in the ſpirit, but I think it not adviſable.

Do not ſuffer yourſelves to be prevailed on to add more than one third of juice, as above preſcribed, in hopes the wine may be richer, for that would render it infallibly hard and unpleaſant, nor yet a greater porportion of ſugar, as it would certainly deprive it of its pure vinous taſte.

By this management you may have wine, letting it have a proper age, equal to Madeira, at leaſt ſuperior to moſt wines commonly imported, and for much leſs money.

In regard to the quantity of wines intended to be made, take this example, remembering that 12 lb. of ſugar is equal to a gallon of liquid.

For inſtance, ſuppoſe you intend to make 30 gallons only, then there muſt be,

8 gallons of juice,	24 gallons of mixture,
16 of water,	3 multiplied by
24 gallons of mixture	12) 72 pounds of ſugar, equal to
6 gallons produced by ſugar	6 gallons of liquid.
30 gallons.	

And ſo proportionably for any quantity you pleaſe to make.

The common cyder preſſes, if thoroughly clean, will do well in making large quantities, the ſmall hand-ſcrew preſs, is moſt convenient for ſuch who make leſs.

N. B. An extraordinary good ſpirit, for medicinal and other uſes, may be diſtilled from currant juice, by adding a quart of melaſſes to a gallon of juice, to give it a proper fermentation.

Extracts of a LETTER from Dr. LORIMER, *of West-Florida, to* HUGH WILLIAMSON, *M. D. Read before the Society,* 21*st April,* 1769.

WHEN I read the plan for enlarging your Society, one part of it particularly called to my mind an introduction to the conclusion of the modern part of the Universal History, wherein the geography of this globe is considered in a new light, with a view to discoveries. In that article it is observed, that the lines which measure the greatest length of the old and of the new continents are nearly equal, and that they incline to the equator in the same angle, but in opposite directions. It is farther remarked, that each of them divide their respective continents into two tracts of land almost of the same superficial contents, and that these continents seem fixed by nature as a counterpoize to one another. Your Society take notice of the similarity between the east side of the old continent, and the east side of the new, in vegetable productions, &c. and vice versa. Now let me contribute one proof of this proposition amongst many others. The odoriferous skimmi of japan is a native of West-Florida. Our agent is a great naturalist, and particularly intent on procuring specimens of this plant. I hope in a little time to be able to give you and him a pretty satisfactory account of it. We have a variety of shrubs, with aromatic and odoriferous bark. I am really of opinion that the common plants have a more exquisite flavour in this climate than in other countries. There is a kind of sarsaparilla, which answers the intention, but I question, whether it would sell well at first. We have snake-root and many other medicinal plants, and I do not doubt but some articles, may be discovered which are yet unknown in the Materia Medica. There is a beautiful kind of bean, which some of our sailors having eat of, were surprized with a vomiting and purging, just as another crew were by eating poke for sallad. There is likewise a plant of the pea kind, said to be used by the Indians as an univerſal remedy in venereal caſes. I hope ſoon to be better acquainted with theſe things: Though I am ſorry to ſay that I am no great botaniſt, nor have we any man of eminence in that way. Here is certainly a great field to employ naturaliſts. Minerals, eſpecially iron, we have in abundance. I have a very good natural magnet, found within ſix miles of this town. There is an excellent chalybeat water juſt by, it's elaſtic ſpirit has driven the cork out of the bottle which contained it. The country is full of navigable rivers, and runs of the fineſt freſh water. About Mobile and at the ſwampy mouths of ſome rivers, it muſt be a little unhealthy, but it is far from being ſo bad as has been imagined. In April 1765, when I was notified as ſurgeon to the forces here at the war office, I unluckily prognoſticated the fate of our troops which were then to be ſent out. It is now evident that it was miſconduct entirely that ocaſioned the loſs of ſo many ſoldiers and ſubjects. I am juſt making out a ſtate of the medical conſtitution of this climate; as an introduction to which I have given a ſhort general account of the ſituation of the country and the temperature of the air; for which laſt purpoſe I have taken the height of the thermometer generally three times every day for one whole year, and I have noted all the extraordinary variations for almoſt three other years. Nothing elſe could give an idea of a climate, where the thermometer will riſe or fall ſome times 20 degrees in a few hours, and at other ſeaſons not 2 in many days, the extremes being at leaſt from 17 to 98 degrees of Farenheit's ſcale. Your ſociety obſerve, that on the eaſt coaſt of North-America and of China, the north-weſt winds are cold and piercing, the ſouth-weſt warm and dry, the north-eaſt cold and wet, the ſouth-eaſt wet but warm; and that the caſe is different on the weſt coaſt of Europe and at California. Now on this coaſt, which is neither the eaſt nor weſt ſide of a continent; in winter the ſoutherly winds are warm and moiſt, the northerly cold and dry: In ſummer we have the daily ſea breeze from the

South, and in the night or morning a refreſhing gentle land wind from the north. The ſky in this country is remarkably ſerene, eſpecially when the winds are northerly. A thought juſt ſtrikes me, that, according to the foregoing ſimilarities, our coaſt ſhould reſemble that of Perſia from the river Indus to the gulph of Ormus, but as there is no Miſſiſippi on that coaſt, we may compare the mouths of that river with thoſe of the Ganges, and the country about Bengal, to that of New-Orleans. The Spaniſh main, as we call it, ſhall be Arabia, and Spirito Sancto, in Eaſt-Florida, may repreſent Madraſs. However, to return to what we know of our own ſituation. The gulph of Mexico may be conſidered as one great whirlpool. The general courſe of the waters in the great oceans, as well as the current of the air within and near the torrid zone, being from eaſt to weſt; the force of the atlantic comes upon the Weſt-India Iſlands, and the lengths of theſe iſlands are in that direction. When the waters get into the great Gulph, they are obſtructed every where, and as it were turned round by the land, the greateſt velocity of this great body of water will be towards the Equator, and it muſt get out where it meets with the leaſt reſiſtance, that is on the ſide towards the Pole, and there it forms the ſtrong current or paſſage, called the Gulph of Florida. The natural courſe therefore of the waters on our coaſt, ſhould be from Weſt to Eaſt; but here there are frequent currents which are very irregular, depending moſt probably on the winds, but ſeldom on that which blows on the ſpot. By the general law of the tides, there ſhould be flood for one ſix hours, and ebb for the ſix following nearly, but here an ebb-tide will continue for eighteen or twenty hours, and the flood only four or ſix, *et vice verſa*. A ſoutherly wind always riſes and keeps up the waters in our bays, and the northerly winds almoſt empty them, yet it muſt be allowed that theſe ebbs and floods are not equable during this continuance, for upon accurate obſervation there is a tendency to two ebbs and

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as many floods every twenty-four hours, though they are overpowered by the winds or currents. The entrance of our bays and rivers are defended as it were by a ſhallow or ſand bank, which forms a bar farther out towards the ſea, than is uſual in Europe; the depth on the bars is not at all proportional to that within the rivers: All the riſe on the bars is about a foot while in the bays it is almoſt three. The mouths of our rivers are frequently divided into different channels by a kind of ſwamp covered with reeds, and all this is moſt probably occaſioned by a kind of conflict between theſe currents, and the riſing of our rivers at certain ſeaſons of the year. There are no dangerous ſhoals on this coaſt, unleſs you fall too far to the eaſtward about Cape-Blaze, or St. George's Iſlands. The latitude of the Cape being the moſt ſoutherly land in Weſt-Florida is about 29°. 40′. and from thence to the entrance of Sancta Roſa bay, which is in 30°. 30′ the land gradually declines to the North. From Sancta Roſa to the entrance of Mobile Bay in lat 30°. 17′ it falls again to the ſouthward; and from Mobile Bay to the entrance of the lakes it is nearly Eaſt and Weſt. There is no ſuch thing as recommending any map of this country. Bellin, and ſuch as have copied from him, give ſome reſemblance of the coaſt, but they are all erroneous, and that in very material articles. If Mr. Gauld's ſurveys are not ſoon publiſhed, he will poſſibly ſend a copy of them for your Society, but he is juſt now ſo engaged that he cannot ſet about ſuch a work. Thus far I think it neceſſary at preſent to inform you from his papers; that the bay of Spirito Sancto is ſufficient for firſt rate ſhips, but that is in Eaſt-Florida. The harbour of Penſacola will only admit ſuch as draw 21 feet water, though that is ſufficient for 50 or 60 gun ſhips, and there is a road ſted lately diſcovered behind the chandeliers, which is much more commodious than that at Ship Iſland in its neighbourhood; it will admit veſſels of any ſize, and is ſheltered from all winds except the North and North-Weſt, in which caſes they can eaſily put

put to ſea, and make for Penſacola or Spirito Sancto, if neceſſary. The bay of St. Joſeph is not unlike that publiſhed by Jeffereys, it has 18 feet water good, fine anchorage, and would be a moſt advantageous ſituation for a fiſhery, ſalt pans, &c. The bay of St. Andrew juſt adjacent is as much larger as it is unlike to any thing yet publiſhed, it extends from South-Eaſt to North-Weſt, and is a moſt commodious habour for veſſels of 13 feet draught. The bay of Sancta Roſa is ſtill more extenſive; it lies from South-Weſt to North-Eaſt, but can eaſily anſwer for the Penſacola pettiaugers, which by the long channel within the iſland, and the river which falls into the head of the bay, and extends North Eaſt almoſt to the Lower Creek Nation, may trade with the Indians. The lands upon this river at ſome diſtance from the bay are good, but all along this coaſt there is little elſe than a ſandy beach and pine barren. But for a deſcription of the rivers Miſſiſippi, Pearls, Paſcogoula, the Tombechy, and Albama, which fall into the bay of Mobile, the bay and river of Perdido, juſt contiguous to Penſacola, the Scamby, and ſo forth, I refer you entirely to Mr.———, who is a much better judge than I am of the advantages which may be made of their produce, &c.

I ſhall ſend you a deſcription of an univerſal magnetic needle. It gives the variation and dip at the ſame time, the laſt of which I preſume with more accuracy than any yet extant. It anſwers in all parts of the world, without the addition or alteration of any poiſe, ſuch as our beſt compaſſes now have. A collection of American magnetical obſervations is much wanted; with the courſe of the line of no variation in-land, and the dip, which I imagine will be found greater than in the ſame latitudes on the European ſide. The farther to the North and Weſt, that the obſervations could be made the better. This was a ſubject which I had deſpaired of ever ſeeing reduced to any kind of regularity, but I am now well ſatisfied that it may. I have great expectations from the plan of your Society, and ſhall

ſhall make it my buſineſs to prepare ſomething or other, by the time I can expect to have the favour of a few lines from you. I moſt ſincerely wiſh you ſucceſs, and am, Sir,

Your moſt obedient

Humble Servant,

J. LORIMER.

Penſacola, Jan. 7, 1769.

A Catalogue of ſuch FOREIGN PLANTS *as are worthy of being encouraged in our American Colonies for the purpoſes of Medicine, Agriculture, and Commerce.*

[*From a Pamphlet by* JOHN ELLIS, *F.R.S. Preſented by the Honorable* THOMAS PENN, *Eſq. to the* American Philoſophical Society, *through the hands of* SAMUEL POWELL, *Eſq.*]

To avoid confuſion in the botanical names, both the generical and ſpecific, or trivial names of the plants, are ſet down, with the page referred to in the celebrated Linnæus's ſecond edition of his ſpecies of plants. Other authors of the beſt authority are mentioned, where Linnæus is ſilent.

Latin Names.	2d Ed. L. Sp.	*Engliſh Names.*	*Obſervations.*
Rubia Peregrina	p. 158	Turkey Madder	The firſt is ſuppoſed to be the ſame that is now cultivated in Smyrna for a crimſon dye.
Rubia Tinctorum	p. 158	Dyers Madder*	
Quercus Suber	p. 1413	Cork-bearing oak	Grows in the ſouthern parts of France, Spain, and Portugal.
Quercus Ægilops	p. 1414	Avellanea or Valenida oak	The cups of the acorns, which are very large, uſed here in dying, grow in Greece and Natolia, particularly in the iſland of Zia in the Archipelago, where Tournefort ſays they gather in one year 5000 Cwt.
Quercus Gallifera	Parkinſon, 1386	Gall-bearing oak	Galls from Aleppo and Smyrna. This oak is not yet known in England: The acorns may be brought over in wax, and ſent to the Floridas, Georgia, and South-Carolina.
Carthamus Tinctorius	Lin. Sp. 1162	Safflower	Much uſed in dying, grows in Egypt.
Rhamnus catharticus minor	Tournft. 593	Buckthorns that produce yellow berries of Avignon	Uſed by painters and dyers; both theſe plants produce berries fit for this purpoſe.
Rhamnus Saxatilis	Lin. Sp. 1671		
Olea Europea	p. 11	Olives of ſeveral varieties	For oil; theſe grow in France, Spain, and Italy. Young plants and ripe fruit of the French and Spaniſh ſorts, may be brought from thence.
Seſamum Orientale	p. 883	Oily grain	Propagated in the Levant for oil, which does not ſoon grow rancid by keeping.

* This plant is a native of the warmeſt parts of Europe, and is better calculated for the climate of the Floridas than either of Holland or England, where it is cultivated; but principally in the former from whence we are chiefly ſupplied with this valuable dye. The chemiſts ſay, and with reaſon, that the warmth of the climate exalts the colour. If ſo, it may be well worth the attention of the public to encourage the planting of ſo valuable an article of commerce in a climate and ſoil that ſeems ſo much better adapted to it, where the land is cheap, and where vegetation is ſo much quicker and more luxuriant; and while we encourage the growth of it in our colonies, we may have the advantage of manufacturing this valuable commodity at home, for which at preſent we pay ſums ſcarcely credible, to the Dutch.

Latin

Latin Names.	2d Ed. L. Sp.	*English Names.*	*Observations.*
Goſſypium herbaceum Goſſypium hirſutum	p. 975	Two ſorts of annual cotton	Both theſe kinds of annual cotton are yearly ſown in Turkey, and would grow well in the warm climates of North America, as the Floridas, Georgia, Carolina, and Virginia.
Salſola Soda Salſola Sativa and Chenopodium maritimum	p. 323 p. 321	Theſe kinds of glaſſwort for Barilla	Theſe are ſown yearly in fields near the ſea in Spain, for making Barilla, for ſoap, glaſs, &c.
Ceratonia Siliqua	p. 1513	Locuſt tree, or St. John's Bread	The pods are excellent food for hard-working cattle, and uſed for this purpoſe on the ſea-coaſt of Spain, where they are eaſily propagated from ſeeds or cuttings.
Piſtachia Vera	p. 1454	Piſtachia-tree	They are propagated about Aleppo, where the female or fruit-bearing ones are ingrafted on ſtocks raiſed from the nuts.
Piſtachia Terebinthus	p. 1455	Chio Turpentine tree	This kind of turpentine is uſed in medicine.
Piſtachia Lentiſcus	p. 1455	Maſtick-tree	Gum maſtick from the iſle of Scio; as this tree, commonly called Lentiſcus, is doubted to be the genuine Maſtick-tree, ſeeds of the true kind may be procured from the iſle of Scio.
* Styrax Officinale	p. 635	Gum Storax tree	This tree grows in Italy, Syria, and India; but the warmer climates yield the beſt gum.
Convolvulus Scammonia	p. 218	Gum Scammony	Seeds of the Plant, from whence this excellent drug is procured, were ſent into England about 20 years ago, from Aleppo, by the late Dr. Alex. Ruſſel: It bears this climate very well, and produces ſeed in hot ſummers; but requires the warmer climates of Carolina, Georgia and the Floridas, to make the gumreſin that flows from it a beneficial article of commerce. It is ſo frequently adulterated in Turkey, that, in order to have it genuine, it is well worth propagating in our colonies.
Papaver Somniferum	p. 726	True Opium Poppy	This is recommended to be ſown in our ſouthern colonies of North-America, for the ſake of obtaining the opium pure. †
Caſſia Senna	p. 539	Alexandrian purging Senna	This grows in Upper-Egypt, and is brought from thence to Alexandria; it would not be difficult to procure the ſeeds of this uſeful drug.
Croton Sebiferum	p. 1425	Tallow tree of China	This plant grows in moiſt places in China, and is of great uſe in that country.
Rheum Palmatum	p. 521	True Rhubarb	The ſeed of this plant was brought to England about five years ago, by Dr. Mounſey, F. R. S. from Moſcow, and appears by experiment

* There is a reſinous juice, which by age, hardens into a ſolid brittle reſin, of a pungent, warm, balſamic taſte, and very fragrant ſmell, not unlike the ſtorax calamita, heightened with a little ambergris, which is produced from the Styrax aceris folio of Ray, or Liquidambar Styraciflua of Linnæus, Spec. plant. 1418, which grows in perfection in the Foridas. This, Dr. Lewis, in his Materia Medica, p. 353, ſays, might be applied to valuable medicinal purpoſes. The French, in Du Pratz' hiſtory of Louiſiana, ſpeak with rapture of its healing qualities, and the high eſteem it is in among the Indians of Florida, on account of it's infinite virtues: It is known to the Engliſh by the name of the ſweet gum-tree, and to the French by the name of Copalm. This is well worth the attention of the College of Phyſicians, as we can have it genuine, whereas the Storax from the Eaſt is often adulterated.

† The ſeed of this ſpecies of poppy is recommended by a phyſician of great eminence as proper for the ſame purpoſes in medicine as ſweet almonds are uſed. It is obſerved not to have the leaſt degree of a narcotic quality in it.

Latin Names.	2d Ed. L. Sp.	*Engliſh Names.*	*Obſervations.*
			periment to be the genuine true Rhubarb of the ſhops, and is a moſt valuable acquiſition to this country, as it will grow well in a deep rich ſoil, inclining to a ſandy or gravelly loam, but not in too wet a ſituation, and may be cultivated both here and in North-America Mr. Ingliſh has raiſed this plant with ſo much ſucceſs at his country houſe at Hampſtead, as to be able not only to produce ſome excellent good rhubarb, but a ſufficient quantity of ripe ſeed to make a large plantation; and at the ſame time has moſt generouſly beſtowed a great deal of ſeed to be ſent to our American colonies, where, no doubt, but it will prove in a few years a moſt beneficial article of commerce.
Calamus Rotang PterocarpusDraco Dracæna Draco	p. 463 p. 1662 Lin. Syſt. Ed. 12 p. 246	Three ſorts of Gum Dragon, or Dragon's blood.	1. From a kind of cane in the Eaſt-Indies. 2. From Java and Surinam. 3. From the Canary and Madeira iſlands.
Dolichos Soja	Lin. Sp. 1023	A kind of kidbean called Daidſu	Uſed for making Soye * or Indian Ketchup. See Kæmp. Amœnitat.
Laurus Caſſia	p. 528	Caſſia Lignea tree	Grows in Sumatra.
Laurus Cinamomum	p. 528	Cinnamon tree	In Ceylon, Guadaloupe, and in moſt of our newly ceded iſlands.
Laur. Camphora	p. 528	Camphire tree†	In Japan, and in Sumatra, now in England in the green houſes about London. It will grow freely where oranges and lemons do.
Cycas Circinalis	p. 1658	Saga Palm tree	In Java, and the warmeſt parts of the Eaſt-Indies.
Amyris Gileadenſis	Lin. Mant. 165	True balm of Gilead tree ‡	Lately diſcovered in Arabia by Dr. Forſkall, and deſcribed by Dr. Linnæus in a late diſſertation.

* The method of preparing Eaſt-India Soye, or India Ketchup.

Take a certain meaſure, for inſtance a gallon, of that ſort of kidney-beans, called Daidſu by the Japoneſe, and Caravances by the Europeans; let them be boiled till they are ſoft; alſo a gallon of bruiſed wheat or barley, (but wheat makes the blackeſt Soye) and a gallon of common ſalt. Let the boiled caravances be mixed with the bruiſed wheat, and be kept covered cloſe a day and a night in a warm place, that it may ferment. Then put the mixture of the caravances and wheat, together with the gallon of ſalt, into an earthen veſſel, with two gallons and an half of common water, and cover it up very cloſe. The next day ſtir it about well with a battering machine or mill (*Rutabulum*) for ſeveral days, twice or thrice a day, in order to blend it more thoroughly together. This work muſt be continued for two or three months, then ſtrain off and preſs out the liquor, and keep it for uſe in wooden veſſels; the older it is the clearer it will be, and of ſo much more value. After it is preſſed out, you may pour on the remaining maſs more water, then ſtir it about violently, and in ſome days after you may preſs out more Soye.

† The camphire from Sumatra is greatly preferable to that of Japan; we are not certain whether it is from a different ſpecies of tree, but it ſeems well worth inquiring into, as the effects of proportionable quantities in medicine are ſurprizingly different, perhaps it may be owing to the great difference of heat in the climates.

‡ We have in the iſland of Jamaica, a ſpecies of tree of this genus, called by Linæus Amyris Balſamifera. See Species Plantarum, p. 496. Sir Hans Sloane, in his hiſt. of Jam. vol. II. p. 24, calls this tree Lignum Rhodium, from the odoriferous ſmell of it's wood when burnt, which it diffuſes a great way; for which reaſon he believes it to be the tree that afforded the agreeable ſcent which Columbus perceived on the South ſhore of Cuba, upon the diſcovery of that iſland, as is mentioned by ſeveral hiſtorians. Dr. Pat. Browne, in his hiſtory of Jamaica, p. 208, calls this tree white candlewood, or roſewood, and commends it much; he ſays it is very reſinous, burns freely, and affords a moſt agreeable ſmell; and that all the parts of this tree are full of warm and acromatic particles.——Quere, Whether it is not worth while to extract the balſam, as it agrees ſo near in character and genus with that moſt valuable drug the balſam of Mecca

Arundo

Latin Names.	2d Ed. L. Sp.	*Englifh Names.*	*Obfervations.*
Arundo Bambo	p. 120	The True Bamboo cane	Of great ufe in China, and might be alfo in our American iflands.*
Anacardus Orientalis	Kæmpffer Amœn. p. 793	Siam varnifh tree called Tonrack by the Japonefe	The fruit of this is the Malaca bean, or marking nut, and the Oriental Anacardium of the fhops. This is the common varnifh of the Eaft-Indies, as defcribed by Kœmpffer. This tree is unknown to the botanifts.
Thea	p. 734	Tea	From Japan and China. See Kæmpffer's Amœnitates, p. 60. †
Gardenia Florida	p. 305	Umky of the Chinefe	Ufed in dying fcarlet in China. The pulp that furround the feeds, gives in warm water a moft excellent yellow colour, inclining to orange. See Phil. Tranf. Vol. 52, p 654, where there is an exact figure of it.
Magnifera Indica	p. 290	Eaft-India Mango tree	This excellent fruit is much efteemed in the Eaft-Indies, and it is faid there is a tree of it now growing in the ifland of Madeira. By the defcription which Dr. Solander gives of this fruit, at Rio Janeiro in Brazil, it is not fo good as the Eaft-India fort.
Morus papyrifera	p. 1399	Paper Mulberry tree	Ufed for making paper in China and Japan. See Kæmp. Amœnit. p. 467. This has been fome time in the Englifh gardens.
Cinchona Officinalis	p. 244	Jefuits Bark tree	This grows at Loxa, in the province of Peru; and could it be obtained fo as to be cultivated in our American iflands, would be of infinite advantage to us.
Dorftenia Contrayerva	p. 176	Contrayerva root	This grows in New-Spain, Mexico, and Peru.
Smilax Sarfaparilla	p. 1459	Sarfaparilla root	It is brought from the Bay of Campeachy, and the gulph of Honduras, where it grows in plenty, and might eafily be propagated in Florida.
Copaifera Officinalis	p. 557	Balfam Copaiva tree	In Brazil, and Martinico.
Toluifera Balfamum	p. 549	Balfam Tolu tree	This tree grows near Carthagena, in South-America.
Hymenea Courbaril	p. 537	The Locuft or Gum Copal tree for the fineft tranfparent varnifh	This tree is known to yield the true Gum Copal, and that the difference between this and Gum Anime, may be owing to foil and heat of climate; it grows wild in our American iflands, the Mufquito Shore, and in Terra Firma.
Jalapium Officinarum	Dale 183	True Jalap	This plant is fuppofed by fome to be a kind of Bindweed or Convolvulus, that grows near Mexico; by others it is thought to be a fpecies of Marvel of Peru. As we are uncertain of the genus, it is well worth enquiring into, as a moft ufeful drug, in order to propagate it in our colonies.

Bixa

* The French had brought this moft ufeful plant from the Eaft-Indies to their Weft-India Iflands: A few roots have been got from thence to Grenada, and will perhaps in time become familiar in our iflands. But too much pains cannot be taken in the propagation of this plant, as it's ufes are manifold and extenfive, both in building, and all kinds of domeftic inftruments.

† It is afferted by fome people, that the green tea and the bohea tea are two different fpecies, but without foundation; they are one and the fame fpecies. It is the nature of the foil, the culture, and manner of gathering and drying the leaves, that makes the difference; for take a green tea tree and plant it in the bohea country, and it will produce bohea tea, and fo the contrary. This is a fact attefted by gentlemen now in London, that have refided many years in China, and who have had great experience in this article.

Latin Names.	2d Ed. L. Sp.	*Engliſh Names.*	*Obſervations.*
Bixa Orellana	Lin. Sp. 730	Arnotto, for dying	This grows in all the warm climates of America. The French cultivate it, but what the Spaniards ſend is much richer in colour, and more valuable.
Mimoſa Senegal	p. 1506	Gum Senegal tree	This grows in Egypt, and in Senegal.
Mimoſa Nilotica	p. 1506	Gum Arabic	In Egypt, from whence the ſeeds may be procured.
Ficus Sycomorus	p. 1513	True Sycamore of Zacheus	This is reckoned the moſt durable timber we know. The repoſitories of the Mummies found in Egypt are made of this timber.
Ficus Carica	p. 1513	Turkey Figs	Figs grow in the greateſt perfection in Carolina, and would become a valuable trade if they had the method of curing them as in Turkey.
Vitis Apyrena	p. 293	Currants, or Corinthian grapes	The cuttings of this vine might be procured from Zant.
Fraxinis Ornus	p. 1510	Calabrian Manna Aſh *	This is worth trying in our ſouthern colonies, where the heats are violent in the ſummer. It is common in our nurſery gardens.
Amygdalus Communis	p. 677	Sweet Almonds	Theſe would grow to great perfection in our ſouthern colonies.
Capparis Spinoſa	p. 720	Caper tree	This ſhrub requires a rocky ſoil to grow in, as it is about Marſeilles and Toulon.
Punica Granatum†	p. 676	Balauſtians or the bloſſoms of the double flowering pomgranate	This tree would thrive extremely well in our ſouthern provinces, and yield a profitable article in their bloſſoms. Plants of this kind are to be bought from moſt of our nurſery men.
Lichen Roccella	p. 1622	Argal, Canary-weed or Orchell	'Tis poſſible this valuable plant may be found in our American iſlands, as well as in the Canaries and Cape Verd iſlands.
Ciſtus Ladanifera	p. 737	Gum Labdanum	In Spain and the Archipelago.
Bubon Galbanum	p. 364	Gum Galbanum	In Ethiopia.
Paſtinaca Opoponax	p. 376	Gum Opoponax	In Sicily.
Amomum Cardamomum.	p. 2	Cardamums	In the Eaſt-Indies.
Curcuma Longa	p. 3	Tumerick	In the Eaſt-Indies.
Aſtragalus Tragacantha	p. 1073	Gum Tragacanth or Gum Dragon	In the ſouth of France and in Sicily.
Cucumis Colycinthis	p. 1435	Coloquintida, or bitter apple	In Africa.
Gentiana lutea	p. 329	Gentian	In the Alps, Apennines, and Pyrenees. To be had of the nurſery men.
Similax China	p. 1459	China root	In China, and in New Spain.
Pimpinella Aniſum	p. 379	Aniſe ſeeds	In Egypt.
Gambogia Gutta	p. 728	Gamboge	In the Eaſt-Indies.
Quercus Coccifera	p. 1413	Alkermes oak	About Marſeilles and Toulon.
Myrrha Offic.	Dale. 325	Gum Myrrh	In Abyſſinia. The characters of this plant and the five following, are not yet known to the botaniſts.
Benzionum Offic.	Dale. 303	Gum Benjamin	In Sumatra and Java.
Ammoniacum Offic.	Dale. 119	Gum Ammoniacum	In Africa.
Balſamum Peruanum	Dale. 337	Natural Balſam of Peru	In Peru.

Olibanum

* There is no drug ſo liable to adulteration as this: And therefore, as it is a medicine ſo frequently in uſe among perſons of tender conſtitutions, eſpecially young children, great care ſhould be taken to have it genuine.

† The ſingle flowering or fruit-bearing Pomegranate, will afford the moſt grateful addition to the fruits of our colonies, and a valuable medicine. The ripe fruit full of ſeeds is to be met with at our fruit-ſhops in the winter ſeaſon: From the ſeeds of ſuch fruit this tree may be eaſily propagated.

Latin Names.	2d Ed. L. Sp.	*English Names.*	*Observations.*
Olibanum Thus Masculum	Dale. 348	Frankincense	In the Upper Egypt and interior parts of Africa.
Nux Moschata Offic.	Dale. 302	Nutmegs with Mace *	In Amboyna.
Caryophylus aromaticus	Lin. Sp. 735	Cloves	In the Molucca islands.
Piper Nigrum	p. 40	Pepper	Sumatra.
Garcinia Mongastona	p. 635	Mangosteens	A most delicious fruit, grows in Java, and in several parts of the East-Indies.
Lechee		Lechee of China	This fruit is highly commended by all persons who have been in China. ‖
Ipecacuanha	Dale 170 Margrave 17	Ipecacuanha of the shops or Brazilian root	Very useful in medicine, and worthy of our attention to propagate it in our West-India islands: At present it's genus is unknown to the botanists.
Ferula Assa Fœtida	Lin. Sp. 356	Assa Fœtida, or Devil's dung, called Hing in the Malay language.	The gum of this plant is much used in medicine. Kæmpf. 535 and 536.

* Specimens of the Nutmeg-tree in fruit from the island of Tobago have been lately received by the Earl of Hillsborough, which his Lordship has sent, with specimens of many other curious plants, for the information of the public, to the British Museum. They are certainly of the same genus with the true nutmeg, and possibly may be improved by cultivation; the mace evidently covers them, and they have all the characters and the same leaves with the wild nutmeg tree described by Rumphius, in his Herbarium Amboinense, published by Burman.

‖ The characters of this fruit are not yet known to the botanists.

To this catalogue may be added liquorice, saffron, and aloes socotrina: Of the two first we do not raise near a sufficiency at home for our own consumption, but are obliged to import those articles from Spain.

The Society having thought proper to give a place to the foregoing Catalogue; it may be necessary to subjoin some DIRECTIONS, *(taken also from Mr. Ellis's Pamphlet, for bringing over Seeds and Plants from distant Countries in a state of Vegetation.*

MANY valuable trees and plants, yet unknown to us, grow in distant countries, particularly in the northern provinces of China, about the latitude of 40 degrees, which would thrive well in North-America, more especially in these middle colonies, which lie about the same latitude. But as the distance is great, the manner of preserving the seeds properly, so as to keep them in a state of vegetation, is an affair of considerable consequence and some difficulty. The following hints are therefore offered for that purpose.

In

In the firſt place it ought to be carefully attended to, that the ſeeds ſhould be perfectly ripe when they are gathered; and they ſhould be gathered, if poſſible, in dry weather; afterwards they ſhould be ſpread thin on paper or matts, in a dry airy room, but not in ſunſhine. The time neceſſary for this operation will vary according to the heat of the climate, or ſeaſon of the year, from a fortnight to a month, or perhaps two may be neceſſary; the hotter the ſeaſon, the leſs time will ſuffice. This is to carry off their superfluous moiſture, which if confined would immediately turn to mouldineſs, and end in rottenneſs.

As there are two methods that have ſucceeded, and put us in poſſeſſion of ſeveral young plants of the true tea-tree of China, I ſhall mention them both, in order to aſſiſt the collector in bringing home the ſeeds of many valuable plants.

The firſt is by covering them with bees-wax in the manner explained in Phil. Tranſact vol. LVIII. p. 75.

It principally conſiſts in chooſing only ſuch ſeeds as are perfectly ſound and ripe. To prove this, we muſt cut open ſome of them to judge what ſituation the reſt may be in, taking care to lay aſide any that are outwardly defective, or marked with the wounds of inſects. When a proper choice of them is made, they ſhould be wiped extremely clean, to prevent any dirt or moiſture being incloſed; each ſeed then ſhould be rolled up carefully in a coat of ſoft bees-wax half an inch thick: The deep yellow Engliſh bees-wax is the beſt. When you have covered the number you intend to incloſe, pour ſome of this bees-wax melted into a chip-box of ſeven inches long, four broad, and three deep, till it is above half full; and juſt before it begins to harden, while it is yet fluid, put in the ſeeds you have rolled up in rows till the box is near full; then pour over them ſome more wax while it is juſt fluid, taking care when it is cold to ſtop all the cracks or chinks that may have proceeded from the ſhrinking of the wax, with ſome very ſoft wax; then put on the cover of the box, and keep it in as cool and airy a place as you can.

The

The method of inclofing tea-feeds fingly in wax, and bringing them over in that ftate, has been practifed for fome time; but few have fucceeded, owing to the thinnefs of the coat of wax, or putting paper firft round them, or inclofing them too moift.

To this I muft add a method that promifes fuccefs for bringing over plants from the Weft-Indies, and the fouthern parts of North-America, particularly Weft-Florida, the voyage from hence being longer than from the Weft-Indies, and more attention is required to keep the plants in health, than from any other parts of our North-American fettlements: But as there is a good deal of difference in the climates of thefe places, it will be neceffary to obferve, that plants from the Weft-Indies fhould be put on board in the latter end of fpring, fo as to arrive here in warm weather, otherwife they will be deftroyed by the cold of this latitude; and the ever-greens, which are the moft curious from Weft-Florida, muft be fent in the winter months, while their juices are inactive, fo as to arrive here before the heats come on. If the plants fent from thefe countries were planted in pots or boxes, and kept there a year, they might be brought over with very little hazard; or even if they were firft tranfplanted from the woods into a garden, till they had formed roots, they might be fent with much more fafety.

The fize of the boxes that will be moft convenient for ftowing them on board merchant-fhips, where there is very little room to fpare, fhould be three feet long, fifteen inches broad, and from eighteen inches to two feet deep, according to the fize of the young trees; but the fmalleft will be moft likely to fucceed, provided they are well rooted. There muft be a narrow ledge nailed all round the infide of the box, within fix inches of the bottom, to faften laths or packthread to form a kind of lattice-work, by which the plants may be the better fecured in their places. If the plants are packed up juft before the fhip fails, it will be fo much the better.

When

When they are dug up, care muſt be taken to preſerve as much earth as can be about their roots; and if it ſhould fall off, it muſt be ſupplied with more earth, ſo as to form a ball about the roots of each plant, which muſt be ſurrounded with wet moſs, and carefully tied about with packthread, to keep the earth about the roots moiſt: Perhaps it may be neceſſary to encloſe the moſs with ſome paper or broad leaves (as the palmetto) that the packthread may bind the moſs the cloſer. Loamy earth will continue moiſt the longeſt. There muſt be three inches deep of wet moſs put into the bottom of the box, and the young trees placed in rows upright cloſe to each other, ſtuffing wet moſs in the vacancies between them and on the ſurface; over this palmetto leaves, if to be had, ſhould be put to keep in the moiſture, and over them the laths are to be faſtened croſs and croſs to the ledges or packthreads to be laced to and fro, to keep the whole ſteady and tight. The lid of the box ſhould be either nailed down cloſe, or may have hinges and a padlock to ſecure it from being opened, as may be found neceſſary, with proper directions marked on it to keep the lid uppermoſt. There muſt be two handles fixed, one at each end, by which means there will be leſs danger of diſturbing the plants. Near the upper part of the ends of the box, there muſt be ſeveral holes bored to give air: Or in making the box there may be a narrow vacancy left between the boards of one third of an inch wide, near the top, to let out the foul air; and perhaps it may be neceſſary to nail along the upper edge of theſe openings liſt, or ſlips of ſail-cloth, to hang over them, to ſecure the plants from any ſpray of the ſea; and at the ſame time it will not prevent the air from paſſing through. Boxes with plants packed in this manner, muſt be placed where there is free air, that is, out of the way of the foul air of the ſhip's hold.

The following method of preſerving ſeeds from turning rancid from their long confinement, and the great heat of the climates which they muſt neceſſarily paſs through from China,

China, was communicated to me ſome years ago by the celebrated profeſſor Linnæus, of Upſal, in Sweden. He adviſes, that each ſort of ſeed ſhould be put up in ſeparate papers, with fine ſand among them, to abſorb any moiſture (dried, loamy or ſoapy earth may be tried): Theſe papers, he ſays, ſhould be packed cloſe in cylindrical glaſs, or earthen veſſels, and the mouths covered over with a bladder, or leather tied faſt round the rims: he then directs that theſe veſſels, with the ſeeds in them, ſhould be put into other veſſels, which ſhould be ſo large, that the inner veſſel may be covered on all ſides, for the ſpace of two inches, with the following mixture of ſalts. Half common culinary ſalt; the other half to conſiſt of two parts of ſalt-petre, and one part of ſal-ammoniac, both reduced to a powder, and all thoroughly mixed together, to be placed about the inner veſſel, rather moiſt than dry. This he calls a refrigeratory; and ſays it will keep the ſeeds cool, and hinder putrefaction. Perhaps if ſmall tight boxes, or caſks or bottles of ſeeds were incloſed in caſks full of ſalts, it might be of the ſame uſe, provided the ſalts do not get at the ſeeds; and as ſal-ammoniac may not be eaſily met with, half common ſalt, and the other half ſalt-petre, or common ſalt alone, might anſwer the ſame end. But it would be very neceſſary to try both methods, to know whether the latter would anſwer the purpoſe of the former, as it would be attended with much leſs trouble, and might prove a uſeful method to our ſeedſmen, in ſending ſeeds from hence to thoſe warm climates.

The ſmalleſt ſeeds being very liable to loſe their vegetative power by long voyages through warm climates, it may be worth while to try the following experiment upon ſuch kinds as we know for certain are ſound. Dip ſome ſquare pieces of cotton cloth in melted wax, and while it is ſoft and almoſt cold, ſtrew the ſurface of each piece over with each ſort of ſmall ſeed, then roll them up tight, and incloſe each roll in ſome ſoft bees-wax, wrapping up each of them in a piece of paper, with the name of the ſeed on it; theſe may be either ſurrounded as before with ſalts, or packed without the ſalts, in a box, as is moſt convenient,

There are many ſeeds, which we receive both from the Weſt-Indies and the ſouthern parts of our North-American colonies, as South-Carolina, Georgia, &c. which the gardeners find very difficult to raiſe here, unleſs the following method is purſued. Divide a box, according to your quantity and ſorts of ſeeds, into ſeveral ſquare partitions; then mix the ſeeds with loamy earth and cut moſs, and put each ſort into its ſeparate cell, filling it up to the top: The earth and moſs muſt be rather inclining to dry than wet; then nail the lid down very cloſe on your box, keeping it in an airy ſituation. If the voyage does not exceed two months, they will arrive in good order in the ſpring; and, though many of them may begin to germinate, yet, if they are ſown directly, they will ſucceed much better than thoſe that are brought over in papers, as is well known to our moſt curious gardeners. Seeds of the nutmeg-tree from Tobago, the cinnamon-tree, the cocoa or chocolate-nut, and Avocado pear, muſt be brought in this manner. Seeds of all the ſorts of magnolias, ſtewartias, chionanthus, and many others from South-Carolina, will ſucceed better this way, than any other method we yet know.

The ſeeds of many of the ſmall ſucculent fruits may be brought to England from very diſtant parts, by preſſing them together, ſqueezing out their watery juices, and drying them in ſmall cakes gradually, that they may become hard; they may be then wrapt up in white writing paper, not ſpongy, as this is apt to attract and retain moiſture; but I believe it will be found, that a covering of wax will be better than one of paper.

The Alpine ſtrawberry was firſt ſent to England in a letter from Turin to *Henry Baker* Eſq; F. R. S. by preſſing the pulp with the ſeeds thin upon paper, and letting it dry before they were incloſed. The paper mulberry from China was brought hither about the year 1754, much in the ſame manner. Theſe

Theſe hints may prompt us to try the larger ſucculent fruits; for inſtance, the mangoes, lechees, and others of this kind: If their fleſhy part, when they are very ripe, was brought to the conſiſtence of raiſins or dried figs, it would keep their kernels plump, and in this ſtate they might be better preſerved in wax, than by any other method yet known.

An Attempt to account for the CHANGE *of* CLIMATE, *which has been obſerved in the Middle Colonies in North-America.* *By* HUGH WILLIAMSON, *M. D.* *Read before the Society, Auguſt* 17*th*, 1770.

IT is generally remarked by people who have reſided long in Pennſylvania and the neighbouring colonies, that within the laſt forty or fifty years there has been a very obſervable change of climate, that our winters are not ſo intenſely cold, nor our ſummers ſo diſagreeably warm as they have been.

That we may be enabled to account for theſe phœnomena it will be neceſſary to take a tranſient view of the general cauſe of winds, and the remarkable difference of heat and cold, that is obſerved in different countries under the ſame parallels.

Though the Sun is doubtleſs the general ſource of heat, yet we obſerve that countries are not heated in proportion to their diſtance from the Sun, nor even in proportion to their diſtance from the equator. The inhabitants of the polar circles are hardly a perceivable diſtance, not a twenty-thouſandth part farther from the Sun, than thoſe between the tropics, yet the former are chilled with perpetual cold, while the others are ſcorched with conſtant heat.

When the rays of the Sun ſtrike the Earth in a perpendicular direction, they will be reflected in the ſame direction on the particles of air through which they have paſſed, and thus increaſe their heat; a greater number of direct rays will alſo ſtrike the earth in any given ſpace, than when

when they fall obliquely; therefore, the nearer the direction of the Sun's rays is to a perpendicular with the surface of the earth, the greater, *cætera paribus*, will the heat be. Hence, countries ſhould be colder the nearer they are to the poles. But,

We obſerve that the air may be heated to a very different degree in different countries, which are in the ſame latitude, according as they abound in rough mountains, fertile plains, or ſandy deſerts; as they are ſurrounded by land or by ſea, or according to the different wind, which prevail in thoſe countries. The temperature of Pennſylvania is very different from that of Portugal; and the temperature of England is different from that of Saxony, on the neighbouring continent, though they be under the ſame parallels. In order then that we may be enabled to form an eſtimate of the heat of any country, we muſt not only conſider the latitude of the place, but alſo the face and ſituation of the country, and the winds which generally prevail there, if any of theſe ſhould alter, the climate muſt alſo be changed. The face of a country may be altered by cultivation, and a tranſient view of the general cauſe of winds will convince us, that their courſe may alſo be changed.

It is generally believed that moſt winds are occaſioned by the heat of the Sun. Were the Sun to ſtand ſtill over any particular part of the ſurface of the earth, the wind would conſtantly blow to that place from all directions. For the air in that part being rarified by the heat of the ſun, would be expanded and thus become lighter, whence it would aſcend, and the heavier air in the neighbouring parts would ruſh in, to occupy it's place; this too being heated both by the ſun's rays, and by the warm ſurface of the earth, would inſtantly aſcend to give place to that which was colder. But as the ſun moves, or ſeems to move, between the tropics, from Eaſt to Weſt, there ſhould be a conſtant current of air ſetting towards the ſun from the North, South, and Eaſtward, while the current, which would

would alſo come from the Weſt, is prevented or turned back by the ſun, who moves with great rapidity on the oppoſite direction. The current coming from the North and South falls in with that from the Eaſtward, and is preſently bent in the ſame direction. This conſtitutes what ſeamen call a *trade wind;* ſuch is found in the Atlantic and in the Great South Sea.

Were the ſurface of the earth homogeneous, were it all covered with water, or all ſmooth dry land, the eaſterly winds would always prevail quite round the globe to ſome diſtance beyond the tropics. But the waters along the equator are divided by two or three conſiderable portions of land, which retain the heat in a different manner from the water, and reflect the ſun's rays in very different proportions, ſo that they not only ſtop the eaſterly current of air, but often change it to the oppoſite direction. For along the weſterly coaſt of Africa, and South-America, the winds commonly blow from the weſt. That is to ſay, they blow from a cold ſurface to that which is warmer, they blow from the ſea in upon the land. For,

In warm countries, or in the warm ſeaſon of any country, the ſurface of the land is warmer than the ſurface of the water.

In cold ſeaſons of temperate countries, the ſurface of the land is colder than the ſurface of the water:

The ſurface of the earth being immovably expoſed to the ſun, receives and retains the heat, and grows warmer by every adventitious ray; ſo that a hard ſmooth ſurface will ſometimes become intolerable to the touch, but the heat does not ſink deep, except in a conſiderable progreſs of time.

The ſurface of the ſea is not ſoon heated, for the particles which are uppermoſt this hour, will preſently be overwhelmed by thoſe which are colder, and they by others in ſucceſſion; whence it happens, that though the ſurface of the ſea will not become ſo warm by a ſummer's heat as the ſurface of the earth in the ſame climate, yet the heat will penetrate deeper, and be longer retained. Let

Let us transfer these trite and general reafonings to the fituation of our middle colonies, with refpect to land and water. Our coaft runs nearly from North-Eaft to the South-Weft, fo that if the land fhould at any time be colder than the fea, and a current of cold air fhould fet towards the fea, it muft pafs from the North-Weft to the South-Eaft: But fuch winds we find generally take place during our winter feafon. For the Atlantic to the South-Eaftward, is greatly heated during the fummer feafon, and will not foon lofe that heat when the fun goes to the Southward in the winter; add to this, a very notable circumftance, which is, that our coaft is conftantly wafhed by a current of warm water, which being driven to the Weft by the eafterly trade winds near the equator, is checked in the gulph of Mexico, and obliged to efcape to the North-Eaftward, to give place to the fucceeding current. But the furface of thefe colonies foon grows cold in the abfence of the Sun. Hence violent torrents of winds pafs towards the Atlantic during the winter feafon; the colder the air is over the continent, the more violent will thofe North-Wefters be.

Can we difcover any change of circumftances, which might reduce the violence of thofe North-Wefters, or remove them entirely? It is very obvious that hard fmooth furfaces reflect heat better than thofe which are rough and unequal; the furface of a looking glafs, or any polifhed metal, will reflect more light and heat, than the rough furface of a board. In the fame manner we obferve, that rocks and fmooth beds of fand reflect more heat, than a foft broken furface of clay. A clear fmooth field alfo reflects more heat, than the fame fpace would have done, when it was covered with bufhes and trees.

If the furface of this continent were fo clear and fmooth, that it would reflect fo much heat as might warm the incumbent atmofphere, equal to the degree of heat produced by the neighbouring Atlantic, an equilibrium would be reftored, and we fhould have no ftated north-weft winds: But

But we have already made confiderable approaches to this very period, feveral members of the Society muft have obferved, that our North-Weft winds, during the winter feafon are lefs frequent, lefs violent and of fhorter continuance, than formerly they were. Seamen, who are deeply interefted in this fubject inform us, that in the winter feafon they have been beating off our coaft three, four, or five weeks, not able to put in, by reafon of the North-Wefters; they are now feldom kept off twice that number of days. It is alfo agreed, that the hardnefs of our frofts, the quantity and continuance of our fnows, are very unequal now, to what they have been, fince the fettlement of this province.

It has been objected, that the fmall alteration which the furface of a country undergoes in being cleared and cultivated, is not equal to producing fuch confiderable changes of climate, as has been obferved to take place in many parts of the world. I fhall not fay, that a change of climate may not arife from other caufes than the one I have defcribed. It is very certain that the fimple folution of water in air will produce cold, which may be increafed by a folution of nitrous falt. There are fundry other caufes, from which the heat of the air may be increafed or diminifhed, yet I cannot recollect a fingle inftance of any remarkable change of climate, which may not be fairly deduced from the fole cultivation of the country. The change which has happened in Italy, and fome countries to the eaftward, within the laft feventeen centuries, is thought to be a ftrong objection to this general rule. It is faid, "that Italy was better cultivated in the Auguftine age than "it is now; but the climate is much more temperate now "than it was at that time. This feems to contradict the "opinion, *that the cultivation of a country will render the* "*air more temperate.*"

I fhall confider this obfervation the more attentively, becaufe I find it has been made by an ingenious writer, of great claffical erudition.*

It

* See Philofophical Tranfactions, vol. 58.

It is not to be diſſembled that their winters in Italy were extremely cold about ſeventeen hundred years ago. Virgil has carefully deſcribed the manner in which cattle are to be ſheltered in the winter, leſt they ſhould be deſtroyed by the froſt and ſnow; he alſo ſpeaks of wine being frozen in the caſks, and ſeveral other proofs of ſuch extreme cold, as would ſurprize us in this province. Though it is alſo clear, that the Italians are now as great ſtrangers to cold and froſt, as thoſe of Georgia or South-Carolina. To account for this remarkable change, we muſt go beyond the narrow limits of Italy; we muſt traverſe the face of Hungary, Poland and Germany, thoſe vaſt regions to the northward of Rome. The Germans have certainly made immenſe progreſs in population and agriculture, ſince Julius Cæſar with a few legions overran that country; for notwithſtanding the elegance with which Cæſar deſcribes his victories, he certainly had to contend with a ſett of barbarians and ſavages, whoſe country was rude and uncultivated as their minds. The general face of thoſe kingdoms was covered with wild extenſive forreſts, a few of which remain to this day. The ſmall ſcattered tribes who occupied them, had done very little towards the perfection of agriculture. From theſe uncultivated deſerts piercing North-Winds uſed to deſcend in torrents on the ſhivering Italian, though his own little commonwealth were finely cultivated. No perſon need be informed how numerous the nations are, who now inhabit Hungary, Poland and Germany, or how generally thoſe regions are now cultivated, even to the very edge of the Baltic and German Ocean, ſo that if the cold is greatly moderated in Germany, and the adjacent Northern ſtates, which I believe is generally allowed, we may eaſily perceive how it ſhould be moderated to a much greater degree in Italy, which being in a low latitude was only annoyed by the cold winds from the Northern kingdoms. For the air was at that time ſo cold over thoſe uncultivated regions, that it could effectually deſtroy the balance in the warmer atmoſphere of Italy, which at preſent is not the caſe. As

As we might have conjectured from eftablifhed principles of philofophy, that clearing and fmoothing the face of a country, would promote the heat of the atmofphere, and in many cafes would prevent or mitigate thofe winter blafts, which are the general origin of cold, whence the winters muft become more temperate, and as facts appear to fupport and confirm our reafoning on this fubject, we may rationally conclude, that in a feries of years, when the virtuous induftry of pofterity fhall have cultivated the interior part of this country, we fhall feldom be vifited by frofts or fnows, but may enjoy fuch a temperature in the midft of winter, as fhall hardly deftroy the moft tender plants.

Perhaps it may be apprehended, that as clearing the country, will mitigate the cold of our winters, it will alfo increafe the heat of our fummers; but I apprehend, that on a careful attention to this fubject we fhall find, that the fame caufe will in thofe feafons appear to produce different effects, and that inftead of more heat, we fhall prefently have lefs in fummer than ufual.

It is well known, that during the greateft fummer heats of this or any other country, the extraordinary heat of the atmofphere does not rife to any confiderable height. In the upper regions it is perpetually cold, both becaufe the air in thofe parts is too far from the earth, to be warmed by the heat of its furface, and becaufe the air in thofe regions not being preffed by fuch a weight of incumbent atmofphere is too rare to be fufceptible of a great degree of heat; for the heat of the air, as of every other body, that is warmed by the Sun, depends not only upon the fimple action of the particles of light upon thofe of the air, but alfo upon the mutual action of the particles of air upon one another, which, by their elafticity, propagate or continue that motion, called heat, which was originally excited by the Sun's rays. Therefore, the rarer the atmofphere is, the lefs heat will be produced therein by the Sun, *& vice verfa.* Hence we obferve, that in the warmeft countries the tops of mountains are always covered with ſnow. Whoever will carry a thermometer on a very warm day to the top of an high ſteeple, will find that the mercury immediately falls ſeveral degrees, and riſes again as he deſcends. From this it is obvious that nothing is wanting in the midſt of ſummer to render the country agreeably cool, but a proper mixture of the cold air which is above, with the warm air below. This would be effected by any cauſe that might increaſe our ſummer winds. For though the ſimple motion of the air does not by any means produce cold, yet, moderate blaſts will naturally introduce a colder atmoſphere, eſpecially when they paſs over hills or any unequal ſurface, by which the equilibrium of the atmoſphere is deſtroyed, the cold air always tending towards the ſurface. Hence a ſummer's guſt is generally attended by a ſudden change in the temperature of the air. Tall timber greatly impedes the circulation of the air, for it retards the motion of that part which is near the ſurface, and which, from its denſity and ſituation being moſt heated, becomes the general origin of ſuch agitations as take place in the upper regions. We ſhall often find it extremely ſultry and warm in a ſmall field, ſurrounded by tall woods, when no ſuch inconveniency is perceived on an extenſive clear plain in the neighbourhood. From theſe particulars we may conclude, that when this country ſhall be diverſified, as it muſt be in a ſeries of years, by vaſt tracts of clear land, interſected here and there by great ridges of uncultivated mountains, a much greater degree of heat being reflected by the plains than from the neighbouring mountains, and an eaſy circulation of air produced on the plains; our land winds in ſummer, to ſay nothing of thoſe which come from the ſea, or from the lakes, muſt certainly be much freſher and more frequent than they now are, and conſequently our ſummer heats be more temperate.

A conſiderable change in the temperature of our ſeaſons may doubtleſs effect a change in the produce of our lands.

Temperate

Temperate ſeaſons muſt be friendly to meadows and paſturage, provided we continue to get regular ſupplies of rain; but of this, there is ſome reaſon to doubt, unleſs our mountains, with which this country happily abounds, ſhould befriend us greatly. The decreaſe of our froſts and ſnows in winter, muſt for many years prove injurious to our wheat and winter's grain. The viciſſitudes of freezing and thawing have already become ſo frequent, that it is high time for the farmer to provide ſome remedy, whereby he may prevent his wheat from being thrown out in the winter ſeaſon.

A conſiderable change in the temperature of our ſeaſons, may one day oblige the tobacco planter to migrate towards the Carolinas and Florida, which will be the natural retreat of that plant, when the ſeaſons admoniſh the Virginian to cultivate wheat and Indian corn. The tender vine, which would now be deſtroyed by our winter's froſt, in a few years ſhall ſupply the North-American with every ſpecies of wine. Poſterity will doubtleſs tranſplant the ſeveral odoriferous, aromatic, and medicinal plants of the eaſtern countries, which muſt flouriſh in one or another part of North-America, where they will find a climate and ſoil favourable to their growth, as that of their native country.

Every friend to humanity muſt rejoice more in the pleaſing proſpect of the advantages we may gain in point of health, from the cultivation or this country, than from all the additional luxuries we may enjoy, though both the Indies were brought to our doors. The ſalutary effects which have reſulted from cleanſing and paving the ſtreets of Philadelphia, are obvious to every inhabitant. For cauſes ſomewhat ſimilar to theſe, the general improvement of the colonies have already produced very deſirable effects. While the face of this country was clad with woods, and every valley afforded a ſwamp or ſtagnant marſh, by a copious perſpiration through the leaves of trees or plants, and a general exhalation from the ſurface of ponds and

marſhes,

marſhes, the air was conſtantly charged with a groſs putreſcent fluid. Hence a ſeries of irregular, nervous, bilious, remitting and intermitting fevers, which for many years have maintained a fatal reign through many parts of this country, but are now evidently on the decline. Pleuritic and other inflammatory fevers, with the ſeveral diſeaſes, of cold ſeaſons, are alſo obſerved to remit their violence, as our winters grow more temperate.

Since the cultivation of the colonies, and the conſequent change of climate, has ſuch effects on the diſeaſes of the human body, and muſt continue to produce ſuch remarkable changes in their appearance, it is certainly the duty of every phyſician, to be careful to trace the hiſtory of every diſeaſe, obſerve the ſeveral changes they undergo, and mark, with a jealous attention, the riſe of every new diſeaſe, which may appear on the decline of others, that ſo he may be enabled to bring effectual and ſeaſonable relief to ſuch perſons, as may be committed to his care.

SECT. III.

MISCELLANEOUS PAPERS.

An account of the Eruption of VESUVIUS, in 1767, *communicated in a letter from an Engliſh gentleman reſiding at Naples, to* JOHN MORGAN, *M. D. F. R. S. and Profeſſor of Medicine in the College of Philadelphia.*

NAPLES, *November* 3, 1767.

SIR,

WE have had a moſt extraordinary eruption of Veſuvius lately. As I imagine an account of the diſturbance it has given us will not be diſagreeable to you, I ſhall therefore do myſelf the pleaſure of communicating to you what I know, and have ſeen myſelf, of this ſurpriſing phænomenon.

The

The beginning of it is exactly defcribed in Pliny the younger's letter to Tacitus*. The firft alarm was taken from a column of black fmoke, thrown out with fuch violence as to appear like an immenfe pine, branching out on all fides after a great height of trunk, when the diminution of the force that threw it out, allowed the air to operate by fpreading it. The whole mountain was foon wrapped round with utter darknefs; and it's place was only to be diftinguifhed by the many ftreams of fire that were darted in different directions, and made this darknefs vifible†.

It appeared to me very unaccountable at firft, but I afterwards found, by the affiftance of my glaffes, that thefe different directions were produced by the particular motion impreffed upon the fire, as it iffued from the feveral mouths which gave vent to Vefuvius. It was very extraordinary to obferve fome of thefe ftreams defcending perpendicularly, whilft others mounted upwards in a ftraight line. The former appearance was owing to innumerable ignited ftones in their fall, after having been thrown from fome fuperior aperture, that acquired fuch velocity from their weight, and fuch a blending of light from their proximity, as to feem one impetuous torrent of fire; though on the ufual appearance of thefe falling ftones, they are fcattered, and are plainly to be diftinguifhed as feparate bodies.

All this, as a mere object of fight, would rather have been amufing; but a frequency of the moft terrible explofions made it very alarming, efpecially to me, in a houfe that fhakes with the leaft motion. The noife of the largeft cannon

* As it may give the curious reader pleafure to compare the above defcription with the more ftriking paffages of Pliny the younger's letter, on the fame fubject, we have here fubjoined them.

" Nubes, incertum procul intuentibus ex quo monte, Vefuviam fuiffe poftea cognitum eft, oriebatur: cujus fimilitudinem & formam non alia magis arbor, quam Pinus expreflerit. Nam longiffimo velut trunco efflata in altum, quibufdam ramis diffundebatur. Credo quia recenti fpiritu evecta, dein fenefcente eo deftituta, aut etiam pondere fuo victa, in latitudinem vanefcebat, candida interdum, interdum fordida & maculofa, prout terrem cineremve fuftulerat

Plinii Epiftol. xvi. *lib.* vi.

† " Interim e *Vefuvio* monte pluribus locis latiffime flammæ atque incendia relucebant, quorum fulgor & claritas tenebras noctis excipiebat.

" Jam dies alibi, illic nox omnibus noxibus nigrior denfiorque, quam tamen faces multæ variaque lumina folvebant." *Ibidem.*

" Ab altero latere nubes atra & horrenda ignei fpiritus tortis vibratifque difcurfibus rupta, in longas flammarum figuras dehifcebat, fulgoribus illæ & fimiles, & majores erant.

Plinii Epiftol. xx. *lib.* vi.

cannon fired from the caſtle, not three hundred yards from me, is a mere whiſper to theſe exploſions. My little houſehold had retreated to the rooms backward, built againſt the hill, and I made moſt of my obſervations in the doorway of my neweſt and thickeſt wall. One or two, however, the moſt ſevere of theſe ſhocks, that raiſed my man, who 'till then had kept by me, from the ground, cauſed me to heſitate, and think of making a prudent retreat; * but it occurred to me on a little reflection, that the ſtreets might have been equally dangerous from mixing with a tumultuous concourſe of people, thronging after the pictures of Madona, and of the ſaints carried in proceſſion, with which the whole city was crowded all night: I thought it moſt prudent, therefore, to keep out of the way. The ſhocks afterwards abated, or I was more uſed to them, and a moſt comfortable † lava made its ſally, from a ſeeming opening in the whole ſide of the mountain at once, and ruſhed forward with an impetuoſity that in two hours, brought it within two miles of Portici‡, which quieted me for that night. The King was then at his palace there, which Veſuvius ſeemed to be reclaiming from his Majeſty's encroachments. The place was by no means held tenable againſt him; and the King, the courtiers, and numbers of families, then in theſe environs at their Villegiatura§, were put to the route at midnight: Some of the court thought themſelves not ſecure even when they reached Naples, and, I am told, continued their flight to Caſerta ‖.

The

* "In commune conſultant, intra tectane ſubſiſtant, an in aperto vagentur; nam crebris vaſtique tremoribus tecta nutabant, & quaſi emota ſedibus ſuis, nunc huc, nunc illuc abire aut referri videbantur." *Plinii Epiſtol.* xx. *lib.* vi.

† The melted fiery matter thrown out by *Veſuvius*, which grows hard as it cools, and appears to be a ſemi-vitrified ſubſtance. It is here called comfortable, becauſe the mountain generally becomes more quiet upon its being caſt out.

‡ *Portici*; a ſmall town on the bay of Naples, at about ſix miles diſtance from that city, built on the ruins of or rather directly over, the ancient Herculaneum. His Sicilian Majeſty has a palace here, furniſhed with many curioſities, found in Herculaneum, and frequently keeps his court at Portici.

§ This is an Italian word, which ſignifies the being in the country, or the time of being in the country to take one's pleaſure.

‖ A town twelve miles from Naples, on the contrary ſide from Veſuvius, where the king ſometimes holds his court.

The next day all was quieted by a profuſe lava that has filled up the hollow way between the Hermit's * and Veſuvius, of at leaſt an hundred feet in breadth.

The ſecond night, however, was as turbulent at the mountain, but not ſo alarming at Naples as the firſt, becauſe the mountain burſt ſooner, and on the other ſide of it, from whence a lava equally copious was delivered, and after fewer throes.

The third day the agitation of the earth and air was very inconſiderable; but an immenſe quantity of cinders and aſhes filled the whole atmoſphere †, ſo as to take our bright Sun, from us, and to leave us no more of him than we have in London, when thouſands of leſs alarming volcanoes from good kitckens, render the air, in winter, often impervious to any but his ſtrongeſt rays; and he appeared all day of the ſanguineous colour in which Pliny deſcribes him‡.

The fourth day we had for three hours or more, one continual thunder, without the terrible exploſions however of the firſt and ſecond nights; and I took great comfort to myſelf on ſeeing the conſtant courſe of cinders and aſhes thrown up. For, I looked upon it as the effect, if I may uſe the figure, of a bellows blown by all the winds, that would ſoon deſtroy or ſeparate the combuſtible enemy: Accordingly theſe aſhes were the only inconvenience that remained.

But on Sunday, the ſeventh day, the quantity of aſhes that filled the air was ſo great, that having rode out to take a nearer view of the volcano, I was obliged to gallop home with my eyes ſhut, as I could no longer open them from the pain theſe aſhes put me to §.

All

* In the ſolitary place, about half way up Mount Veſuvius, is an hermitage, where thoſe whoſe curioſity leads them to examine this wonderful phænomenon generally call, and are provided with refreſhment by the hermit.

† "Jam navibus cinis inciderat: quo proprius accederet calidior & denſior: Jam pumices etiam, nigrique & ambuſti & fracti igne lapides: Jam vadum ſubitum, ruinaque montis littora obſtantia.'.

‡ "Tandem illa caligo tenuata quaſi in fumum, nebulamve deceſſit: mox dies verus, ſol etiam efulſit, luridus tamen, qualis eſſe, cum deficit, ſolet. Occurſabant trepidantibus adhuc oculis mutata omnia altoque cinere, tanquam nive, obducta." *Plinii Epiſtol.* xx. *lib.* vi.

§ "Paullum reluxit, quod non dies nobis, ſed ventantis ignis indicium videbatur, & ignis quidem longius ſubſtitit: tenebræ ruſus, cinis ruſus multus & gravis: hunc & identidem aſſurgentes excutiebamus, oberti alioqui, atque etiam obliſi pondere eſſemus." *Plinii Epiſtol.* xx *lib.* vi.

All is now quiet and the lava on this ſide is ſtopped, after laying waſte the largeſt tract of cultivated ground that it has deſtroyed at once within this century. The greateſt eruptions of it have been in the year 1707, in the year 1737, and this of 1767. I leave your deep naturaliſts to account for this periodical criſis; and it may not be the firſt mere accidental obſervation that has given birth to a profound ſyſtem*.

A deſcription

* Some of the moſt remarkable eruptions of Veſuvius have happened as follow:

Anno Dom. 76, Mount Veſuvius caſt forth ſuch quantities of ſmoke and flame as to obſcure the day, and deſtroyed the cities of Pompeium and Herculaneum.

In the year 80, on the 23d of Auguſt, the elder Pliny, in order to be better acquainted with the cauſe of the extraordinary eruption of Veſuvius, ventured ſo near, that this great naturaliſt periſhed in his enquiry.

Anno 472, Veſuvius ejected flames, in ſuch abundance, that they were ſeen even at Conſtantinople; they obſcured the Sun at noon-day, and the fire ravaged and burnt all Campania.

Anno 1007, Veſuvius vomited out ſo great a quantity of flames, that all the neighbouring country ſuffered greatly by them.

In the year 1630, Veſuvius threw out flames, in ſuch abundance, that upwards of 4000 perſons loſt their lives, and a large tract of land was deſtroyed.

In the year 1717, Dr. Berkley, afterwards Biſhop of Cloyne in Ireland, viſited Veſuvius, at leaſt with as much boldneſs and curioſity as Pliny the elder. The account given by the Biſhop, of that mountain, was communicated to the Royal Society by Dr. Arbuthnot, and is publiſhed in the Philoſophical Tranſactions. It is thus deſcribed by the Biſhop. "The other mouth "was lower in the ſide of the ſame new formed hill; I could diſcern it to be filled with red hot "liquid matter, like that in the furnace of a glaſs-houſe, which raged and wrought as the "waves of the ſea, cauſing a ſhort abrupt noiſe, like what may be imagined to proceed from "a ſea of quickſilver daſhing among uneven rocks. This ſtuff would ſometimes ſpew over, and "run down the convex ſide of the conical hill, and appeared at firſt red hot; it changed colour "and hardened as it cooled, ſhewing the firſt rudiments of an eruption, or, if I may ſo ſay, "an eruption in miniature."

The conflagration in 1731 was ſo deſtructive, that it occaſioned the following curious inſcription, which is placed about three miles diſtant from Naples, in the road to Veſuvius.

Poſteri, poſteri, veſtra res agitur.
Dies facem præfert diei; nudius perendino.
Advortite.
Vicies ab ſatu ſolis, niſi fabulator hiſtoria, arſit Veſuvius,
Immani ſemper clade hæſitantium:
Ne poſthac incertos occupet, moneo.
Uterum gerit mons hic bitumine, alumine, ferro,
Auro, argento, nitro, aquarum fontibus, gravem.
Serius, ocius igneſcit, pelagoque influente pariet:
Sed ante parturit, concutitur, concutit ſolum,
Fumigat, corruſcat, flammigerat, quatit
Aerem, horrendum immugit, boat, tonat,
Arcet finibus accolas.
Emigra dum licet.
Jam jam initur, erumpit, mixtum igne
Lacum evomit, præcipiti ruit ille lapſu.
Seramque fugam prævertit.
Si corripit, actum eſt, periiſti.
Anno Salutis 1631,
Tu, ſi ſapis, audi clamantem lapidem.
Sperne larem, ſperne ſarcinulas;
Mora nulla, fuge.

In

A description of a SELF-MOVING *or* SENTINEL REGISTER, *invented by* WILLIAM HENRY *of Lancaster.*

THE machine consists of the following parts:

1. *A*, A door or common register, applied in the flue of a furnace. The door is fitted in a frame, and made to slide easily up and down. Plate VI. Fig. 1.

2. *B*, a balance or beam, moving on a center; the two arms are of unequal lengths, the longer exceeding the shorter in the proportion of two to one; the extremity of each arm is formed into a segment of a circle, whose radius is equal in length to each respective arm. These segments must be equal to the greatest rise or fall of each end of the balance when in use.

The length of the whole beam or balance must be regulated by the situation of the register *A*, and the copper *C*, hereafter mentioned.

3. *C*, A copper vessel, about 13 inches diameter, and 10 inches deep, with a double bottom and sides, which are placed about an inch and a half apart from each other,

IN ENGLISH THUS:

Posterity, posterity, this is your concern.
One day enlightens the next, that next
improves the third.
Be attentive.
Twenty times, since the creation of the Sun,
has Vesuvius blazed, never without a horrid
destruction of those, that hesitated to fly.
This is a warning, that it may never
seize you unapprized.
The womb of this mountain is pregnant with
bitumen, alum, iron, gold, silver, nitre
and fountains of water.
Sooner or later it kindles, and, when the sea
rushes in, will give its birth vent.
But, before its labours come on, it is shaken,
and shakes the earth round it; smokes, gleams,
throws up bickering flames, shakes the air,
roars horridly, bellows, thunders, drives the
inhabitants from its quarters.
Retire whilst you may;
Now, now, its throes come on, it bursts out,
it flings up lakes mixt with fire;
Down, down it rushes and precipitate
Prevents your tardy flight, and stamps your fate:
If it once surprizes you, all is over.
If you are wise, hear this speaking stone.
Neglect your domestic concerns, neglect your
goods and chattels, there is no delaying;
Fly.

leaving a ſpace between to contain air. The top or cover is brazed on, and the whole made air-tight. Through the top is inſerted a braſs cock, and alſo a braſs or copper cylinder, open at both ends, about two inches and a quarter in diameter, and two feet long, ſo fixed as to riſe fourteen inches above the top, and to reach near to the bottom of the veſſel.

Through the ſide of the innermoſt veſſel, near the top, are ſome holes made, whereby the air in the cavity between the two bottoms and ſides may communicate with the air in the inſide of the veſſel.

4. *D*, A phial two inches diameter, and ſeven inches deep, corked and ſealed, with a hook fixed in the cork, by which the phial is ſuſpended.

Theſe are the principal parts of the machine, which are to be applied as follows.

From the ſurface let there be an horizontal flue, of a convenient length. In the walls of the flue, the frame, in which the regiſter ſlides, is fixed perpendicularly, ſo that when the regiſter is down, the flue is cloſed, when the regiſter is drawn up, the flue is opened, and the higher it is raiſed, the more is the paſſage of the fire enlarged.

To the ſhorter end of the balance, which is ſupported on a proper fulcrum, at a convenient heighth, the regiſter is ſuſpended by a chain and a rod; the chain is juſt long enough to wind over the ſegment of the circle, at the end of the beam. The regiſter is made ſo heavy, as to deſcend by its own weight.

At the diſtance of two, three, or more feet from the regiſter, and on the flue of the ſurface, the copper veſſel *C* is fixed, ſo as to receive a heat from the fire paſſing through the flue. The end of the longeſt arm of the balance extends directly over the cylinder fixed in the copper, and to it the phial *D* is ſuſpended, ſo as to hang within the tube, and by ſuch a length of chain and rod as will allow it to be about two or three inches immerſed in the tube, when the balance is in equilibrio. On the ſame end

end of the beam on which the phial is ſuſpended, a weight is hung ſufficient, with the weight of the phial, to over-balance the regiſter, and raiſe it, and conſequently open the flue. When the flue is opened to a due degree, the regiſter is held in that ſituation, until ſo much water is poured into the copper through the cock, as will fill one third of the veſſel; then ſhut the cock, and pour water into the cylinder, until it riſes high enough to float the phial. By pouring water into the cylinder, the air in the veſſel is compreſſed, and finding no way to eſcape, as the veſſel is air tight, it reſiſts the water, and prevents its occupying the whole ſpace; and therefore the upper part of the veſſel is apparently empty. The phial is loaded with ſhot, ſo that it will ſwim about one third above the water. When the water riſes in the tube, the phial riſes with it, in which caſe the regiſter *A* is ſo ballanced, that it deſcends, and cloſes the flue.

After this deſcription, the principles on which the Sentinel Regiſter acts, muſt be obvious to every perſon acquainted with the elaſticity of the air, and that this elaſticity is encreaſed by heat. For when the fire in the furnace is encreaſed, the degree of heat in the flue is alſo encreaſed; this encreaſes the elaſticity of the air contained between the double bottom and ſides of the copper, and conſequently of that, which occupies the ſpace above the water, as there is a communication by means of the holes already deſcribed. The elaſticity of the air being encreaſed it expands, and by its expanſion forces the water up the tube; the water being raiſed, carries the phial with it, whereupon the regiſter preponderating deſcends, cloſes the flue, and by leſſening the draught of the chimney or flue, deadens or checks the fire in the furnace. By this means again the heat in the flue is diminiſhed, the air in the cavity becomes cooler, and conſequently leſs elaſtic, whereupon the water deſcends in the tube, and with it the phial to its ſtationary point. By the deſcent of the phial the regiſter is raiſed, and opens the flue; by which means it ſtands

ſtands as a ſentinel over the fire, and preſerves an equal degree of heat.

That this will be the effect of the machine, I can atteſt, having uſed it for more than a year.

It is ſubmitted to the curious, whether this machine might not be uſefully applied, 1ſt, to regulate the heat of chymical and alchymical furnaces, where long digeſtions, and a uniform degree of heat are required; 2dly, in the making of ſteel, and in burning of porcelain ware, in which a due regulation of the fire is of great importance; 3dly, in green or hot houſes, and in apartments for hatching chickens, according to the Egyptian method. With a little alteration it might be applied to the purpoſe of opening doors, windows, and other paſſages, for a draught of air, and thereby preſerve a due temperature of the air in hoſpitals, &c.

An Account of a MACHINE *for pumping Veſſels at Sea, without the Labour of Men. By* RICHARD WELLS.

IN the courſe of the immenſe trade now purſued on the ocean, veſſels are continually ſubject to leaks, which too often prove fatal to the crews, who, wearied out with inceſſant pumping, are obliged, at laſt, to ſubmit to their unhappy fate, and deſponding ſink into their watery graves. It is therefore much to be deſired, that ſome method could be ſuggeſted for preſerving the lives of ſo intrepid and uſeful a ſet of men. What has occured to me on this ſubject, I beg leave to lay before the Society, and flatter myſelf, it will not prove altogether unworthy of notice.

When a veſſel ſprings a leak at ſea, which cannot be diſcovered, inſtead of exhauſting the crew with continual working at the pumps, they may form, with very little trouble, a machine to diſcharge the water, which will work itſelf, without any aſſiſtance from the hands on board.

Let

Let a ſpar or ſpare top-maſt be cut to the length of eight or ten feet, or more, according to the ſize of the veſſel; mortice four holes through the thickeſt end, through which run four oars, fixing them tight, exactly in the middle; to the four handles of the oars nail on four blades (made of ſtaves) the ſize of the other ends, which will form a very good water wheel, if the oars are ſtrong; then fix into the oppoſite end, what is commonly called a crank; the iron handle of a grindſtone would ſuit extremely well; if not to be had, any ſtrong bar of iron may be bent into that form, wedging it tight, to prevent its twiſting round: then nail up a new pair of chaps on the fore part of the pump, for a new handle to be fixed in, which will point with its outer end to the bow of the veſſel; this handle will be ſhort on the outſide, but as long on the inſide as the diameter of the bore of the pump will admit, in order that the ſpear may be plunged the deeper, and of courſe make the longer ſtroke; the handle muſt be large enough to have a ſlit ſawed up it, ſufficient to admit a ſtave edge ways, which muſt be faſtened with a ſtrong or iron pin, on which it may work; the lower end of the ſtave muſt be bored, to admit the round end of the crank; then fix the ſhaft with the oars (or arms) over the gunwale on two crotches, one ſpiked to the gunwale, and the other near the pump, cutting in the ſhaft a circular notch, as well to make it run eaſier, by leſſening the friction, as to keep the whole ſteady. A bolt muſt be fixed in each crotch, cloſe over the ſhaft, to keep it from riſing; as ſoon as the wheel touches the water, it will turn round, and the crank, by means of the ſtave fixed on its end, will work the handle of the pump. If the bore be four inches, and the piſton or ſpear moves eighteen inches at a ſtroke, it will diſcharge 220 cubic inches of water, and admitting the arms of a wheel to be ſix feet from the center, it will turn round about 146 times in a mile, or 730 times in an hour, when the ſhip ſails five knots, which is equal to nine hog-ſheads. If the ſurface of the water in the whole be fifteen

feet

feet from the nozle of the pump, a man can raiſe in an hour, with common working, about thirty-eight hogſheads, which far exceeds the work performed by the wheel; but this calculation is made on pumps of the common ſize, I would therefore propoſe that all veſſels ſhould carry larger pumps, the advantage of which will appear from the following table:

A 4 inch bore will diſcharge per hour, ſailing at the rate of five knots, - - - -	9 hogſheads
5 inch, - - - -	14 and an half.
6 ditto, - - - -	20 and $\frac{3}{4}$ths.
7 ditto, - - - -	28 and $\frac{1}{4}$th.
8 ditto, - - - -	37 hogſheads.

Hence we find, that a pump of eight inches bore, will diſcharge with the wheel nearly the ſame quantity that a man commonly raiſes. If both pumps be ſet to work by the crank, double the quantity, or 74 hogſheads will be diſcharged; but if a cog wheel, of about three feet ten inches, with 51 cogs, be fixed on the end of the ſhaft or axis, and the crank be paſſed through a trundle or lanthorn wheel, of about two feet diameter, with thirteen rounds, to work with the axis parallel to the deck, and fixed to the pumps, in the manner uſed by brewers and diſtillers, the crank will make about four turns to one revolution of the great wheel, and of courſe deliver 296 hogſheads per hour; yet as the reſiſtance made by the pumps will, in ſome meaſure, impede the motions of the wheel, it will not turn at the rate of 730 times in an hour, for which ſuppoſe a deduction of one third, which is certainly a great allowance, the quantity then diſcharged per hour is about 200 hogſheads, which is more than equal to the conſtant work of five men; thus if a veſſel ſailing at the rate of 5 knots, delivers 200 hogſheads per hour, equal to five men's work.

6 knots is 240	- -	equal to 6 ditto.
7 knots 280	- -	equal to 7 ditto.
8 knots 320	- -	equal to 8 men's work.

I am

I am aware of many objections that will be ſuggeſted. In the firſt place it will be ſaid, that pumps of eight inches bore, will be too large to be worked by the ſtrength of men, when the wheel cannot be applied. I anſwer, no more force is required to diſcharge a gallon of water at a ſtroke from an eight inch, than from a four inch bore; as the ſhort end of the lever or handle to the eight inch bore, need not be above a quarter part the length of the four inch, which will give a purchaſe to the ſailor at the long end of the lever, ſufficient to raiſe the piſton or ſpear a quarter the heighth of what is required in a four inch bore, for a piſton moving three inches in an eight inch bore, will deliver juſt about the ſame quantity of water. It will be further objected, that in ſtormy weather, when veſſels generally make the moſt water, the wheel could not be put overboard. I own there is ſome force in this objection, but if a remedy is beneficial in ſome caſes, though not adequate in all, it ought not to be totally rejected. Many leaks happen at ſea in moderate weather, and even thoſe which are occaſioned by damage in a ſtorm, often continue when the waves are abated. Sailors are frequently unhappily waſhed overboard, and poſſibly thoſe who may have ſurvived the ſtorm, are too few, and too weak, to keep the ſhip clear of water, and perform the other neceſſary duties on board, in ſuch caſes, this machine would be evidently uſeful. It may alſo be urged, that the wind at ſuch time may be ſo much ahead, that the ſhip cannot make way enough through the water to work the pumps; to which I reply, when life is in danger, when grim death ſtares the affrighted crew in the face, the port of deſtination is not to be conſidered, but the veſſel muſt be ſteered for that ſhore, which beſt ſuits the working of the pumps, and keeping her above water.

I would therefore propoſe, that every veſſel ſhould not only have pumps of eight inches bore, but be provided with a ſhaft, crank, and proper wheels, which might eaſily be ſtowed away in little room, as the paddles of the

water

water wheel may be unſhipped, and the whole procured at a ſmall expence.

Theſe hints, together with the model, I ſubmit to the inſpection of the Society, and hope ſome improvement may be made on this plan, which will prove uſeful to mankind.

REFERENCES. Plate VI. *fig*. 2.

A. *Top-maſt or ſhaft of the wheel.* B. *Oars or arms of the wheel.* C. *Crank.* D. *Pump.* E. *Props on the deck, to ſupport the ſhaft.*

An ABSTRACT *of ſundry papers and propoſals for improving the inland navigation of Pennſylvania and Maryland, by opening a communication between the tide waters of Delaware and Suſquehannah, or Cheſapeak-Bay; with a ſcheme for an eaſy and ſhort land communication between the waters of Suſquehannah and Chriſtiana Creek, a branch of Delaware; to which are annexed ſome eſtimates of expence. &c.*

THE American Philoſophical Society, held at Philadelphia, have always conſidered it as one great end of their inſtitution, to ſet on foot, and forward the execution of ſuch public ſpirited undertakings, as have a tendency to advance the landed and commercial intereſt of the Britiſh colonies in general, and particularly of thoſe middle colonies, with which they are more immediately connected.

With this view it was, that they appointed different committees to view the ground, and conſider in what manner a water communication might be beſt opened between the provinces of Maryland and Pennſylvania; and particularly by what means the large and increaſing number of frontier ſettlers, eſpecially thoſe on the Suſquehannah and its branches, might be enabled to bring their produce to market at the cheapeſt rate, whether by land or water.

To

To enable the Society to make theſe ſurveys, levels, &c. the merchants in Philadelphia generouſly ſubſcribed near two hundred pounds.

The firſt place propoſed to be viewed, was the ground between the tide waters of Apoquiniminck and Bohemia, marked AB, in the annexed map (plate VII.) and John Lukens, Eſq. Surveyor-General, John Sellers, Matthew Clarkſon, and Joſeph Ellicot, Eſquires, Meſſrs. Thomas Gilpin, Richard Sittiforth, William Killen, John Stapler, of Pennſylvania, and William Rumſey, Eſq. of Maryland, were appointed a committee for this ſervice, May 5th, 1769, who having performed the ſame, their report, ſigned by the three firſt named gentlemen, was given in to the ſociety, June 19th 1769, ſetting forth, "That they had viewed the ground aforeſaid, taken the levels, ſurveyed the diſtance, and eſſayed a calculation of the expence, which would attend the cutting a canal in that place, which they were of opinion might be executed with locks for the ſum of forty thouſand pounds* Pennſylvania money.

"The depth of earth from the higheſt ground to the level of navigation being very great, they declined making any eſtimate of what the coſt would be, to make a clear paſſage from river to river, without locks, judging it an undertaking beyond our preſent abilities."

The whole length of the ground where this canal is propoſed, from tide to tide, is 5 miles 107 perches. They found the waters in the Head Branch of Bohemia about eighteen feet below the ſurface of the higheſt ground, through which the canal muſt go, and the water in the Head Branch of Apoquiniminck, about twenty-ſix feet below the ſame. The tide waters are ſixty-ſix feet below the higheſt ground.

They found that for making a lock navigation (under the above circumſtances) 208805 cubic yards of earth muſt be removed, that 10,260 perches of ſtone wall would be neceſſary for ſecuring the banks of the canal; that three mills muſt be purchaſed that ſtand in the way of the execution of the plan, and that ſix locks muſt be erected; all

which

* One Spaniſh milled Dollar paſſes in Pennſylvania for Seven Shillings and Six-Pence; by which all eſtimates in the currency of that Province may be turned into Sterling.

which, they judge, might be done at the expence of forty thoufand pounds, as aforefaid.

Mr. Thomas Gilpin, one of the above committee, laid before the Society a plan of a canal, and the elevation of the ground, &c. between Chefter river, in Maryland, and Duck Creek, in Pennfylvania, at the place marked CD, in the annexed map. "The diftance from tide to tide is here about twelve miles, and the length of the canal, by the courfes it muft take, would be fourteen miles. The heighth of the middle ground above the tide is thirty-three feet;" and he reports, "that the water in Chefter River and Duck Creek is fufficient to fupply the canal and locks to the height of twenty-two feet above the tides. He eftimates only about eight thoufand and fifty pounds for making a navigation for flat-bottomed boats, that would carry one thoufand bufhels of wheat each; but to make it fit for fhallops, with a lock navigation, he ftates the whole expence at twenty-eight thoufand two hundred and ninety-eight pounds."

Several difficulties having been apprehended in both the above plans, and particularly the great expence in executing the firft to any advantage; and that if the fecond could be executed at the expence propofed, it would carry all the navigation of the river Sufquehannah (which is the great object in view,) too far down into Chefopeak-Bay, for an advantageous communication with Philadelphia; it was therefore propofed, that fome other places fhould be examined, by which the water carriage between Sufquehannah and Delaware might be rendered fhorter, and more practicable.

Committees were accordingly appointed to examine, furvey and level the ground, between the navigable waters of Delaware river in Pennfylvania, and Elk river that empties into Chefopeake, near the mouth of Sufquehannah. This fervice was compleated by the committee with great diligence, and in the extremity of winter, as they found it beft to proceed when the furface of the waters

ters and marſhes were frozen over. Their report was delivered to the Society, 16th February, 1770; an abſtract of which follows, viz.

" That they had divided themſelves into two parties for the greater expedition; one of which parties, viz. Samuel Roads, Eſq; the Revd. John Ewing, Meſſrs. Richard Sittiforth, and Joſeph Horatio Anderſon, undertook to ſurvey and level the ground between the tide water of Red Lion Creek which empties into the Bay of Delaware about ſix miles below New-Caſtle, and the tide water of Long Creek, which is a branch of Elk-River, (the ground marked EF, in the plan). The other party, conſiſting of Meſſrs. John Stapler, Joel Bailey, Thomas Gilpin, and Levi Hollingſworth, undertook to ſurvey and level the ground marked GH, between the navigable waters of Chriſtiana Creek, which empties into Delaware about four miles above New-Caſtle, and the Head of Elk River.

The work being finiſhed, they report further, " That they find it a very eaſy and practicable matter to cut a canal in either of the above places, ſufficiently large to anſwer the purpoſe of a Barge navigation, as it is called, and that at a moderate expence. Or if a Lock navigation ſhould be thought more eligible, as by that means the ſame veſſels that bring the produce and merchandize to the canals, may proceed to market without unloading, this alſo (although it might be attended with a greater expence) is alſo practicable at both the above places."

As to the barge navigation, &c. (ſhould that be thought beſt) they obſerve that " the ground in both places will admit of a canal being dug on a level between the tide waters of Delaware and Cheſopeake; in which barges may continually ply, loading and unloading at each end; while ſhallops, boats, and other ſmall craft may come to the ends of the canal, to bring or carry off the various articles of commerce that may be conveyed through this communication. Wharehouſes muſt be built at each end of the canal, to prevent uneceſſary delays, and damage of the goods.

goods. The head waters of Chriſtiana and Elk rivers may be brought in to ſupply either of theſe canals.

The committee further report, that when they had compleated their ſurveys, &c. as above; they proceeded, agreeable to their inſtructions, to Peach Bottom Ferry, on Suſquehannah, in order to make the beſt enquiry they could, concerning the different falls and rifts in that river; and to examine where the beſt and ſhorteſt road could be made from that place to Chriſtiana Bridge.

With reſpect to the different falls they report, from the beſt information they could obtain, "That the Bald Friar Falls, are the moſt difficult to paſs in that river. Theſe lie in Maryland, about three miles below the Southern boundary of this province; that the other Falls are often paſſed in canoes, flats, rafts, &c. that they all diſappear in the time of a freſh, and therefore may be paſſed with the greateſt ſafety, and that in the intermediate parts of the river, the current is ſo ſlow and gentle, that it is eaſy to row, or even ſail againſt it. From the great quantity of water which this river contains, it appears obvious, that with a very moderate expence a channel may be opened through the ſeveral Falls, by blowing up a few rocks, ſo as to make a good navigation, without doing any detriment to the other parts of the river by leſſening its depth; or where it may be judged more expedient, a ſmall canal may be cut on the ſhore, ſo as to avoid all difficulty and danger from them. They cannot aſcertain the expence of this work with preciſion, but they apprehend it will not amount to more than four thouſand pounds."

With reſpect to the road, they add, "That from the mouth of Peters's creek, (which empties into Suſquehannah, at Peach Bottom, about three miles above the boundary line of the province, and where a very convenient harbour may be made for boats,) they had examined the ground, and find a good road may be made from thence to Chriſtiana Bridge, by an eaſy aſcent along the valley of this creek, which extends about two miles from the river in a direction

direction nearly parallel to the ſaid Weſt line. The ground admits of a good road from this to the place where the ſaid boundary line croſſes Octorara Creek, near the Horſe-Shoe Ford; after which it may be continued near the ſaid line until it meets with the boundary of Newcaſtle county. That part of the road which lies in Newcaſtle county is already made, and there is a law in that government, for keeping it in good repair. There are no hills to obſtruct it, except at Octorara Creek and Great Elk; the moſt convenient places of paſſing which appear to be at Wilkie's Mill, and the abovementioned Horſe-Shoe Ford, where the hills may be eaſily aſcended by winding a little on the Pennſylvania ſide. This road may be made at a ſmall expence, and will reduce the diſtance between Peach Bottom and the tide waters of Chriſtiana to about thirty-two miles. Bridges muſt be thrown over the ſtreams of Octorara and Elk, as they are frequently ſo high as not to be forded. The whole expence of this work, they ſuppoſe will not exceed a thouſand or fifteen hundred pounds.

"Upon the whole, they remark, that the river Suſquehannah is the natural channel through which the produce of three-fourths of this province muſt in time be conveyed to market for exportation, and through which great part of the back inhabitants will be ſupplied with foreign commodities.

"That this conveyance will become eaſy and cheap, to the ſettlers above the Peach Bottom or Bald Friar Falls; and may, by proper encouragement, be found the moſt uſeful and convenient for all the Weſtern trade.

"That a road from Peach Bottom to the navigable waters of Chriſtiana Creek, will reduce the whole land carriage of the moſt remote inhabitants on the various branches of the Suſquehannah to thirty-two miles, which appears to be the ſhorteſt portage from that river, to the navigable branches of Delaware, which can be had within the limits of this government; and that the conveyance from Chriſtiana to Philadelphia is known to be ſafe and eaſy.

"That

"That clearing a channel through the Bald Friar Falls, and opening a canal through either of the abovementioned levels, will not only reduce the whole trade of the Susquehannah to a water carriage, but will open ſuch a communication between the Delaware, and all the rivers of the Cheſopeak-Bay, as will greatly advance the commercial intereſt of all the colonies adjoining thereon, by reducing the expence of carriage, on the various articles of traffic, which are yearly tranſported from one province to another, through theſe extenſive waters."

R E M A R K S.

Firſt, With reſpect to the water communication propoſed from the mouth of Red Lion Creek, on Delaware, below Newcaſtle, to the navigable branches of Elk-River, at the place marked EF, it appears from the drafts, &c. that the ſame may be executed by cutting either from Long Creek or Broad Creek.

The length of the canal, if from Long-Creek to Delaware, is 10 miles, 135 perches; if from Broad-Creek to ditto, it is 9 miles 200 perches; and either of theſe canals leads immediately into Delaware.

The committee declare themſelves fully ſatisfied, that a good canal, either for a barge or lock navigation, may be made in this place, through one of the hollows adjoining the ridge on which they carried their level, at a leſs expence than at any place of equal convenience. The ſeverity of the ſeaſon did not permit them to carry their level along any of theſe hollows, or to examine the ſoil ſo ſtrictly, as that they could pretend to make an accurate eſtimate of the expence. But, by the beſt judgment they could form, the ground to be dug and moved for a barge navigation, is about 420,000 cubic yards, and the whole expence of this and the other work neceſſary for a barge navigation in this place, they eſtimate at £. 14,426.

Secondly, With reſpect to the canal propoſed from Elk-river to the navigable waters of Chriſtiana-Creek, near the

the bridge at the place marked GH; the diſtance or length of the ſame, by the different courſes, is 12 miles, 10 perches. The hight of the higheſt ground above the level of the tide is ſixty-eight feet and a half.

The ground to be dug and moved, for a barge navigation, they make 387860 cubic yards.

And the whole expence of completing the canal, or a barge navigation, -	£. 19,396 : 10
The additional expence for a lock navigation	40,924 : 10
Total for a lock navigation,	£. 60,321

The difference between the expence of a barge and lock navigation being ſo great, the committee therefore recommend the former for the preſent.

The particular eſtimates upon which the foregoing abſtract is founded, together with the plans of ſurveys, elevations of the ground, and Drafts of the different propoſed canals, being too large to be inſerted in the tranſactions of the ſociety, are therefore lodged in their cabinet for the inſpection of thoſe who may deſire further ſatisfaction, in regard to the practicability of carrying either of the above ſchemes into execution, which on a due conſideration of all circumſtances may be judged moſt for the public ſervice.

In the mean time the immediate opening the propoſed new road from Peach-Bottom on Suſquehannah, to the tide waters of Chriſtiana-Creek, is recommended as a matter of the utmoſt importance, not only to the city of Philadelphia, but to a great part of the ſettlers on the waters of Suſquehannah.

To

To the AMERICAN PHILOSOPHICAL SOCIETY. *&c.*

A Deſcription of a MACHINE for cutting FILES, a Model of which was preſented the Society ſome Time ago.

By B. O.

REFERENCES.

A BENCH, made of well ſeaſoned oak, and the face of it plained very ſmooth. *AAAA.* (Pl. VII. Fig. 2.)

BBBBB, The feet to the bench which ſhould be ſubſtantial.

CCCC, The carriage on which the files are laid, which moves along the face of the bench *AAAA*, parallel to its ſides, and carries the files gradually under the edge of the chiſel *HH*, while the teeth are cut: This carriage is made to move by a contrivance ſomewhat ſimilar to that which carries the log againſt the ſaw of a ſaw mill, as will be more particularly deſcribed.

DDD, Are three iron rods, inverted into the ends of the carriage, *CCCC*, and which paſſes through holes in the ſtuds *EEE*, that are ſcrewed firmly againſt the ends of the bench *AAAA*, for directing the courſe of the carriage *CCCC*, parallel to the ſides of the ſaid bench.

FF, Two upright pillars, mortiſed firmly into the bench *AAAA*, nearly equi-diſtant from each end thereof, near the edge, and directly oppoſite to each other.

GG, The lever or arm, which carries the cutter *HH*, and works on the centers of two ſcrews *KK*, which are fixed into the two pillars *FF*, in a direction right acroſs the bench *AAAA*. By tightening or looſening theſe ſcrews, the arm which carries the chiſel, may be made to work more or leſs ſteady.

L, Is the regulating ſcrew, by means of which the files may be made coarſer or finer; this ſcrew works in a ſtud *M*, which is ſcrewed firmly upon the top of the pillar *F*. The lower end of the ſcrew *L*, bears againſt the upper part of the arm *GG*, and limits the height which it can riſe.

N, A

N, A ſteel ſpring that is ſcrewed to the other pillar *F*, by one end, the other end of which preſſes againſt a pillar *O*, that is fixed upon the arm *GG*, and by its preſſure forces the ſaid arm upwards, until it meets with the regulating ſcrew *L*.

P, Is an arm with a claw at the end, marked 6, the other end is fixed by a joint into the end of the ſtud or pillar *O*, and by the motion of the arm *GG*, is made to move the ratch-wheel *Q*; this ratch-wheel is fixed upon an axis, which carries a ſmall trundle head or pinion *R*, on the oppoſite end; this takes into a piece *SSSSS*, which is indented with teeth, and ſcrewed firmly againſt one ſide of the carriage *CCCC*, and by means of this the carriage has a motion communicated to it.

TT, Is a clamp for faſtening one end of the file in the place or bed on which it is to be cut.

V, Is another clamp or dog at the oppoſite end, which works by a joint *W*, firmly fixed into the carriage *CCCC*.

Y, A bridge, likewiſe ſcrewed into the carriage, through which the ſcrew *X* paſſes, and preſſes with its lower end againſt the upper ſide of the clamp *V*, under which clamp the other end of the file *ZZ*, is placed and held firmly in its place while it is cutting, by the preſſure of the ſaid clamp or dog *V*.

7, 7, 7, 7, Is a bed of lead, which is let into a cavity that is formed in the body of the carriage, ſomething broader and longer than the largeſt ſized files; the upper face of this bed of lead is formed variouſly, ſo as to fit the different kinds of files which may be required.

2, Two catches, which takes into the teeth of the ratch-wheel *Q*, to prevent a recoil of its motion.

3, 3, Is a bridge to ſupport one end of the axis 4, of the ratch-wheel *Q*.

5, A ſtud to ſupport the other end of the axis of the ratch-wheel, *Q*.

When the file or files are laid in their place, the machine muſt be regulated to cut them of the due degree of fineneſs, finenefs, by means of the regulating fcrew, *L*, which, by fcrewing it further through the arm, *M*, will make the files finer, and *vice verfa*, by unfcrewing it a little, will make them coarfer; for the arm *GG*, can by that means, have liberty to rife the higher, which will occafion the arm *PP*, with the claw, to move further along the periphery of the ratch-wheel, and confequently communicate a more extenfive motion to the carriage *CCCC*, and make the files coarfer.

When the machine is thus adjufted, a blind man might cut a file with more exactnefs than can be done in the ufual method with the keeneft fight; for, by ftriking with a hammer on the head of the cutter or chifel *HH*, all the movements are fet at work, and, by repeating the ftroke with the hammer, the files on one fide will at length be cut; then they muft be turned, and the operation repeated, for cutting the other fide. It is needlefs to enlarge much on the utility or extent of this machine; for, on an examination, it will appear to perfons of but an indifferent mechanical fkill, that it may be made to work by water as readily as by hand, to cut coarfe or fine, large or fmall files, or any number at a time; but it may be more particularly ufeful for cutting very fine fmall files for watchmakers, as they may be executed by this machine with the greateft equality and nicety imaginable: And as to the materials and dimenfions of the feveral parts, I fhall leave that to the judgment and fkill of the artift, who may have occafion to make one, only obferving, that the wole fhould be capable to bear a good deal of violence.

Sect. IV.

MEDICAL PAPERS.

An Analyſis *of the* CHALYBEATE WATERS *of* BRISTOL, *in* Pennſylvania; *in two letters from Dr.* JOHN DE NORMANDIE, *of Briſtol, addreſſed to Dr.* THOMAS BOND, *one of the Vice Preſidents of the American Philoſophical Society, held at Philadelphia; and by him communicated to the ſaid Society.*

LETTER I.

Briſtol, in Pennſylvania, Sept. 10, 1768.

DEAR SIR,

ON ſeeing amongſt the many uſeful purpoſes of inſtituting the American Philoſophical Society, that of communicating to the public new methods of curing and preventing diſeaſes, is deſervedly included; I take the liberty of requeſting you to preſent my moſt reſpectful compliments to the worthy members of it, and beg their favourable acceptance of the incloſed Analyſis of the Briſtol mineral water, and of an account of the means whereby a village, long unhealthy, has been rendered remarkably healthy.

To the AMERICAN PHILOSOPHICAL SOCIETY, *held at Philadelphia, &c.*

THE great improvements the laſt and the preſent age have made in the healing art, the encouragement given to the ſtudy of phyſic by the eſtabliſhment of medical ſchools in North America, and eſpecially in your city, where the ſeveral branches of medicine are regularly taught, muſt afford the moſt ſenſible pleaſure to every humane diſpoſition, and prove an encouragement to all who are intereſted in the health of their fellow creatures, to exert themſelves in purſuing every diſcovery which may tend to the

the relief of the ſick, or the reinſtatement of an impaired conſtitution.

From theſe conſiderations, I have undertaken to try the following experiments upon the Chalybeate waters of Briſtol, in Pennſylvania, with a view to diſcover their contents, as a guide to the further inveſtigation of their virtues and uſes; and particularly, their application in the cure of diſeaſes. For although it muſt be confeſſed, that a chymical analyſis is, in ſome meaſure, an uncertain teſt of the medical virtues of any compound; and that the qualities of its conſtituent parts, when ſeparated, may not only differ from, but are ſometimes oppoſite to, thoſe of the mixture; yet when we want the teſtimony of experience, a chymical analyſis is the beſt means of inveſtigating the truth, and diſcovering the virtues of the compound.

Thus, if from the following experiments it ſhall be found that the waters of Briſtol, are impregnated with the principles of thoſe of Bath or Spa, it will be no forced concluſion to ſay, they may be beneficial in caſes ſimilar to theſe that have been happily cured by the latter.

Experiment I. A ſmall portion of white oak bark, infuſed in the waters, induced an immediate change from tranſparency to a dark purple colour, which it retained 24 hours, without depoſiting any ſediment.

II. Some of the ſame water, after being made hot, or expoſed for a few hours to the open air, in a great meaſure loſt its irony taſte, and received no other colour than a common tincture from the white oak bark.

III. One drop of ſtrong oil of vitriol, in two ounces of the water, produced no ſenſible alteration; and the water after ſtanding ſome time continued tranſparent, without depoſiting any okeriſh or other ſediment to the ſides or bottom.

IV. Ol. tart. pr. deliq. dropt in ſome of the ſame water, induced a change in the colour, rendering it ſomewhat yellow; and in time precipitated to the bottom of the cup a fine gold coloured oker.

V. Sixteen

V. Sixteen ounces avoirdupois, carefully evaporated to a drynefs in a China bowl in B. M. left one grain of a yellowifh brown powder of the tafte of tart. tartariz.

VI. Linen, moiftened with the fcum floating on the top of the fpring, is tinged with a ftrong iron mold.

VII. This water in weight is exactly the fame as that of rain water.

From thefe few experiments, it is fufficiently evident that this water, in its natural ftate, contains a large portion of iron diffolved in pure water by means of an acid, which acid is extremely volatile, and probably of the vitriolic kind; principles fimilar to thofe of the much celebrated waters of the German Spa, with which they likewife agree in the effects which immediately follow upon drinking them; fuch as quickening the pulfe, exciting an agreeable warmth in the ftomach, promoting the appetite, and occafioning a flow of fpirits, and a greater degree of chearfulnefs.

Hence we may juftly conclude, that like thofe they will be very beneficial in all that numerous train of difeafes, which arife from a debilitated and relaxed ftate of the folid parts of the human body, brought on by living in warm climates, immoderate evacutions, &c. fuch as hypochondriacal complaints, melancholy, lofs of appetite, and indigeftion, with habitual ficknefs and pains of the ftomach and bowels, and all their unhappy confequences; rickets, lamenefs, and fome paralytic complaints; and that they will likewife prove powerful deobftruents and alteratives, opening obftructions, and difcharging what is obnoxious by the feveral emunctories.

Nor indeed are thefe virtues attributed to them from conjecture and analogy only; but in fome meafure, from the teftimony of fact and experience. For although it would not be very eafy, till the waters become more generally known, to collect any number of accurate and well attefted cafes, yet, from the ftricteft enquiry from perfons who have fpent their lives, near thefe fprings, it is certain

certain they have, for a long time, been remarkable for their ſalutary effects, ſtrengthening the ſtomach, reſtoring loſt appetite, &c. And that numbers have left the place perfectly cured of diſeaſes which, for many years, had eluded the moſt powerful remedies.

But as Briſtol was formerly an unhealthy place, and prejudices againſt it may ſtill remain in the minds of numbers of perſons, who otherwiſe would be willing to try the benefits of theſe waters, it may not be improper to aſſign the cauſes why it was then ſo, and how from their removal, it is now become an exceeding healthy ſpot.

The town of Briſtol is ſituate on a high dry bank, with the river Delaware to the eaſtward and ſouthward. There is a quantity of low ground to the ſouthward and weſtward, which in its natural ſtate, was overflowed by every ſpring tide; to the northweſt there is a large pond of water, which, when filled by the winter's rain, overflowed the neighbouring hollow clayey ground, and there remained ſtagnant, until exhaled by the ſucceeding warmer ſeaſons, which was ſeldom before the middle of autumn; at which time agues, remitting, intermitting, and continued fevers, and indeed every ſpecies of autumnal diſorders, prevailed, not only amongſt ſtrangers, but even the inhabitants. This continued to be the caſe until the owners of the low marſhy grounds, to the ſouthward and weſtward of the town, embanked and improved them; and a few public ſpirited inhabitants employed perſons to cut ditches to drain off the ſuperfluous water, as it flowed out of the pond. After theſe improvements, the place became healthy; the inhabitants were no longer particularly ſubject to fevers of any kind, and, for ſeveral years paſt, have enjoyed as much health, as any people in any part of America.

LETTER. II.

SIR,

SOME months ago, in a letter to you (communicated to the public by the Philoſophical Society) I gave you a ſhort analyſis of the Briſtol Chalybeate waters.

I have

I have ſince had opportunities of proſecuting that ſubject farther, by a number of additional experiments, which, together with the hiſtories of ſeveral caſes, that have occurred in my attendance here, will more clearly aſcertain the contents of theſe waters, and determine the effects which may be expected from their uſe, in the cure of diſeaſes.

I therefore take the liberty to tranſmit you the following account, which I flatter myſelf, will be favourably received as an uſeful ſupplement to my former letter.

The experiments I related to you my laſt, tended chiefly to ſhew that theſe waters owed their chief impregnation to iron kept in ſolution, by means of an acid, which I judged to be of the vitriolic kind.

Thoſe which I am now to communicate to you confirm this opinion, and at the ſame time diſcover ſome other principles, in their compoſition, with which I was before unacquainted, and which probably increaſe their medical virtues.

Experiment I. Upon the addition of Sp. Sal. Arom. to he water a ſlight effervefcence enſued, and upon ſtanding about an hour, a light yellow matter was ſeperated and floated on the top of the liquor.

II. From a mixture of lime water, the ſame ſeparation was made, but fell to the bottom of the liquor.

III. Powder'd chalk added to the water produced the ſame ſeparation, but not in ſo ſhort a time, as in the preceding experiments.

IV. The reſiduum, after a ſlight calcination, was ſtrongly attracted by the magnet.

V. A ſolution of crude Sal. Ammon. being mixed with the water, was ſucceeded by the ſame appearance as the addition of lime-water.

VI. The reſiduum after evaporation in Baln. Mar. before calcination, diſcovered to the taſte a conſiderable portion of ſalt, which left a coldneſs on the tongue, and when ſeparated by ſolution, filtration and evaporation, appeared of of the colour of falt of amber, and fhott into right angled cryftals, which through a microfcope appeared beautifully feathered; and from every experiment was found perfectly neutral.

VII. Silver immerfed for fome time in the water acquired a flight yellow colour.

VIII. The refiduum thrown on a red hot iron fparkled very much, and emitted a fulphureous fmell, what remained on the iron had not the leaft perceptible tafte of falt.

IX. The waters, and the folution of the chryftalized falt, changed fyrup of violets, to a fine light green.

The firft four of thefe experiments, in which the waters were decompofed as well by a volatile alkali, as by lime water, and an abforbent earth, and the refiduum (after a flight calcination) being attracted by the magnet, evidently prove that they are impregnated with a confiderable portion of iron.

The fifth experiment (in which a decompofition takes place by means of a double elective attraction) fhews that the acid in thefe waters, has a ftronger affinity with alkalies, than that which is the bafis of Sal. Ammoniac, (which is the marine acid,) and muft be either the nitrous or vitriolic. And from a decompofition taking place, on the addition of common nitre with the Chalybeate waters, in about the fame time as when left expofed in the open air, we may rationally conclude the acid to be of the vitriolic kind.

The fixth experiment fhews that there is a fmall portion of neutral falts in thefe waters, which from the coldnefs with which they affect the tongue, and the appearance of the cryftals, are probably of the ammoniacal kind.

The feventh and eighth experiments together with the fmell of the bath and the confiderable fætor which the waters acquire when kept for any time, evidently fhew that they contain a third principle, which is fulphur, This indeed (as well as the falt) is in a fmall quantity, yet it may contribute fomewhat to the medicinal virtues of thefe fprings.

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The ninth experiment ſeems to prove them to tend rather to an alkaline nature, but as this was in a very trifling degree, it may be accounted for from the eſcape of the acid which is extremely volatile.

Theſe experiments compared with thoſe I have already communicated to you ſufficiently diſcover the conſtituent parts of theſe waters.

From ſome other experiments I find they inſtantly lather with ſoap, are ſomewhat lighter than common water, that they no ways coagulate milk, even when boiled with it, and that when mixed with an equal quantity of it, they prevent in ſome meaſure its aceſcency; from the firſt and ſecond of which facts, we may naturally ſuppoſe them more powerfully deobſtruent, and from the two laſt we may draw this uſeful corollary, that they may not only be uſed with ſafety along with a milk diet, but that they realy in a chymical ſenſe prevent the ill conſequences which often attend ſuch a diet in a weak ſtomach. From this circumſtance their efficacy muſt be in many caſes greatly increaſed.

When drank, they act as a quick diuretic, always increaſing the quantity of urine. They generally at firſt drinking prove cathartic, always tinge the excrements black, and ſometimes, from the ſtate of the ſtomach prove emetic. They exhilarate the ſpirits, and in ſome inſtances produce a momentary intoxication. They communicate an immediate vigor and ſtrength to the whole conſtitution, as is evident to many patients, who with fatigue walk to the wells; but in returning home, are not ſenſible of any wearineſs or languor.

They promote digeſtion, ſtrengthen the ſtomach and create an appetite. Theſe are their conſtant and immediate effects in almoſt every ſtate of the body, from which one might reaſonably conclude, that they would be highly beneficial in many diſeaſes. But as the beſt teſt of their utility are facts, I ſhall ſelect ſome few out of thoſe caſes, which this ſeaſon has already afforded me.

Caſe 1ſt. W. A. A labouring man, of a ſallow duſky complexion, who for twelve years paſt, had been afflicted with phegadenic ulcers in his legs, and for the laſt eight years a ſchirrous liver and ſpleen, for which the moſt powerful deobſtruent, aperient, and alterative medicines had been preſcribed without effect, was employed in ſinking the Bath, and digging drains, to carry off the waſte water for ten days, during which time he was generally up to his knees in mud, ochre, and water. In that time the ulcers on his legs intirely healed up, without the uſe of any kind of medicine or dreſſing, except a piece of linen cloth over the ſores. He was then retained as bath keeper, in which ſtation his buſineſs led him into the bath ſeveral times every day; and in eight weeks (during which time he conſtantly drank the waters) the diſorder in his liver and ſpleen gradually gave way; and at this time, without the uſe of any medicine, he has perfectly recovered his health and complexion. To him the waters at firſt proved gently purgative, and afterwards diuretic.

2d W. W. Aged about nineteen years, for two years paſt had been afflicted with violent rheumatic complaints, to ſuch a degree that at the time of his coming to the bath it was with difficulty he could raiſe himſelf when ſeated, and the muſcles of his neck were ſo rigid and contracted that he could not move his head; he found ſenſible benefit from the firſt uſe of the bath, and by continuing it for about ſeven weeks, perfectly recovered his health, and the uſe of his limbs.

3d. L. M. Had for near two years been afflicted with a weakneſs at his ſtomach, inability in the organs of digeſtion to perform their office, and at times a general laſſitude and wearineſs over every part of his body, brought on by too violent exerciſe. Upon drinking and bathing a ſhort time, he received very ſenſible benefit, all his complaints ceaſed, and he gained a much better appetite than he had ever experienced while labouring under his diſorder.

4th. Mrs. *H.* For five years had been afflicted with a violent

violent cough, attended with pain in her breaſt and a hectic fever which never had abated from the uſe of medicine. By drinking and bathing for four weeks, ſhe perfectly recovered her health without any medicine, and returned home with a very good appetite.

5th. Miſs *R.* For two years paſt had been ſubject to pains in her ſtomach and head, obſtructions in her liver, ſlight cough, perpetually feveriſh, with loſs of appetite, and reſtleſs nights, for which a variety of medicines had ineffectually been uſed, they only affording a temporary relief. In this ſtate ſhe came to the wells, in ſo low a condition that ſhe could not walk the length of a ſtreet but with the greateſt difficulty. At firſt ſhe daily rode to the bath, but after uſing it for ſome time, ſo far recovered, that ſhe could walk without any inconvenience, and after ſtaying about five weeks, returned home very hearty, had a good appetite, and reſted well.

6th. J. F. For the laſt five months ſubject to an inceſſant cough, the effect of a violent cold, came to the wells and drank the waters for ten days, in which time his cough by degrees abated, and he returned home perfectly cured.

7th. Mrs. *K.* Had complaints ſimilar to thoſe mentioned in the caſe of Miſs *R.* but attended with frequent acrid, black ſtools, which afforded no relief from her complaints. She drank the waters, and went into the bath for five weeks, in which time ſhe recovered her complexion and fleſh, and a much better ſtate of health, than ſhe had enjoyed for a number of years.

8th Miſs *H.* About five weeks before ſhe was brought to the bath, was ſeized with ſpaſmodic contractions in her left arm, a paralytic complaint over all the ſame ſide, her ſpeech was much affected, one ſide of her mouth drawn up, and ſhe had hardly any power over one hand and foot, from which the beſt adapted medicines and the uſe of a common cold bath had afforded no relief. Immediately on uſing the Chalybeate bath, her ſpaſms began to abate, and

and ſoon left her. She ſtill remains at bath, has perfectly recovered her ſpeech, and at this time, without the ſtricteſt examination, you cannot diſcover the leaſt remains of her diſorder; ſhe can now work with her needle, and dreſs herſelf as uſual. She took ſome few nervous ſtimulating medicines during the time of bathing.

9th. Mr. *D*: Who had been for ſome years conſtantly ſubject to a nervous cholic, which rendered his life a burthen to him, came to Briſtol, and, after uſing the bath and drinking the waters for two weeks, left the place perfectly cured without the uſe of any other medicine.

10th. Mrs. — For the laſt twelve years of her life was ſubject to obſtructions in her liver, attended with an almoſt conſtant menſtruation, loſs of appetite, oedematous ſwelling in her legs and feet, and diſturbed and reſtleſs nights. At the ſolicitation of her friends, ſhe came to Briſtol with a conſtitution almoſt wore down, and with a prepoſſeſſion that her caſe did not admit of any relief. After a ſhort time bathing, and drinking the waters, the ſwelling in her feet and legs abated, her appetite and ſleep returned, the diſorder in her liver, and every other complaint abated, her colour returned, and ſhe now enjoys a much better ſtate of health than ſhe had experienced for a number of years, with the pleaſing proſpect of a perfect recovery.

From theſe caſes, as well as from the ſenſible effects upon firſt drinking theſe waters, it is evident that they are a ſafe and active Chalybeate, exerting the moſt powerful effects upon the human conſtitution, and agreeing with the moſt delicate ſubjects; and that they are ſafely and ſucceſsfully drank in many caſes where the common and uſual preparations of iron are attended with dangerous conſequences; which perhaps may be owing to the extreme ſubtlety and minuteneſs of its parts, and the interpoſition of ſo large a quantity of pure water; or it may poſſibly depend on the nature of the mixture, which cannot eaſily be imitated by any artificial preparation.

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In particular, theſe caſes teach us, the moſt happy effects are to be expected from theſe waters in old and obſtinate ulcers, which they quickly and readily diſpoſe to heal. That they penetrate the moſt remote and minute veſſels of the body, prove powerful deobſtruents, and remove the moſt obſtinate of diſeaſes, glandulous obſtructions, even after they had reſiſted the moſt powerful medicines. And hence they may prove highly beneficial in ſtrumous and ſcrofulous caſes of children, in jaundice, and other obſtructions of the liver, ſpleen, and myſenteric glands, which lay the foundation for ſo many and ſuch obſtinate chronical complaints; as alſo in caſes of obſtructed catamenia, and where, from relaxation, the flow is too abundant.

They likewiſe, as appears from the caſes of *W. W.* and *L. M.* cure moſt obſtinate rheumatiſms, and that languor and uneaſineſs which often ariſe from too violent exerciſe, and which are nearly allied to the rheumatiſm.

And however prejudices may operate againſt the uſe of Chalybeate waters in diſorders of the lungs, nothing is more certain than that theſe I am now treating of, have afforded effectual relief in violent coughs, even where they have been of long ſtanding, and when attended with hectic complaints; as is evident from the caſes of Mrs. *H.* Miſs *R.* and *J. F.* which laſt was the only caſe in which drinking the waters without bathing completed the cure. Nor indeed is this doctrine of the uſe of Chalybeate waters in pulmonary and hectic complaints intirely new. Morton preſcribes them in the phthiſis pulmonalis, in which he does not ſtand ſingle. And there have been inſtances of conſiderable relief afforded by them even in the laſt ſtages of a conſumption. Some reſtrictions and cautions are certainly neceſſary in their uſe, but they would be too tedious to mention here, and muſt be left to the judgment of the phyſician.

In nervous diſorders ariſing from relaxation, one would naturally expect from them the happieſt effects, and in fact

fact they have been found very effectual in palsies and nervous cholicks, as in cases of Miss *H.* and Mr. *D.* In short, these waters, in every disease which arises from that fruitful source of complaints, relaxed and weakened state of the solids, may with great propriety and truth be termed specific; but in no cases have their good effects been more evident or remarkable, than in a depraved and dibilitated state of the organs of digestion, arising from inactivity, and a sedentary life, from continuing too long in warm climates, or from excessive and free living; here the remedy is immediately applied to the seate of the disease, and of consequence must produce the most immediate effects, nor indeed has there been one instance, in which, if properly persevered in, they have failed of affording relief.

Every particular here asserted is confirmed by experiments that have been carefully made, and by many cases, from which these few are selected, and in stating of which the public may rest assured, that the most scrupulous fidelity has been observed, by

Dear Sir,

Yours, &c.

Oct. 6th, 1769. *JOHN DE NORMANDIE.*

To Doctor Thomas Bond.

The Case of a TETANOS *and* LOCKED JAW, *cured by amazing quantities of* Opium, *by Doctor* Archibald Gloster, *of* St. John's, Antigua; *communicated to* John Morgan, M. D. *F. R. S. Professor of Physic, in the College of Philadelphia; and by him laid before the American Philosophical Society.*

A NEGRO, aged forty years, having suffered the excessive heat of the sun in the day, imprudently laid himself down and slept on the damp earth in the night. The next morning, he perceived a stiffness in the muscles of of his jaws, with a ſomewhat painful, or rather uneaſy ſenſation in thoſe of the neck; having no other complaint at the time, he was blooded, and had an emolient liniment for the parts affected, and was ordered a lenient purge, *ex Mann. & Sal. Glaub.* This operated immediately.

The day following the pains in his jaws increaſed, the muſcles of his back and neck were frequently ſeized with violent ſpaſms, which proceeded to the muſcles of his thighs and legs, rendering them quite rigid.

He could ſcarcely refrain from crying out at theſe times, and could not, but with difficulty, open his teeth, ſo far as to admit a knife between. Luckily for him his under jaw projected naturally beyond the upper jaw, ſo that his food paſſed between his teeth, and he had no great difficulty in ſwallowing liquids. His pulſe was ſlow and ſmall, and his ſkin was below the natural heat: He had no ſleep, for ſo ſoon as he doſed, ſevere ſpaſms would rouſe him.

Having obſerved in the London Medical Eſſays, that theſe complaints had been ſucceſsfully treated with free exhibitions of opium, and having before this obſtinate caſe came under my obſervation relieved patients by very liberal doſes of it, I thought nothing in the Materia Medica would be ſo likely to yield relief in this caſe. I therefore preſcribed on the evening of the ſecond day as follow, *viz.*

June 7th. R. *Pulv: Contrayerv: Com': ℨ iſs. Nitre: pur: Camph: Opic pur: ana ℨſs. M D in P Æ ſex. Cap: unam 3tia quaque horâ.*

8th. He was no better, his ſtiffneſs continued with frequent ſpaſms ſevere and painful. The powders were repeated with ℈ij of opium.

9th. He had no ſleep, no diſturbance in his mind, nor the leaſt affection of the Senſorium Commune which could be attributed to the opium. His powders were repeated as yeſterday; he took liquid food, ſuch as weak broths, gruels and ptiſans. A general bath was ordered, in which he was put ſtiff as a ſtake, and the ſpine with all the rigid

parts

parts were well rubbed after the uſe of it, with a liniment,

ex Camph. ʒi. *ſolut: in Ol: Oliv:* ℥vj.
Tenet: Tebaic: ʒiij. *M:*

10*th*. The powders were repeated with ʒ*i* of opium to be given every two hours as uſual.

A particular bath likewiſe, conſiſting of emollient and diſcutient herbs, was directed for the muſcles of his jaws and neck, which were moſt ſeverely convulſed; indeed the maſſeter muſcles were to the touch like wood.

11*th*. The patient was no better: I began to deſpair of him: Emollient clyſters were thrown up morning and evening, he being very coſtive, as well from the uſe of the opium, as from the effects of the diſeaſe. His mind was clear and undiſturbed, he had no ſleep, nor even drowſineſs; nor did there appear any of the uſual effects of opium given in much ſmaller quantities. However I knew that nothing but opium could anſwer our purpoſe, and though I had gone as great lengths with it as any one in theſe parts would venture, yet I not only perſiſted in its uſe, but increaſed its quantity to ʒ*iſs*. in ſix powders, uſing leſs nitre and camphor.

12*th*. Having taken the laſt ſix powders, he thought his ſpaſms recurred leſs frequently. Yet there was no relaxation of the muſcles of the jaws, nor any other favourable alteration. His clyſters were repeated, the baths and liniment continued, and his powders were again ordered.

13*th*. Every thing continued the ſame. He had no ſleep, nor any relaxation of the muſcles. His diſcharges by the clyſters were hard dry ſcybals; his mind was ſtill calm, and not a function of it impaired, or in the leaſt altered. He was wakeful in the day as uſual, and in the evening had an inclination to reſt, but continued to be diſturbed by theſe dreadful ſpaſms.

Still between hopes and deſpair I ordered ſix powders with *two drachms of opium* which was twenty grains of pure ſolid opium in each doſe, to be given every three hours.

14*th*.

14th. Having taken all theſe, he was rather eaſier, his ſpaſms were leſs frequent, yet no perceptible relaxation of the muſcles of his lower jaw followed. His diet was continued as above. His clyſter produced the ſame diſcharges as before. He was eaſier always after the general bath, and the rubbing in of the liniment, all which were continued, and as I had ventured as far with opium as I thought it prudent, I ordered as follows:

R Pul. Contray. Comp.
Cinnab. Antim. } *ana* ℈jſs.
Opii pur.
Moſch. Chinens. ℈ſs to be divided into ſix parts, and one to be given every three hours.

15th. He ſaid he was eaſier, had a very little ſleep; his ſpaſms were leſs frequent, and he was in better ſpirits. This encouraged me to hope for a relaxation of theſe cruel ſpaſms, which have been fatal to ſo many. I therefore boldly returned to the former doſe of opium, and gave ℈ij in the powders with the muſk and cinnabar.

16th. The patient found himſelf much the ſame as yeſterday. His baths, liniments, clyſters, frictions and powders were repeated.

17th. He found himſelf much eaſier to day, his powders were repeated, and his ſpaſms were much relaxed every where, except in his right leg which was very painful. The maſſeters gave way a very little, ſcarcely perceptible.

18th. He was much the ſame as yeſterday, having gained however a little ground. The ſame means were continued, and his powders repeated.

19th. He was rather better, and more free from pain; he could ſit up; the muſcles of the back part of the body were ſo far relaxed as to admit of that poſture, without much pain. He moved his lower jaw from ſide to ſide with ſome eaſe. The ſame powders, &c. were continued.

20th. He could open his mouth ſo far as to admit my little finger into it, but this was done with a horrid grin, and I was afraid the ſpaſm would return with the effort, which is very common. The medicines were repeated.

21ſt. He was much in the ſame condition; ſtill had ſpaſms at greater diſtances, had ſome ſleep, and ſaid he could eat, but I was unwilling to hazard the experiment. His liquid food was continued, his medicines were repeated, and every thing obſerved with the ſame care as before.

22d. He continued to mend; has had ſome ſleep; the maſſeters were relaxed ſtill more; the ſpaſm recurred leſs frequently. He complained of lowneſs of ſpirits, and was deſirous of tobacco to ſmoak, which was allowed. He had a mixture of four ſpoonfuls of old rum in a pint of warm water. His powders were ordered as before with ʒ*j* of opium, and the uſual quantity of muſk, to be given every four hours only.

23d. He was much better, had ſome ſleep, opened his mouth, could chew, and ſtill enjoyed a calm undiſturbed mind. His powders were repeated with ℈*jj of opium which makes fifteen hundred grains of ſolid opium taken in ſeventeen days.*

24th. He had better reſt laſt night and more ſleep than during his illneſs before. He eat a bit of lamb, could open his mouth no farther than yeſterday, but his ſpaſms recurred leſs frequently. His powders with ℈*jj* of opium were ordered as before.

25th. He was much better in all reſpects; he ſlept pretty well laſt night, and could move his legs and arms very freely. There was ſtill a ſpaſm on his maſſeter muſcles, as he could not freely open his mouth. Nothing was ordered but a continuance of his baths, liniments, clyſters, frictions. The powders ordered for him yeſterday not being yet expended.

26th. He continued to mend, although he had not taken about twenty grains of opium the two preceding days. There was no alteration in his ſpirits. The ſpaſms were more relaxed. From this time he was viſited leſs frequently, his medicines given more irregularly, but as he had ſpaſms which recurred now and then 'till the 15th of July he had his bath continued, and took about ʒ*jſs* of muſk, and 96 grains of opium in that ſpace.

July 20th.

July 20th. He is now perfectly well, in good ſpirits, and finds no inconvenience from his preceding ſickneſs, nor any miſchief from the amazing quantity of opium he has ſwallowed down. It is to be noted that from the 16th he was put upon a courſe of nervous pills ex G. Aſſafœtid. and Cinnabar of Antimony without any opium.

Leſt any perſon ſhould imagine the opium which was made uſe of in this caſe, might not be good, I think proper to add that it was freſh, and appeared to be very good, being procured from Meſſrs. Beaven, Druggiſts in London; and that it always anſwered to the uſual effects of opium in the common doſes, in every other inſtance, having made ſufficient uſe of it in my practice, to be certain of its quality.

An account of the effects of the STRAMMONIUM, *or* Thorn-Apple, *by* Benjamin Rush, M. D. *Profeſſor of Chymiſtry, in the College of Philadelphia.*

I WAS called to a child, (between three and four years old) a few days ago, which appeared to be ill with a violent fever, delirium, tremors in her limbs, and a general eruption on her ſkin, accompanied with a conſiderable ſwelling, itching and inflammation. As the ſeaſon for inflammatory diſeaſes was now over, (it being the beginning of Auguſt) and as I had neither ſeen, nor heard, of any caſes which bore the leaſt reſemblance to this in the city, I acknowledge I was much ſurpriſed at it, and knew not what cauſe to call in, to account for a fever attended with ſuch acute ſymptoms, at a time of the year, when moſt of people, eſpecially children, were ſubject to complaints of a very different nature. As her pulſe was pretty full and ſtrong, I immediately ordered her to looſe a little blood, and gave her a few laxative medicines. Beſides theſe, I ordered her to be put into a warm bath, and recommended the application of ſtimulating cataplaſms to her feet. The opening

opening medicines operated the evening after I gave them, and brought away a great number of the afcarides worms which I far from thinking were the caufe of her diforder, as the fymptoms ftill continued with as much violence as ever. I cannot help remarking here, that two of the moft powerful vermifuge medicines we are acquainted with, viz. the *Anthelmia*, or *Worm Grafs* of Jamaica,* and the *Carolina Pink Root*, are both confiderably narcotic, and when taken in too large quantities produce effects fomewhat fimilar to thofe of the Strammonium. Do their vermifuge depend upon their narcotic qualities alone? Are all narcotic fubftances vermifuge? Or may not they be rendered fo, by adminiftering purges after them, in the manner we are directed, after ufing the worm grafs or pink root? Thefe are queftions, which are perhaps foreign to our prefent fubject, and yet when refolved, may have their ufes in medicine. But to return; the mother of the child finding moft of the remedies we had ufed ineffectual, informed me for the firft time, that they had a quantity of *Stramonium* growing in their garden, where the child generally played, and that fhe recollected that fhe had been once difordered in a flight manner, from eating fome of the feeds of it. This led me immediately to treat her complaints in a very different manner from that I had formerly done. I gave her a puke of two grains of Tart. Emetic, diffolved in water by fpoonfuls. It vomited her feveral times, but brought nothing but phlegm from her ftomach. After this I gave her fweet oil in large quantities, mixed with a little of the oleum Ricini, which in a little time brought away a great number of the Strammonium feeds. The relief fhe got from this evacuation, encouraged me to repeat the fame medicine, which I did every day for near a week, till I began to flatter myfelf they were all difcharged from the body. But notwithftanding this, fhe was far from recovering fo rapidly as we wifhed. The tremors ftill continued in her hands at times; her delirium abated, but

* See Dr. Brown's Natural Hiftory of Jamaica.

but it left her ſtupid and blind. The pupils of her eyes were much dilated, and ſhe catched at the bed clothes and at every thing around her, in the ſame manner as a perſon in the laſt ſtage of a fever. As I was perſuaded the oil ſhe had taken, had evacuated all ſuch of the ſeeds as were in the guts, I began to ſuſpect, that her complaints were ſtill kept up by a few ſeeds which ſtill remained in her ſtomach. I therefore gave her four grains of Tart. emetic, in the manner I formerly mentioned, and had the pleaſure to find, that it brought up above eighty of the ſeeds, the ſecond time it puked her. Finding the ſtupor and blindneſs ſtill continue, I repeated the puke, which brought up above twenty more. Upon this all her complaints vaniſhed, and in a few days ſhe appeared perfectly well.

It may perhaps appear ſurprizing to ſome, how ſo many of the ſeeds of the Strammonium ſhould be lodged ſo long in a child's ſtomach, without producing much worſe effects than thoſe we have mentioned, eſpecially when we conſider the accounts which Dr. *Stork* has given us of the effects of a very ſmall quantity of it. In order to account for this, we muſt remark, that the ſeeds the child ſwallowed were of the laſt year's growth, and were become ſo dry and hard as to reſemble little pieces of horn. Beſides the ſeeds of the narcotic plants in general contain but very little of their virtues; even the ſeeds of the poppy itſelf may be taken in large quantities, without producing any of the effects of opium. Dr. *Stork*'s experiments were made entirely with the extract of the Strammonium, two grains of which contain more of the narcotic quality of the plant, than three hundred of the dried ſeeds.

My chief deſign in relating the above caſe, is to make two obſervations, which may be of uſe in other caſes.

1. We learn the wonderful connection between the ſurface of the ſkin and the alimentary canal. Eruptions upon the ſkin are generally attributed to an acrimony in the blood. In the preſent caſe we ſee an eruption occaſioned by acrid ſubſtances irritating the ſtomach and bowels.

It

It would be eaſy to point out ſeveral other matters both of a vegetable and animal nature, which produce effects of the ſame kind almoſt as ſoon as they are received into the ſtomach, and long before they are ſuppoſed to have undergone its action, or of being mixed with the blood. It is impoſſible to tell, what ſpecies of the eruptive diſeaſes are occaſioned by the preſence of morbid matter in the primæ viæ; but in all thoſe caſes, where it is doubtful, it would not be amiſs to ſuſpect it, and to order our medicines accordingly. Dr. *Korr* (of St. Croix) informed me, that he had once an obſtinate humour upon his arm, which alternated with a complaint in his ſtomach, ariſing from the too great predominance of an acid, and that he was never able to remove it with all the applications he could uſe, till he cured the diſorder in his ſtomach by bitter and aſtringent medicines.

A ſecond obſervation upon the above caſe, which I would beg leave to make is, that pukes may often be given to evacuate the contents of the ſtomach, and notwithſtanding they work tolerably well, may not anſwer the purpoſes we intended by them. How often do we diſcover the ſtrongeſt marks of worms being lodged in the ſtomach, and yet how ſeldom are we able to bring them up from thence, by the ordinary pukes we adminiſter. In this, and like caſes therefore, it ſhould be our practiſe to increaſe the doſes of our vomits, or to give ſuch ſubſtances as will deſtroy the life, or virus of thoſe things we would wiſh to expel from the ſtomach. Had the laſt puke, which I gave to the child, which had eaten the Strammonium ſeeds, failed of bringing them up, I have no doubt, but what the plentiful uſe of acids *, (which are ſuch powerful antidotes to other narcotic ſubſtances,) would have rendered them harmleſs. And if we may be allowed to reaſon from analogy, I think we may preſume, that there is ſcarcely a poiſonous ſubſtance in nature but what has an antidote provided for it. What theſe antidotes

* Since writing the above, I have had the pleaſure of hearing from Dr. *Thomas Bond*, and Dr. *Harris*, an account of the good effects of lemon juice in a ſimilar caſe, after the ſtrongeſt pukes had been given to no purpoſe.

antidotes are, can never be determined by reafoning *a priori*, but muft be found out by experiments alone. Confidering the frequency of the accidents which arife from poifons, and the little relief we are able to afford in them, I cannot help thinking an enquiry into this fubject a matter of great importance, and well worthy of the attention of the faculty of phyfic.

An ENQUIRY *into the nature, caufe and cure of the* ANGINA SUFFOCATIVA, *or* Sore Throat Diftemper, *as it is commonly called by the inhabitants of the city and colony of New-York, &c. By* SAMUEL BARD, *M. D. and Profeffor of the Practice of Phyfic in King's College, New-York; communicated to* JOHN MORGAN, *M. D. F. R. S. Profeffor of the Theory and Practice of Phyfic in the College of Philadelphia.*

"*AS a faithful and accurate hiftory of difeafes, their various fymptoms and method of cure, is the moft effec-*
"*tual way of promoting the art of healing; phyficians fhould*
"*defcribe with the utmoft care, the difeafes they would*
"*treat of, and the good and bad effects of any method or*
"*medicines they have ufed in them. But in a more parti-*
"*cular manner is this neceffary, when any new and un-*
"*common diftemper occurs, of which the peculiar patho-*
"*gnomonic and diagnoftic figns fhould be carefully laid*
"*down, and a particular account given of what evacu-*
"*ations, regimen and medicines were ufeful or hurtful in it.*"
—HUXHAM *on* FEVERS, *p.* 267.

FROM a conviction of the truth and importance of thefe obfervations, and in obedience to the precept of fo great a man as *Huxham*, I have determined to attempt the hiftory of a difeafe, which has lately appeared among the children of this city, and which, both as an uncommon and highly dangerous diftemper, well deferves an attentive confideration. In delivering it therefore, I fhall firft carefully

fully enumerate the ſymptoms with which it was attended, and deſcribe the appearances which occurred on inſpecting the bodies of ſuch as died of it; and then lay down the method of cure which has been found to be moſt ſucceſsful in its treatment.

In general, this diſeaſe was confined to children under ten years old, though ſome few grown perſons, particularly women (while it prevailed) had ſymptoms very ſimilar to it. Moſt of thoſe who had it were obſerved to droop for ſeveral days before they were confined. And the firſt ſymptoms, in almoſt every caſe, were a ſlightly inflamed and watery eye, a bloated and livid countenance, with a few red eruptions here and there upon the face, and in one caſe a ſmall ulcer in the noſe, whence ooſed an ichor ſo ſharp as to inflame and erode the upper lip. At the ſame time, or very ſoon after, ſuch as could ſpeak, complained of an uneaſy ſenſation in the throat, but without any great ſoreneſs or pain. Upon examining it, the tonſils appeared ſwelled and ſlightly inflamed, with a few white ſpecks upon them, which, in ſome, increaſed ſo as to cover them all over with one general ſlough; but this, although a frequent ſymptom, did not invariably attend the diſeaſe; and ſome had all the other ſymptoms without it. The breath was either no ways offenſive, or had only that kind of ſmell which is occaſioned by worms; and the ſwallowing was very little, if at all impeded.

Theſe ſymptoms, with a ſlight fever at night, continued in ſome for five or ſix days, without alarming their friends; in others a difficulty of breathing came on within twenty-four hours, eſpecially in the time of ſleep, and was often ſuddenly encreaſed to ſo great a degree as to threaten immediate ſuffocation. In general, however, it came on later, increaſed more gradually, and was not conſtant; but the patient would now and then enjoy an interval of an hour or two, in which he breathed with eaſe, and then again a laborious breathing would enſue, during which he ſeemed incapable of filling his lungs, as if the air was drawn through a too narrow paſſage. This

This ſtage of the diſeaſe was attended with a very great and ſudden proſtration of ſtrength; a very remarkable hollow dry cough, and a peculiar change in the tone of the voice; not eaſily deſcribed, but ſo ſingular, that a perſon who had once heard it, could almoſt certainly know the diſeaſe again by hearing the patient cough or ſpeak. In ſome the voice was almoſt entirely loſt, and would continue very weak and low for ſeveral weeks after recovery. A conſtant fever attended this diſeaſe, but it was much more remarkable in the night than in the day time; and in ſome there was a remarkable remiſſion towards morning. The pulſe at the wriſt was in general quick, ſoft and fluttering, though not very low, and it was remarkable, that at the ſame time the pulſations of the heart were rather ſtrong and ſmart than feeble. The heat was not very great, and the ſkin was commonly moiſt.

Theſe ſymptoms continued for one, two, or three days. By that time it was uſual for them to be greatly increaſed in ſuch as died; and the patients, though commonly ſomewhat comatous from the beginning, now became much more ſo; yet even when the diſorder was at the worſt, they retained their ſenſes, and would give diſtinct anſwers, when ſpoken to; although on being left to themſelves, they lay for the moſt part in a lethargic ſituation, only raiſing up now and then to receive their drink. Great reſtleſsneſs and jactation came on towards the end of the diſeaſe, the ſick perpetually toſſing from one ſide of the bed to the other, but they were ſtill ſo far comatous as to appear to be aſleep, immediately upon changing their ſituation or poſture. An univerſal languor and dejection were obſerved in their countenances; the ſwelling of the face ſubſided; a profuſe ſweat broke out about the head, neck and breaſt, particularly when aſleep; a purging in ſeveral came on; the difficulty of breathing increaſed, ſo as to be frequently almoſt entirely obſtructed, and the patient died apparently from the ſuffocation. This commonly happened before the end of the fourth or fifth day; in ſeveral within thirty-ſix hours from the time the difficulty of breathing came on firſt. One child, however, lived under theſe circumſtances to the eighth day; and the day before he died, his breath and what he expectorated, was ſomewhat offenſive; but this was the only inſtance in which I could diſcover any thing like a diſagreeable ſmell, either from the breath or expectoration.

Out of ſixteen caſes attended with this remarkable ſuffocation in breathing, ſeven died; five of them before the fifth day, the other two about the eighth. Of thoſe who recovered, the diſeaſe was carried off in one, by a plentiful ſallivation, which began on the ſixth day; in moſt of the others by an expectoration of a viſcid mucus.

I diſtinguiſh between the ſallivation and expectoration, becauſe in one the diſcharge ſeemed to come from the ſalivary glands, and was attended with little or no cough; in the others it manifeſtly came from the trachea, and was attended with an inceſſant cough; and I judged the ſallivation to have been a natural criſis, as the patient had taken but grs. vi of calomel before it came on. Her gums were not inflamed, her teeth were not looſe, nor had her breath, or ſaliva, the ſmell of perſons under a mercurial ſalivation. In this caſe the voice, in the ſpace of a few hours, from being pretty ſtrong and loud, became ſo low as to be with difficulty heard.

One of the firſt families in which this diſeaſe appeared, was that of Mr. William Waddell of this place. He had ſeven children in his family, all of whom were taken ill one after another; the four firſt had the diſeaſe as I have juſt now deſcribed, and three of theſe died; the one who recovered was the inſtance I mentioned, in which the diſeaſe was carried off by a ſallivation. The other three were the youngeſt. They had not the difficulty of breathing, but in its ſtead very troubleſome ulcers behind their ears. Theſe began with a few red pimples, which ſoon ran together, itched violently, and diſcharged a great deal of very ſharp ichor, ſo as to erode the neighbouring parts, and in a few days ſpread all over the back part of the ear, and down upon the neck. They all had a fever, particu-

larly

larly at night, and one of them had a perpetual tenefmus. This fymptom appeared in feveral who had the difficulty of breathing, but in none to fo remarkable a degree as in this child.

After this, many other children had fimilar ulcers behind their ears; and fome of them feemed flightly affected with the difficulty of breathing; but it never became alarming while this difcharge continued. Thefe ulcers would continue for feveral weeks, and appeared covered in fome places with floughs, refembling thofe on the tonfils; and at laft grew very painful and uneafy.

In fome cafes they were attended with fwellings of the parotid and fublingual glands, which fubfided on the eruptions appearing behind the ears, and difcharging freely, and again fwelled upon the difcharge being checked.

I met with but two inftances of any thing like this complaint in adult perfons. Both of thefe were women; and one of them had affifted in laying out two of the children that died of it. At firft her fymptoms refembled rather an inflammatory angina, but about the third day the tonfils appeared covered with thick floughs; her pulfe was low and feeble; fhe had a moift fkin; a dejection of fpirits; and fome degree of anxiety, though nothing like the difficult breathing of the children.

The other was a foldier's wife, who for fome time, before fhe perceived any complaint in her throat, laboured under a low fever. Her tonfils were fwelled, and entirely covered with floughs, refembling thofe of the children; but her breath was more offenfive, and fhe had no fuffocation.

I have had an opportunity of examining the nature and feat of this difeafe, from diffection, in three inftances. One was a child of three years old. Her firft complaint was an uneafinefs in her throat. Upon examining it the tonfils appeared fwelled and inflamed, with large white floughs upon them, the edges of which were remarkably more red than the other parts of the throat. She had no great forenefs in her throat, and could fwallow with little or no difficulty. She complained of a pain under her left breaſt; her pulſe was quick, ſoft and fluttering. The heat of her body was not very great, and her ſkin was moiſt; her face was ſwelled; ſhe had a conſiderable proſtration of ſtrength, with a very great difficulty of breathing; a very remarkable hollow cough; and a peculiar change in the tone of her voice. The next day her difficulty of breathing was increaſed, and ſhe drew her breath in the manner before deſcribed, as if the air was forced through too narrow a paſſage, ſo that ſhe ſeemed incapable of filling her lungs: She was exceedingly reſtleſs, toſſing perpetually from ſide to ſide, was ſenſible, and when aſked a queſtion, would give a pertinent anſwer, but otherways ſhe appeared dull and comatous. All theſe ſymptoms continued, or rather increaſed, untill the third night, on which ſhe had five or ſix looſe ſtools, and died early in the morning.

Upon examining the body, which was done on the afternoon of the day ſhe died, I found the fauces, uvula, tonſils, and root of the tongue interſperſed with ſloughs, which ſtill retained their whitiſh colour. Upon removing them, the parts underneath appeared rather pale than inflamed. I perceived no putrid ſmell from them, nor was the corps in the leaſt offenſive. The œſophagus appeared as in a ſound ſtate. The epiglottis was a little inflamed, on its external ſurface, and on the inner ſide, together with the inſide of the whole larynx, was covered with the ſame tough white ſloughs, as the glands of the fauces. The whole trachea, from the larynx down to its diviſion in the lungs, was lined with an inſpiſſated mucus, in form of a membrane, remarkably tough and firm; which, when it came to the firſt ſubdiviſions of the trachea, ſeemed to grow thin and diſappear: It was ſo tough as to require no inconſiderable force to tear it, and came out whole from the trachea, which it left with much eaſe; and reſembled more than any thing, both in thickneſs and appearance, a ſheath of thin ſhammoy leather. The inner membrane of of the trachea was ſlightly inflamed; the lungs too appeared inflamed as in peripneumonic caſes; particularly the

the right lobe, on which there were many large livid ſpots, though neither rotten or offenſive; and the left lobe had ſmall black ſpots on it, reſembling thoſe marks left under the ſkin by gun powder. Upon cutting into any of the larger ſpots, which appeared on the right lobe, a bloody ſanies iſſued from them without frothing, whereas upon cutting thoſe parts which appeared ſound, a whitiſh froth, but ſlightly tinged with blood, followed the knife.

This is a faithful hiſtory of this complaint, as it appeared in all the caſes I have met with.

Dr. *Douglas*, of Boſton, in the year 1736, publiſhed an account of the firſt appearance of the diſeaſe in this country; from which I find that it put on much more malignant and putrid ſymptoms at that time, than it has lately been attended with, eſpecially in this city, where diſeaſes of the putrid kind ſeldom occur; and was ſo conſtantly attended with the eryſipelatous ſymptoms, that he terms it an eruptive miliary fever, with an angina ulcuſculoſa. And even in this place, ſome of the oldeſt, and moſt reſpectable practitioners, aſſure me, they have ſeen, but a few years ago, the ſame diſeaſe of which I am now treating, attended both with the eryſipelatous appearances and highly putrid ſymptoms.

Upon the whole, I am led to conclude that the preſent diſeaſe, as well as other ſimilar diſeaſes, which have made their appearance at different times, and in different places, aroſe from a particular diſpoſition of the air, or *miaſmata ſui generis;* which more or leſs, according to particular circumſtances, generate an acrimony in the humours, and diſpoſe them to putrefaction; and which have a ſingular tendency to attack the throat and trachea, affecting the mucous glands of theſe parts, in ſuch a way, as to occaſion them to ſecret their natural mucus, in greater quantities than is ſufficient for the purpoſes of nature: And which in this particular ſpecies, when ſecreted, is either really of a tougher or more viſcid conſiſtence than natural, or is diſpoſed to become ſo from reſt and ſtagnation.

The

The diſeaſe I have deſcribed, appeared to me to be of an infectious nature, and as all infection muſt be owing to ſomething received into the body, this, therefore, whatever it is, being drawn in by the breath of a healthy child, irritates the glands of the fauces and trachea, as it paſſes by them, and brings about a change in their ſecretions. The infection, however, did not ſeem in the preſent caſe to depend ſo much on any generally prevailing diſpoſition of the air, as upon effluviæ received from the breath of infected perſons. This will account why the diſorder ſhould go through a whole family, and not affect the next door neighbour; and hence we learn a very uſeful leſſon, namely, to remove all the young children in a family, as ſoon as any one is taken with the diſeaſe; by which caution, I am convinced, many lives have been, and may again be preſerved.

I ſhall now proceed to deliver the method of cure, which was found moſt ſucceſsful in the diſeaſe, as far as it fell under my own obſervation. And in the firſt place, as from all the ſymptoms related, it is evident that this diſorder is not always, and in every ſtage, attended with any remarkable degree of putreſcency; and from the diſſections it appears, that an inflammation of the lungs, if not the cauſe, may at leaſt be the conſequence of the diſtemper, one would imagine that V. S. and evacuations were not totally to be forbid; and accordingly we find Dr. *Douglaſs* directing us, that if the fever is high, and the patient is plethoric or accuſtomed to veneſection, to take away ſome blood, but with diſcretion: And if the tonſils are much inflamed, with great pain and difficulty in ſwallowing, to uſe veneſection in the jugulars. And *Huxham* acknowledges, in the ulcerous ſore throats of which he treats, "That there were certainly ſome of them with a "pretty ſmart fever that bore bleeding at the beginning "with advantage, and that he was obliged in ſeveral to "give nitre with diaphoretics."

But *Fothergill* ſpeaking of the ſore throat diſtemper, which came under his notice, and which ſeems to be of a more

more highly putrid kind, aſſures us, that although in ſuch caſes he has been induced to order bleeding, yet it did not appear to have any advantageous effects; and concludes, that nothwithſtanding the vehemence of the ſymptoms, it is proper in general to omit this evacuation; nor can I hear of any perſon who has uſed it, in the ſore throat (which appeared lately amongſt us) with ſucceſs; ſo that I hardly dare venture to preſcribe it, but muſt leave it to the diſcretion of the phyſician, until farther experience ſhall confirm its utility, or forbid its uſe.

There is ſomething very ſingular in the tendency of the virus in this diſeaſe, as I have already hinted, to attack the throat and trachea, nor are the effects its produces there leſs remarkable. Dr. *Fothergill*, in his account of the putrid ſore throat, deſcribes the ſloughs on the tonſils, as mortified eſcars; but in that ſpecies of ſore throat I met with, they appeared as in the trachea, to be nothing more than the mucus of the part, preternaturally thickened into the form of a membrane. At firſt I imagined this to be only a peculiar kind of pus, which is ſometimes found upon the ſurface of internal inflamed membranes; but upon removing it, the membrane of the trachea did not appear to have been ſufficiently inflamed, to juſtify ſuch an opinion. And in a caſe I lately had an opportunity of examining, where the patient died of a very violent inflammation of the internal membrane of the trachea, there was no ſuch mucous lining to be diſcovered upon it. Nor can I think it the effect of any ſpaſm or conſtriction of the lungs, as I never knew it remarked as occuring in ſuch as have died of ſpaſmodic aſthmas, nor is it long ſince I had an opportunity of being ſatisfied as to this particular, in the caſe of a ſailor, who actually died in a violent fit of a ſpaſmodic aſthma, which had laſted for ſeveral days; and yet there was not the leaſt appearance of any ſuch mucous membrane after death, either in the large or ſmaller branches of the trachea. This morbid appearance is particularly noticed by ſeveral gentlemen who have favoured us with an account of the diſſections of thoſe who have died

died under an angina*. Dr. *Monro*, sen. found it in feveral he diffected, and † *Rolandus Martin*, Profeffor of Anatomy at Stockholm, mentions a very remarkable inftance of it, where this mucous membrane defcended into the minuteft branches of the trachea arteria, growing thinner as it defcended deeper into the lungs, until it refembled the membrane which lines the fhell of an egg. He adds, that the lungs were not inflamed, nor in the leaft injured, fo that the infant died merely from the fuffocation. And even thofe who have written of the ulcerous fore throat, as Drs. *Huxham* and *Douglas*, and have not given the appearances from diffection, yet have mentioned many mucous linings being expectorated, which *Douglas* compares to the cuticle raifed by verfications, and *Huxham* conceived to be really pieces of the internal membrane of the the trachea. So that this is a circumftance which feems to be peculiar to the difeafe; and I believe thofe who die, on the fecond or third day, with the ftrangulated breathing, are generally fuffocated by this membrane. The affection therefore, of the mucous glands, muft be confidered as the proximate caufe of this difeafe, and readily accounts for all the other fymptoms; and from it only, efpecially in the beginning of the complaint, can we fafely draw our indications of cure; paying at the fame time a conftant attention to any fymptoms of putrefcency that may occur.

And it is from viewing the difeafe in this light only, that we can account for the ufe of Mercury in it; a medicine, which if we confider it as a fpafmodic complaint, cannot poffibly have any good effect; or if we look upon it merely as a putrid difeafe, feems directly contrary to every intention of cure; but which, neverthelefs, undoubted experience has proved to be highly beneficial. And indeed, if we confider the peculiar acrimony which this difeafe occafions in the fluids in general, independent of putrefaction, and the infpiffation of the mucus of the trachea, we might reafonably conclude *a priore*, that Mercury, which in general corrects acrimony in a very remarkable manner, thins

* See Dr. Withering's Thefis on the Angina Grangrenofa.

† Idem.

thins all the mucous ſecretions, particularly thoſe of the mouth and fauces, and affects the breath very early, would be beneficial in it, and either prevent the formation of this membrane, or promote its ſeparation and expulſion, when already formed. Dr. *Douglas* viewing the matter in this light firſt tried it, and meeting with ſucceſs, afterwards recommended it to others; and in a very few words has explained both his theory and practice in this particular. " Any affection of the throat (ſays he) does frequently " produce a natural ptyaliſm. Mercurials uſed with diſcre- " tion, are a kind of ſpecific in ſuch like ulcers and ulcuſ- " cula, and in fact here moiſten the throat and mouth, ſtop " the ſpreading of the ulcuſcula, and promote the caſting " off of the ſloughs; and as an acceſſary advantage, the pa- " tients being moſtly children, deſtroyed worms. Amongſt " all the preparations calomel anſwered beſt. The gentle " vomiting and few ſtools that it occaſioned in ſome, " did not confound the natural courſe of the diſtemper. " Turbith produces too ſtrong a revulſion, and the erup- " tion is thereby too much diverted. This diſtemper did " not well bear any other evacuation but Mercurials. And in another place, ſays, " the deſpumation of this acrid in- " quination of the juices in our diſtemper, that is, its na- " tural criſis, ſeems to be by the patent and ſalutary emunc- " tories of the fauces and ſkin. In corroſive taints, v. g. " venereal and others, a mercurial ptyaliſm, and ſudorific " decoction of the woods anſwer beſt, this gave us the " hint of promoting the tendency of nature in our illneſs, " by mercurials and gentle breathing ſweats in bed, which " with good management ſeldom failed, excepting where " the necroſis was irremediable from the beginning."

There is a ſingularity in this Gentleman's ſtile, but his obſervations are accurate and judicious; and, as he ſays himſelf, being founded upon real, not imaginary caſes, muſt therefore be of permanent truth. And indeed the caſe I met with, in which the diſorder (and in no trifling degree) was carried off by a very copious ſalivation, is, of itſelf, almoſt

almoſt a ſufficient vindication of this practice; and together with the caſe of that child whoſe body I firſt opened, where I ſaw the moſt powerful antiſeptics faithfully adminiſtered, which not only failed of ſucceſs, but did not even mitigate the ſymptoms, was what firſt led me to enquire more minutely into the nature of the diſeaſe, and of the remedies which had been uſed with moſt ſucceſs in its cure.—Upon reading Dr. *Douglaſs*'s little eſſay, (which gave me the greater ſatisfaction becauſe he wrote upon the diſeaſe as it appeared in this country, and under his own immediate obſervation,) I found he placed his chief dependence upon mercurials, which I was the more readily induced to make trial of, from the appearance I found from diſſection, and the idea I thence naturally formed of this complaint; and the experience I have had of their good effects, fully juſtifies the recommendation Dr. *Douglaſs* has given of them; as the more freely I have uſed them, the better effects I have ſeen from them. Calomel is what I have commonly uſed, and have given it to the quantity of 30 or 40 grains, in five or ſix days, to a child of three or four years old; not only without any ill effects, but to the manifeſt advantage of my patient; relieving the difficulty of breathing, and promoting the caſting off the ſloughs, beyond any other medicine. That it may more immediately enter the blood, and act more powerfully as an attenuant, it ſhould at firſt be joined with a mild opiate; and what is a little remarkable, is, that given in this way, it ſeldom or never raiſed in children any ſalivation; though indeed I ſhould be apprehenſive of no ill conſequences from it, if it ſhould. After the firſt or ſecond doſe, the opiate ſhould be ommitted, as then the mercury will not be ſo apt to go off by the inteſtines, and the opiate if continued will, by leſſening the ſenſibility of the trachea, counteract in ſome meaſure the attenuating effects of the calomel, and alſo increaſe the coma. The operation of the calomel, as an expectorant, will be very much promoted by a prudent uſe of oxymel of ſquills, or leaſt

that

that ſhould purge, by ipecacuahna, given ſo as to puke two or three times.

But although I conſider mercury as the baſis of the cure, eſpecially in the beginning of this diſeaſe, I by no means intend to condemn, or omit the uſe of proper alexipharmics and antiſeptics; of which the ſerpentaria, contrayerva, and peruvian bark are the moſt powerful, and have been uſed with the greateſt ſucceſs. Sweating is certainly one way, by which nature carries off this diſeaſe; inſomuch that *Huxham* declares he did not remember to have had one patient miſcarry, who fell into a ſoft, eaſy, univerſal ſweat: And therefore, whatever method of cure was purſued, this ſhould be always connected with it. The patient ſhould be kept in bed, and as the diſeaſe has a putrid tendency, the diaphoretics ſhould be of the alexipharmic and antiſeptic kinds. The bark is certainly a moſt powerful antiſeptic, and when the ſymptoms of putrefaction, ſuch as a moiſt clammy ſkin, highly putrid breath, and hæmorrhages appear, muſt be attended with advantage. But early in the diſeaſe, while the ſkin continues dry, attended with a great difficulty of breathing, and the ſymptoms of inflammation rather than thoſe of putrefaction prevail, it ſhould be omitted; and here the removal of the diſorder ſhould be attempted, chiefly, by mercurials and mild ſudorifics. And indeed I think the whole art, in the cure of this diſeaſe, depends upon properly timeing theſe remedies, and inſiſting upon one or the other, as the ſymptoms of putrefaction do, more or leſs, prevail.

But beſides a ſalivation, and ſweating, nature frequently carries off this diſeaſe by an eruption on the ſkin, ulcers behind the ears, or in other parts of the body, or an external ſwelling of the throat, all of which ſeem evidently to indicate the uſe of bliſters. And accordingly Drs. *Fothergill* and *Huxham* recommended them; particularly Dr. *Huxham*, who ſays he has ſometimes bliſtered the throat from ear to ear with great ſucceſs. It has indeed been ſaid, that they ſometimes produced mortifications, and that even the

the difcharge they occafioned, feemed to be more than the patient could bear; but as I have never heard this remark confirmed, I cannot help imagining, that the cafes in which they were tried, were particularly unfavourable, and more remarkably putrid than is ufual; for in the child, who died on the eighth day, I applied blifters behind the ears, and they had not the leaft appearance of mortification or gangrene, even after the child's death. And in a cafe of very great danger, which I lately met with, they were certainly of great fervice, and very effectually fupplied the place of thofe natural difcharges, by which nature carries off this difeafe.

I would recommend their application early in the difeafe, from the fame principle that they are applied in inflammatory angina's or pleurifies; to relieve the throat and trachea, and to derive the flow of humours from the internal, to the external parts.

As the cafe to which I refer was a very remarkable one, in which the difeafe was attended with fome of the worft fymptoms I ever faw, and the method I have been advifing was ftrictly purfued, and attended with fuccefs, I cannot help confidering this fuccefs to be in fome meafure a proof of the propriety of the treatment, and for that reafon fhall here infert the cafe at large.

The patient was a child of about two years and a half old, who had complained for about a week of a fore throat and hoarfenefs. The day before I faw her fhe had fome difficulty of breathing, which on that day was greatly increafed, and exactly refembled the breathing of the children whofe cafes I have before related, when moft ftrangulated. Upon examining her throat I found the tonfils fwelled, inflamed, and covered with floughs of a yellowifh colour. Her breath was not in the leaft offenfive; her pulfe was fmall and fluttering, and her fkin pale and clammy. Two very large blifters were immediately applied, one behind each ear, fo as to meet at her throat. She took four grains of calomel, with a quarter of a grain of opium, and was directed

directed to drink a decoction of ſerpentar : virg : diſguiſed with old metheglin, as a common drink; and as her ſkin was pale and clammy, ſhe had a clyſter of one drachm of cort. peruv. and ten grains of ſerpent. virgin. in milk, to be adminiſtered every ſix or eight hours; but of theſe ſhe received but one that night; and as we found ſhe did not retain them, they were ſoon diſcontinued; nor could ſhe be prevailed on to drink but very little of the decoction.

I ſaw her ſeveral times during the firſt day, and ſhe appeared worſe at each time. About eight that evening ſhe had ſomething like a fit; and, at nine the ſtrangulation in her breathing was much increaſed; her pulſe was ſunk; her countenance changed; her noſe appeared to be pinched up; her eyes were fixed and glaſſy; a blue ring was obſervable about her mouth, and ſhe was comatous. I left, her, expecting ſhe would ſoon die. Her bliſters had been dreſſed a little before; had riſen well; and diſcharged freely; and, within two or three hours, as I was informed by the watches who ſat up with her, ſhe ſeemed to revive. The next morning I was greatly ſurpriſed, not only to find her living, but in a ſitting poſture, eating her breakfaſt, with little or no difficulty of breathing, having her natural countenance returned, with ſome colour in her cheeks, and her pulſe rather riſen. At twelve o'clock however her breathing grew more difficult, and though not ſo ſtrangulated as the day before, was very quick and uneaſy. From this time for five days ſhe remained in a very dangerous ſituation, and gave but little reaſon to expect her recovery. Her breathing continued quick and laborious, and her voice was almoſt entirely gone; her pulſe was quick and low; ſhe ſweated profuſely, particularly at nights, and conſtantly lay in her bed in a comatous ſituation, given however diſtinct anſwers when ſpoken to. I could diſcover nothing diſagreeable in her breath, though ſometimes what ſhe brought up was a little offenſive. During this time, and for many days after, the bliſters diſcharged conſiderably, and the matter of the diſcharge was ſo ſharp and corroſive corrofive as to inflame and erode the fkin almoft from the chin to the fterum. She conftantly took twice a day three grains of calomel; and, except the firft dofe, without opium, until fhe had taken upwards of thirty grains; and continued the ufe of the decoction of ferpentar: In as large quantities as fhe could be prevailed on to take it. On the feventh day from the time I firft faw her, fhe began to cough a good deal, with which fhe expectorated pretty freely, and brought up fome very tough mucus. She breathed more freely, opened her eyes and looked about with fome fprightlinefs, and drank a glafs or two of wine. From this time fhe gradually grew better, and by the fifteenth day from the time I faw her, all her fymptoms had left her, except great weaknefs, and fo remarkable a hoarfenefs, or rather lofs of voice, that it was with great difficulty fhe could be heard; and a peculiar fenfibility of the larynx with regard to fluids, fo that the moment fhe attempted to drink fhe fell into a fit of coughing, although fhe could fwallow folid food without difficulty. This however foon left her, but her weaknefs and lownefs of voice continued, a much longer time, fo that in two months fhe could hardly walk alone, or fpeak in a tone above a whifper.

When ulcers appear behind the ears, or in different parts of the body, they require a particular treatment; the difcharge fhould be encouraged by frequently wafhing them with warm milk and water, and poultices of bread and milk be applied to them; but greafy applications always do harm, as they check the difcharge: Nor will they bear digeftives. I was in fome cafes, however, after the difcharge had continued for a great length of time, oblig-ged to check it, with a very weak folution of vitriol. alb. which I found anfwered this intention well; nor did I ever obferve any ill effects from it: But I always ufed it with great caution, and never ventured on it, until I had corrected the general virus of the difeafe, by a previous uf- of mercurials. In refpect to gargles, I would entirely fole

low

low Dr. *Fothergill's* advice. Fomentations applied to the breaſt, and fumigations with the ſteams of ſome mild aromatic herbs, and warm vinegar, not only give eaſe, but ſerve, in ſome meaſure, to attenuate the mucus in the trachea; and by gently ſtimulating the lungs, raiſe a ſlight cough, and promote the expectoration. The treatment of any accidental ſymptoms, after endeavouring to form a juſt idea of the diſeaſe, muſt be left to the diſcretion of the phyſician.

Such are the ſentiments, which, from an attentive obſervation of the ſymptoms, and progreſs of this diſeaſe, I have entertained of its nature, and moſt proper treatment, which nothing, but a real deſire of contributing to the ſtock of medical facts, has induced me to offer to the notice of the public; theſe being the only foundation of a certain and rational practice; and I can anſwer for the fidelity and candor with which I have related, what are here perſerved.

SUBSTANCE *of ſome* PAPERS *that could not be inſerted in their proper Place.*

The following account of an Aurora Borealis *was received from a Correſpondent, at Lancaſter, in Pennſylvania, viz.*

"THAT about half an hour after ſeven in the evening of January 5, 1769, there was ſeen at that place, a bright crepuſculum, riſing out of the North; which in about a quarter of an hour extended itſelf from N. E. to N. W.—The upper part was deeply notched, and roſe in one place to the height of near 40°. above the horizon.

"At three quarters after eight, it was ſo light in the Northern hemiſphere, that a perſon, who felt no decay or infirmity of eye-ſight, might eaſily have read a book print- in Double Pica Roman.

"At nine o'clock, five columns or pyramids, of a very vivid red, roſe perpendicular to the horizon, in the N. W.

—They

—They were unequal in their heights: For, whilſt two of them roſe almoſt to the zenith, others did not exceed 45°. They changed colours alternately from a fiery red to a purple; from that to a yellow; from yellow to a flame colour; and then to red again. Theſe changes were ſo ſudden and quick that they affected the ſenſe ſo ſtrongly as to raiſe horror.

" At a quarter after nine, the columns changed their perpendicular poſition to an oblique one, and immediately began to move towards the Weſt. They ſoon blended together, and formed a dirty red ſky, tinged with yellow.

" N. B. There were no ſtreamers, corruſcations, tremulous or dancing motions, as are common to ſuch phænomena. This was a quiet one, except that it changed colours, and moved towards the Weſt, as already deſcribed.

" During the appearance the air was uncommonly ſevere and chilling; and, though the Heavens were ſerene and beſpangled with ſtars, the atmoſphere felt damp and heavy.

" A little before ten o'clock, the whole ſunk below our horizon and diſappeared."

Mr. Thomas Gilpin *hath preſented a model of a* Horizontal Wind-mill; *and writes to the Society as follows.*

THAT to obviate the difficulty of turning the houſe, or frame, of common wind-mills to the wind, he had contrived a model of a horizontal wind-mill, which he had fixed to three pumps, as he apprehended the chief uſe of ſuch a mill would be the applying it to raiſe water out of mines and quarries, and likewiſe out of wells, or brooks for watering meadows. He thinks alſo it might be further applied to anſwer the various uſes of other wind-mills, without the inconvenience in turning or ſhifting them as the winds ſhift.

" The

" The model is three pumps erect, in a triangular position; in the center is a crank erect in a ſtep, and ſteddied by a neck in a frame, from the ears of the pumps; on the top of the crank are eight arms, and at the ends of each is a ſail which alternately draws with the wind, and folds againſt it, which gives a powerful motion to the crank, which, by a handle to each pump, works them in a regular ſucceſſion."

Mr. John Jones, *of Indian River, Worceſter County, Maryland, gives the following account of a Species of* Grape Vines *which he had diſcovered, different from all others he had ever ſeen.*—

THE bark (he ſays,) is of a grey colour, very ſmooth, and the wood of a firm texture. They delight in a high ſandy ſoil; but will thrive very well in the Cyprus ſwamps. The leaf is very much like that of the Engliſh grape vine, ſuch as is propagated in the gardens near Philadelphia for table uſe.

" The grape is much larger than the Engliſh, of an oval ſhape, and, when quite ripe, is black, adorned with a number of pale red ſpecks, which, on handling, rub off. The pulp is a little like the Fox-grape; but in taſte more delicious. Theſe grapes are ripe in October, and yield an incredible quantity of juice, which, with proper management, he doubts not, would make a valuable wine.

" He employed a perſon to gather about three buſhels and one peck of them when ripe, and immediately had them preſſed; which, to his ſurprize, yielded twelve gallons of pure juice, though a good quantity muſt have been loſt in the preſſing.

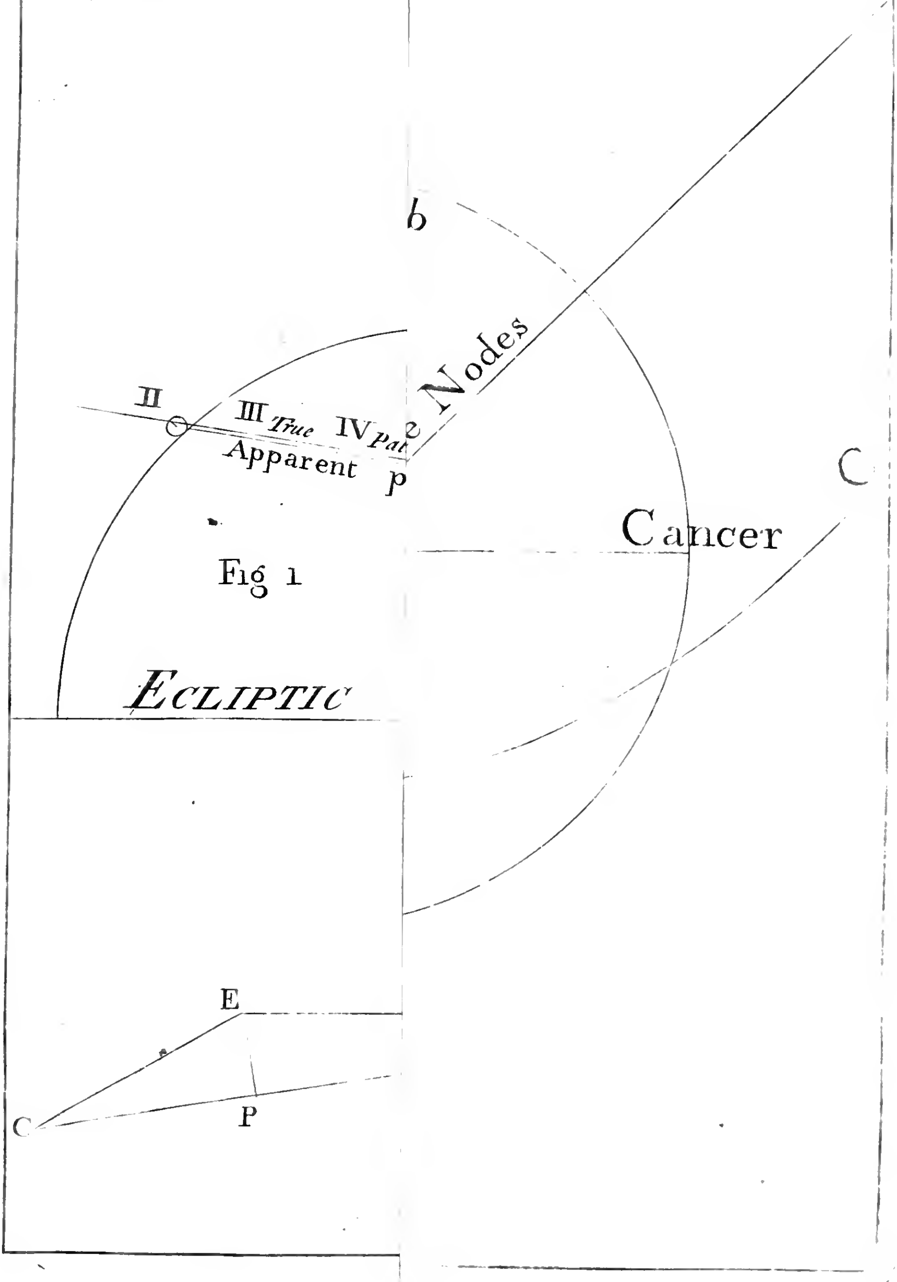
" In about twelve hours after putting the juice in a keg, it began to ferment, and he ſuffered it to go on till it got to be ſo violent, that it might be heard all over a large room. It continued in that ſtate for three days. He then checked it, fearing it might turn acid, though, he ſays, he was afterwards convinced that if he had ſuffered it to ferment as long again, it would have ſeparated the vinous parts from the fleſhy, and given greater fineneſs to the liquor.

" After this it was racked off, and before cold weather buried in the garden, the top about ſix inches under ground; where having continued till the ſummer following, he could not diſcover that it had in the leaſt altered, either in taſte or colour. He obſerves farther that, after eating a quantity of them, or drinking the juice, they leave an aſtringency, as claret is apt to do.

" There is an immenſe quantity of theſe vines growing on the beach, open to the ſea; and they are alſo found in great plenty upon the ridges, and in the ſwamps. Since their diſcovery he has tranſplanted a number of them into his vineyard, from which, in a year or two more, he expects to make a wine much better than is commonly imported."

END OF THE FIRST VOLUME.

PLATE. I


b
Nodes
II
III True
IV Pat
Apparent
P
C
Cancer
Fig 1
ECLIPTIC
E
P
C

checked it, fearing it might turn acid, though, he ſays, he was afterwards convinced that if he had ſuffered it to ferment as long again, it would have ſeparated the vinous parts from the fleſhy, and given greater fineneſs to the liquor.

" After this it was racked off, and before cold weather buried in the garden, the top about ſix inches under ground; where having continued till the ſummer following, he could not diſcover that it had in the leaſt altered, either in taſte or colour. He obſerves farther that, after eating a quantity of them, or drinking the juice, they leave an aſtringency, as claret is apt to do.

" There is an immenſe quantity of theſe vines growing on the beach, open to the ſea; and they are alſo found in great plenty upon the ridges, and in the ſwamps. Since their diſcovery he has tranſplanted a number of them into his vineyard, from which, in a year or two more, he expects to make a wine much better than is commonly imported."

END OF THE FIRST VOLUME.

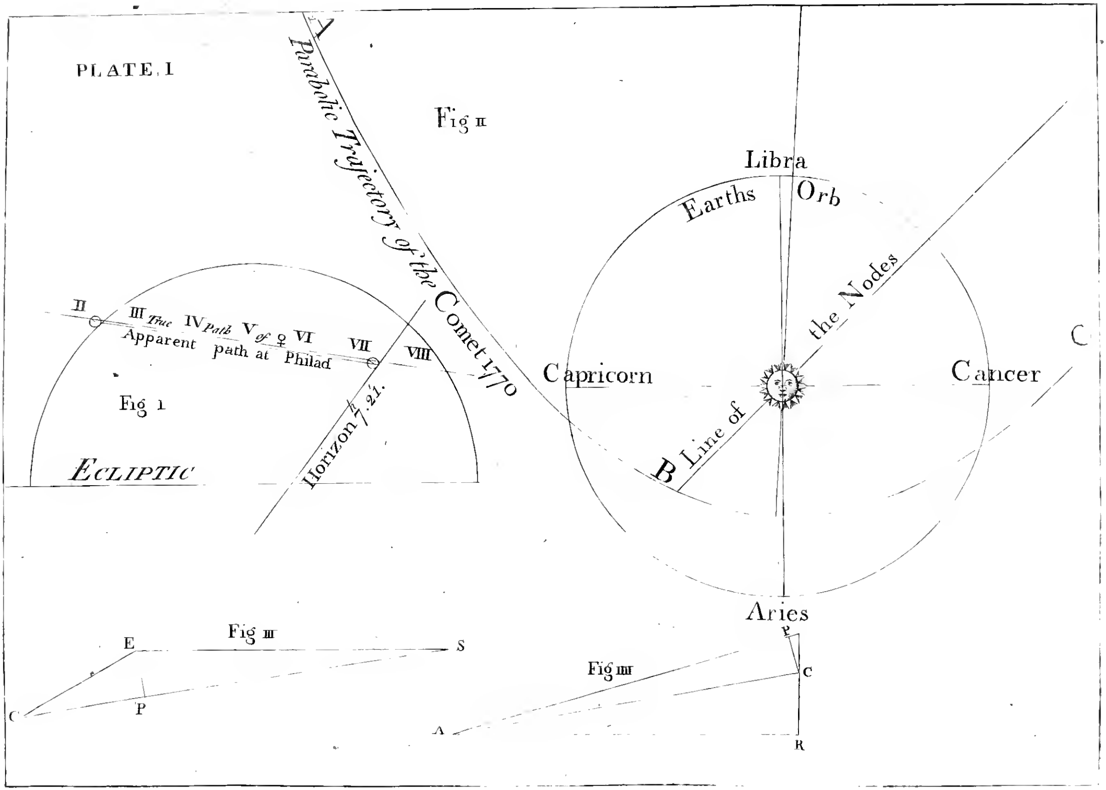
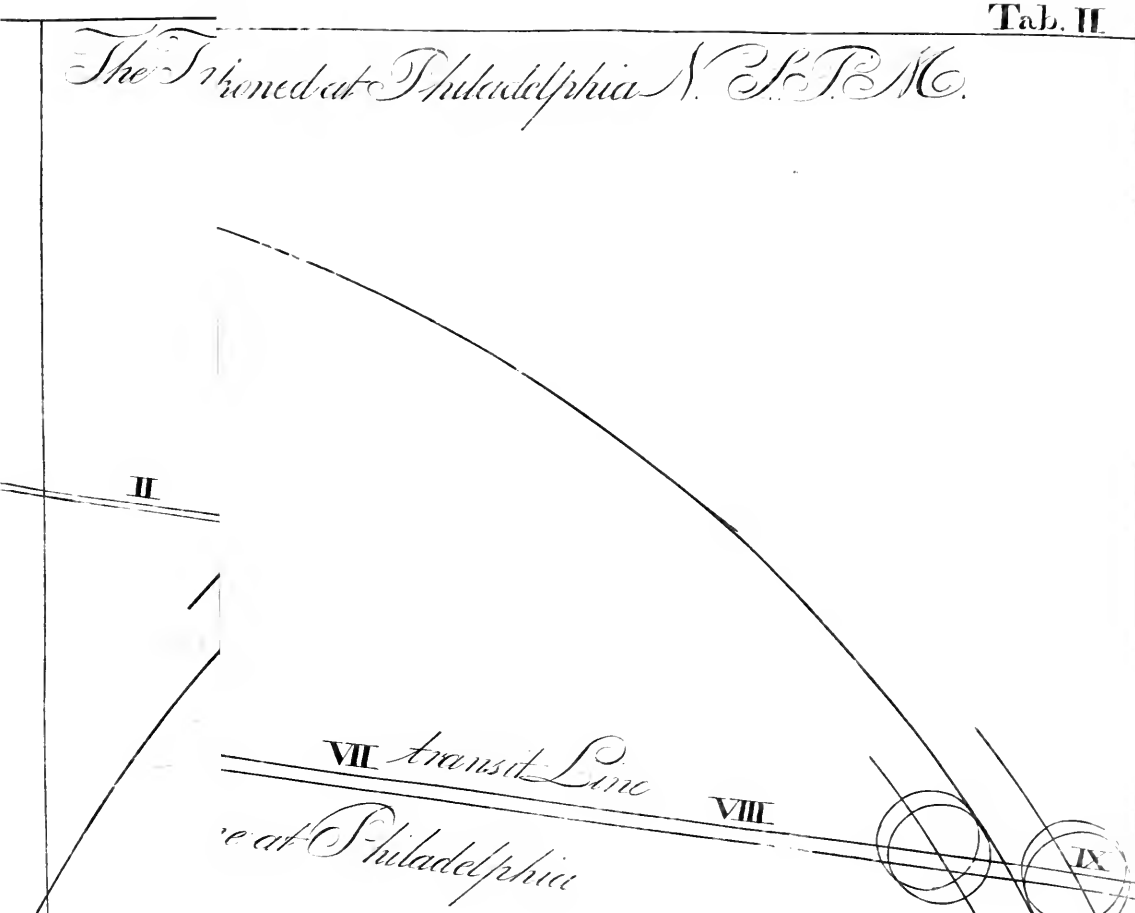


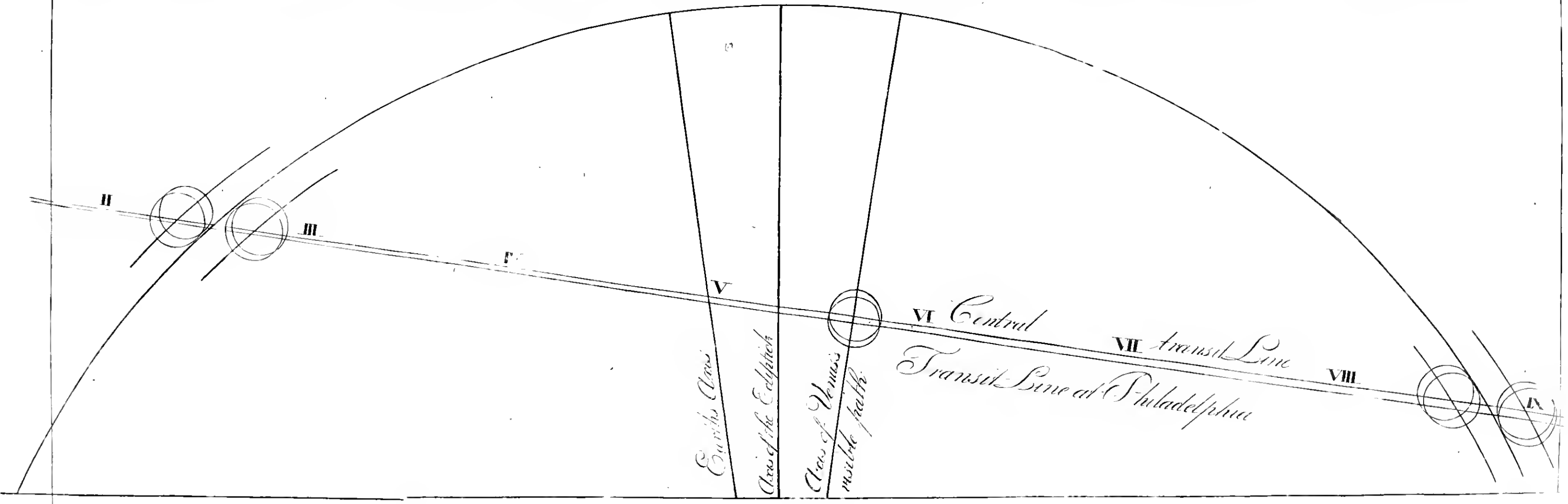
PLATE. I
Parabolic Trajectory of the Comet 1770
A
Fig II
Libra
Earths Orb
the Nodes
Line of
B
C
Capricorn
Cancer
Aries
II III True IV Path V of ♀ VI VII VIII
Apparent path at Philad
Fig 1
Horizon 7.21.
ECLIPTIC
Fig III
E
S
P
C
Fig IIII
P
C
A
R

Tab. II.


The T ioned at Philadelphia N. S. P. M.
II
VII transit Line
VIII
IX
e at Philadelphia

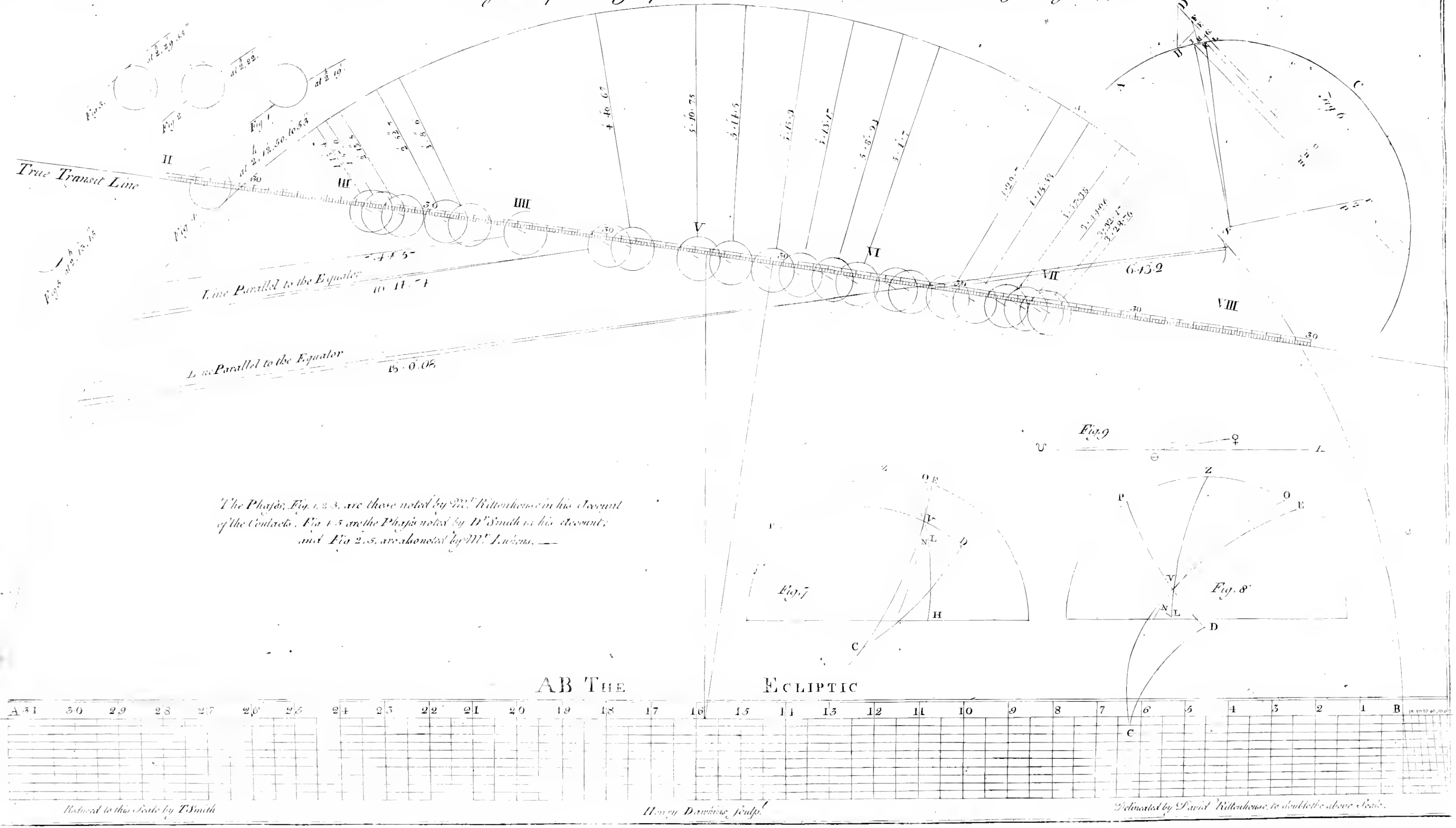
Tab. II

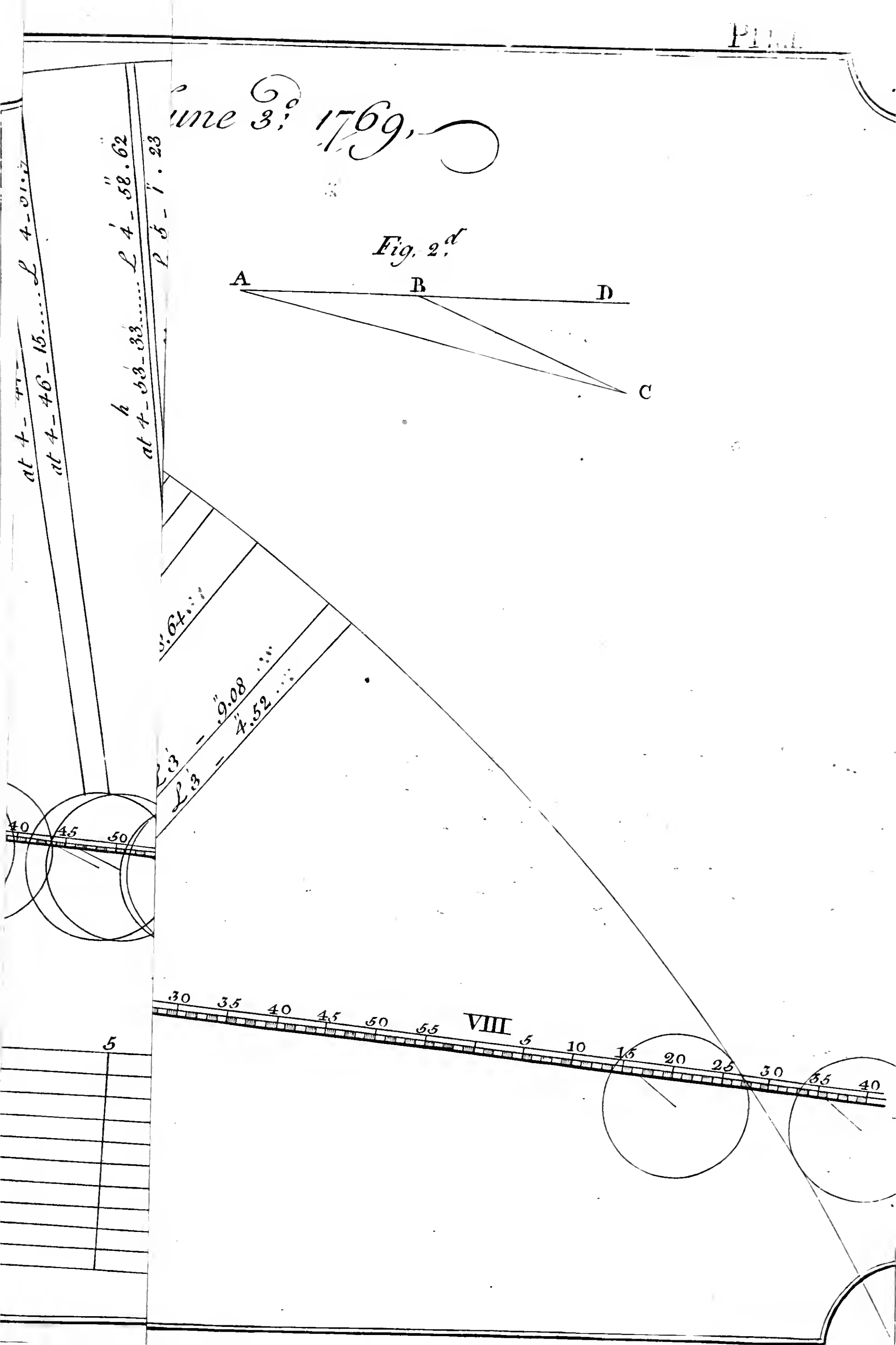
The Transit of Venus over the Sun in the Year 1769 June 3d. 5h. 4'. 43" apparent time as : cioned at Philadelphia N. S. T. M.



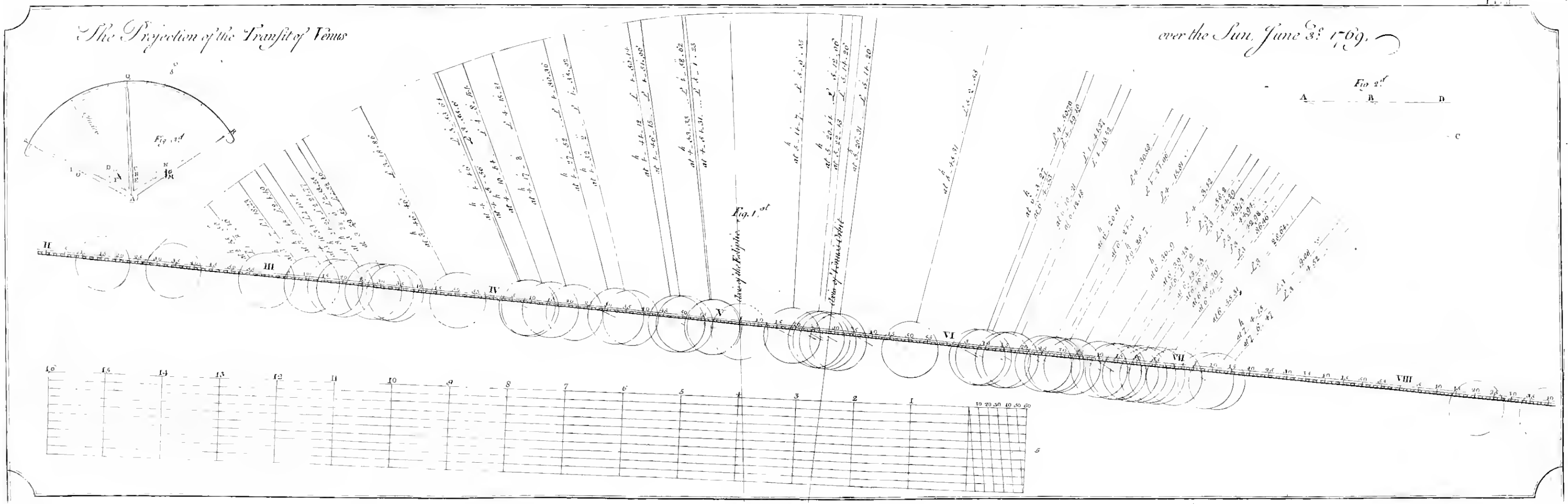
Sun, as observed at

Projection of the Transit of Venus, over the Sun, as observed at Norriton in Pennsylvania June 3 1769.





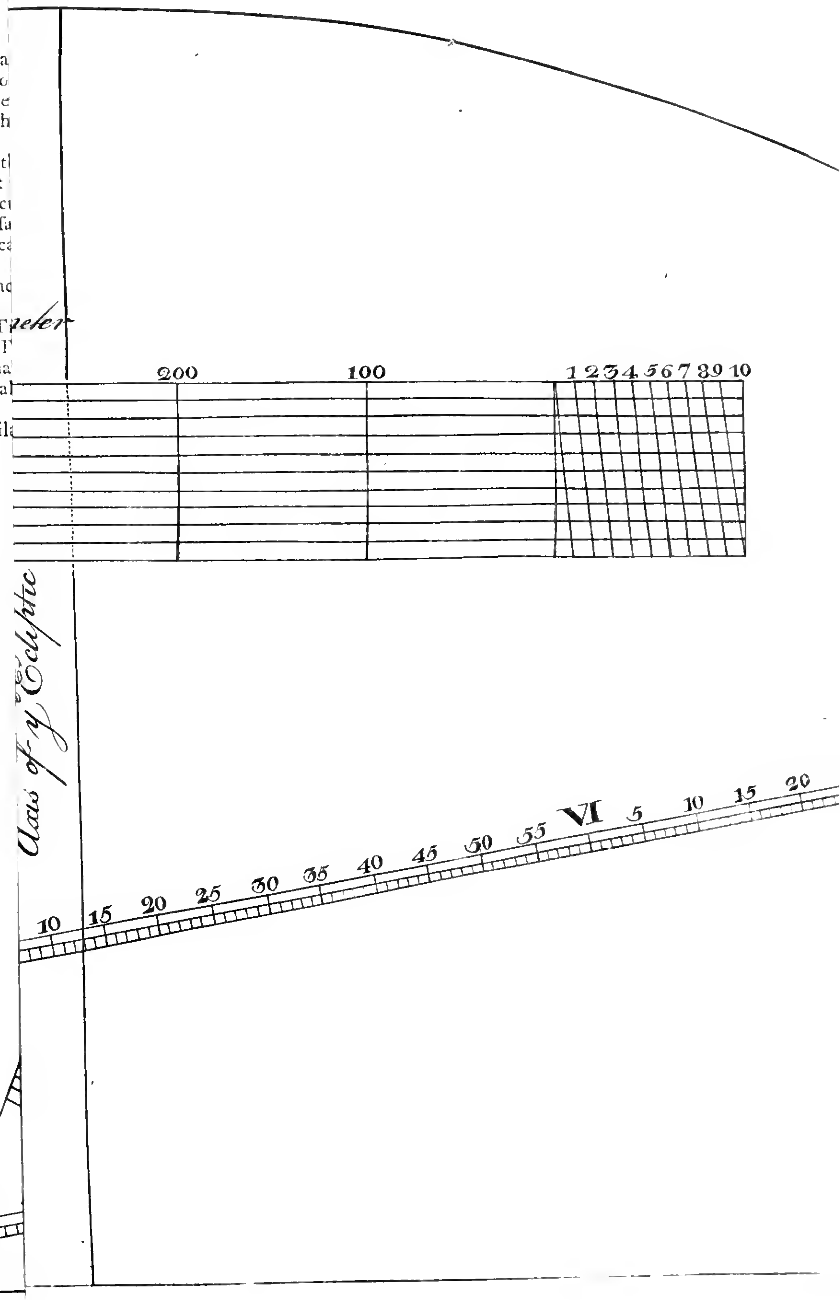
Pl. I
June 3. 1769.
Fig. 2d
A
B
D
C
at 4 - 46 - 15 ..... L 4 - 51.7
at 4 - 53 - 33 ..... L 4' - 58.62
L 5' - 1". 23
L 3' - 9".08
L 3' - 4".52
40
45
50
30
35
40
45
50
55
VIII
5
10
15
20
25
30
35
40
5

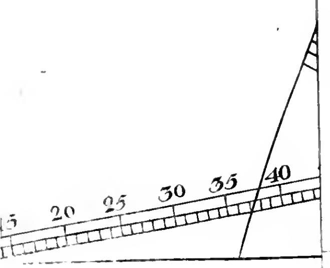

The Projection of the Transit of Venus over the Sun, June 3d. 1769.
Fig. 1st
Fig. 2d
Fig. 3d
A
B
D
C
II
III
IV
V
VI
VII
VIII
Line of the Ecliptic
Line of Venus's Path

...dª. Novʳ. 9) 1769. N.S.

The place of the Sun & Mercury a
The place of the ascending Node o
The Sun's Distance from the Node
The Angle of his visible path with
The Horory Motion of Mercury
The Semidiameter of the Sun on t
The Semidiameter of Mercury at
The Geocentric Latitude of Merc
His Heliocentric Latitude at the sa
The apparent time of the Ecliptic
Meridian of Philadelphia
The time of the nearest approac
and Mercury -
The central Semiduration of the T
The central Semiduration of the T
The apparent time of the externa
The apparent time of the internal

Projected for the Latitude of Phila
West of Greenwich by





A Projection of the Transit of Mercury, over the Sun observed at Philad.a Nov.r 9 1769. N.S.

	s	°	′	″
The place of the Sun & Mercury at the Ecliptical Conjunction	7	17	50	41
The place of the ascending Node of Mercury - -	1	15	35	29
The Sun's Distance from the Node of Mercury - -		2	15	12
The Angle of his visible path with the Ecliptic - -		3	21	18
The Horary Motion of Mercury - - - -		5	55	6
The Semidiameter of the Sun on the Day of the Transit - -		16	10	1
The Semidiameter of Mercury at the same time - - -				4,238
The Geocentric Latitude of Mercury at the Ecliptical Conjunction		7	39	9,5
His Heliocentric Latitude at the same time - - -		16	34	55,8
		h	′	″
The apparent time of the Ecliptical Conjunction according to the Meridian of Philadelphia - - - - - -		5	12	46,5
The time of the nearest approach of the Centers of the Sun and Mercury - - - - - -		5	1	30
The central Semiduration of the Transit between the external contacts		2	25	21
The central Semiduration of the Transit between the internal contacts		2	23	44
The apparent time of the external contact observed at Philadelphia		2	36	9
The apparent time of the internal contact observed at Philadelphia		2	37	30

Projected for the Latitude of Philada. 39° 56′ 54″ & Longitude 75° 8′ 45″ West of Greenwich by JOHN EWING.