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T H E

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PHILOSOPHICAL

1665-1700

TRANSACTIONS

A N D

COLLECTIONS,

To the End of the Year MDCC.

A B R I D G E D,

And disposed under

GENERAL HEADS.

V O L U M E II.

Containing all the

PHYSIOLOGICAL PAPERS.

By *JOHN LOWTHORP*, M. A. and F. R. S.

The **FIFTH EDITION**, Corrected,
In which the **LATIN** Papers are now first translated into **ENGLISH**.

L O N D O N :

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MDCCXLIX.



UNED

THE
PHILOSOPHICAL
TRANSACTIONS

AND
COLLECTIONS

To the King of Great Britain

AND
A. B. R. I. D. G. E. D.

AND
LONDON

GENERAL HEADS

VOLUME III

Containing all the

PHYSIOLOGICAL PAPERS

By JOHN LOKINGTON M. A. and F. R. S.

The FIFTH EDITION

As the LATE Edition was sold out, and the

AND

Printed by W. B. ...
LONDON

(2)
THE
Physiological Papers,

Published and Dispersed in the
Philosophical Transactions

AND
COLLECTIONS,

ABRIDG'D;

And Disposed under

GENERAL HEADS.

CHAP. I.

PHYSIOLOGY.

Meteorology. Pneumaticks.

I. **T**HE *Academie des Sciences* has lately received great Splendour by the Regulations, Encouragement, and Orders, M. L'Abbé Bignon has obtained to it from the King. That *Academy* is now composed of 10 *Honorary Academicians*, which are chosen, learned and eminent Gentlemen; of 8 *Strangers Associates*, which are distinguished by their Learning; 20 *Pensioners* Fellows, 20 *Elèves*, and 20 *French Associates*, who are divided into 6 Classes, viz. Geometricians, Astronomers, Mechanicians, Anatomists, Chymists, and Botanists.

The new Regulation of the Academie des Sciences at Paris; by M. Geoffroy, n. 257. p. 144.

Out of the *Honorary Academicians*, two are elected every Year, one for President, the other for Vice-President: Only 20 *Pensioners* have every Year 1500 *French Livres*; and after the Death of one *Pensioner*, the *Academy* will propose to the King 3 Persons *Associates*, or *Elèves*, or sometimes others; and his Majesty will call one of the 3 for *Pensioner*.

II. 1. I know not how it comes to pass, but the sublimer Studies are not pursued now so much as formerly; whereas after so many new Assurances, they could never be prosecuted to more Advantage. I imagine it is because these unhappy Times are come upon us, and the Wars have obliged Mankind to

The Cause of the present languid State of Philosophy, by M. Leibnitz. n. 255. p. 673.

turn their Cares another way, so that very few of the younger Persons are ambitious to attain to the Glory of their Predecessors. Even Nature has but few now, that cultivate her diligently. As the *French Academy of Sciences* has been lately new regulated by their King; so I wish that a new Ardor were infused into your Royal Society.

By Dr. J.
Wallis, *ib.*
p. 281.

2. What you complain of, that the sublimer Studies are not pursued now so eagerly as formerly, and that Nature now-a-days has not so many diligent Observers, I confess is true in some Measure: But it is not to be wonder'd at, that as all other Things, so the Studies of Men should have their Vicissitudes. Certain it is that in the present Age, which is now drawing to a Period, Knowledge of all Kinds has met with great and even unhop'd for Improvements; as Physicks, Medicine, Chemistry, Anatomy, Botany, Mathematicks, Geometry, Analyticks, Astronomy, Geography, Navigation, Mechanicks, and (what I least rejoice at,) the Art of War itself: And indeed far greater than for many Ages before. For then Men seem'd to aim at nothing farther than to understand what had been deliver'd by *Euclid*, *Aristotle*, and the rest of the Ancients, with little Concern about making a farther Progress; as tho' the Limits of the Sciences had been fix'd by them, which it was presumptuous to go beyond. But after some few had ventured to look farther, others were encouraged to enter into the wide Field of the Sciences. And a new Ardor, a new Effort urged them to attempt new Things, and not without Success. But when it was no longer a new Thing, this new Ardor wore out. Not a few of the diligent Searchers into Nature are already dead, and others must die soon: And the Newness of the Subject will no longer, as before, excite the young Men to tread in the Steps of their Predecessors.

Likewise the Matter itself was great, which now is partly exhausted; so that a Harvest is hardly to be hop'd for, but only a Gleaning. And it seems reasonable to allow, that those that are tired and wearied should have some rest. And hence it is, as the Nature of Mankind is variable, that severer Studies are neglected. Nay, it may happen (tho' I would not have it ominous,) that the Sloth of the next Age may succeed the Industry of the present.

You wish (and so do I too) that as the *French Academy of Sciences* now seems to be form'd a-new, that a new Ardor may likewise be infused into our Royal Society. I have admonish'd them of this in your Words. But they themselves (which you will not be sorry for) had in a Manner prevented my Admonition. For they have lately made some new Regulations for themselves, whereby every Man is to promote some particular Inquiry. But there is this Difference between the *French Academy*, and our Royal Society; They are at the King's Expence, and every one enjoys his Salary; whereas ours do all at their own Expence.

A deep Cave
in the Observ-
atory at Pa-
ris; by M---
A. 74. p. 2217

III. In the Royal Observatory at *Paris*, there is, besides many other Rooms fit for Philosophical Uses and Purposes, a very deep Cave, having 170 Steps of Descent; wherein many Sorts of Experiments are intended to be made, being of that Nature, that they require to be remote from the *Sun-beams* and the open Air; such as are *Thermometrical* ones, and such as concern *Refrigerations*, *Coagulations*, *Inclusions*, and *Conservations of Bodies*, &c.

IV.

IV. 1. The Barometer or Baroscope was first made publick by that noble Searcher of Nature, Mr. *Boyle*, and employed by him and others, to detect all the minute Variations in the Pressure and Weight of Air. With this Instrument he made divers Observations in the Year 1659, and 1660, before any others were publick, or by him so much as heard of.

*Barometers,
and Observa-
tions made
with them.
n. 9. p. 153.*

2. Dr. *J. Beal* is so much pleas'd with the Discovery already made by the Help of this Instrument, that he thinks it to be one of the most wonderful that ever was in the World. For (saith he) who could ever expect, that we Men should find an Art to weigh all the Air that hangs over our Heads, in all the Changes of it, and as it were, to weigh, and to distinguish by Weight, the Winds and the Clouds? Or, who did believe, that by palpable Evidence, we should be able to prove the serenest Air to be the most heavy, and the thickest Air, and when darkest Clouds hang nearest to us, ready to dissolve, or dropping, then to be lightest.

*By Dr. J.
Beal, ib. p.
154.*

1. My Wheel Barometer I could never fill so exactly with Mercury, as to exclude all Air; and therefore I trust more to a Mercurial Cane, and take all my Notes from it. This Cane is but 35 Inches long, of a very slender Cavity, and thick Glass.

ib. p. 155

2. In all my Observations from *May 28, 1664*, to this present (*December 9, 1665*), the Quick-silver never ascended but very little above $30\frac{1}{2}$ Inches.

3. It ascended very seldom so high, (*viz. to $30\frac{1}{4}$ Inches*) chiefly in *December 13, 1664*, the Weather being fickle, fair Evening.

4. I find by my Calendar of *June 22, 1664*, at 5 in the Morning, in a Time of long settled fair Weather, that the Mercury had ascended about half an Inch higher than 30: But I fear some Mistake, because I then took no Impression of Wonder at it; yet for three or four Days, at that time it continued high, in well settled, fair and warm Weather; most part above 30 Inches. So that I may note the Mercury to rise as high in the hottest Summer, as in the coldest Winter Weather.

5. Yet surely I have noted it to ascend a little higher for the Coldness of the Weather; and very frequently, both in Winter and Summer, to be higher in the cold Mornings and Evenings, than in the warmer Mid-day.

6. Generally in settled and fair Weather, both of Winter and Summer, the Mercury is higher than a little before, or after, or in rainy Weather.

7. Again, generally it descended lower after Rain, than it was before Rain.

8. Generally also it falls in great Winds; and somewhat it seemed to sink, when I opened a wide Door to it, to let in stormy Winds: yet I have found it to continue very high in a long stormy Wind of three or four Days.

9. Again, generally it is higher in an East and North Wind (*ceteris paribus*) than in a South and West Wind.

10. I tried several times, by strong Fumes, and thick Smoaks, to alter the Air in my Closet; but I cannot affirm, that the Mercury yielded any more than might be expected from some Increase of Heat. Such as have exact Wheel Barometers, may try whether Odors or Fumes do alleviate the Air.

11. I have not in all this time found the extreamest Changes of the Quick-silver to amount to more than $2\frac{1}{4}$, or to $2\frac{2}{3}$ Inches at most.

12. Very often I have found great Changes in the Air, without any perceptible Change in the Barometer; as in the dewy Nights, when the Moisture descends in a great Quantity, and the Thickness sometimes seems to hide the Stars from us. In the Days foregoing and following, the Vapours have been drawn up so invisibly, that the Air and Sky seemed very clear all Day long. This I account a great Change between ascending and descending Dews and Vapours (which import Levity and Weight) and between thick Air and clear Air; which Changes do sometimes continue, in the alternative Course of Day and Night, for a Week or Fortnight together; and yet the Baroscope holding the same.

13. Sometimes (I say not often) the Baroscope yields not to other very great Changes of the Air: As lately (*Dec. 18.*) an extraordinary bright and clear Day; and the next following quite darkned, some Rain and Snow falling; but the Mercury the same: So on high Winds and Calms, the same.

14. I do conceive, that such as do converse much *sub dio*, and walk much abroad, may find many Particulars much more exactly than I, who have no Leisure for it, can undertake. To instance in one of many: *Dec. 16, 1665*, was a clear cold Day, very sharp and strong East Wind, the Mercury very near 30 Inches high; about 3 in the Afternoon I saw a large black Cloud drawing near us from the East and South-East, with the East Wind. The Mercury changed not that Day, nor the Day following; the Stars and most of the Sky were very bright and clear till nine of the Clock; and then suddenly all the Sky was darken'd, yet no Change of Weather happen'd. *Dec. 17.* the Frost held, and 'twas a clear Day, till about two of the Clock in the Afternoon; and then many thick Clouds appeared low in the West; yet no Change of the Weather here; the Wind, Frost, and Quick-silver, the same. *Dec. 18.* the Mercury fell almost $\frac{1}{4}$ of an Inch, and the Sky and Air so clear and bright, and cold, with an East Wind, that I wonder'd what could cause the Mercury to descend. I expected it should have ascended, as usually it does in such clear Skies. Casually I sent my Servant abroad, and he discovered the remote Hills, about 20 Miles off, covered with Snow. This seemed to manifest that the Air, being discharged of the Clouds by Snow, became lighter.

15. I have seldom seen the Change to be very great at any one time; so that I once wonder'd to see, that in one Day it subsided about $\frac{1}{4}$ of an Inch.

16. *Jan. 13, 1666*, the Mercury stood (as it did also the Day before) a quarter above 30 Inches; yet both Days very dark and cloudy, sometimes very thick and misty Air; which seldom falls out: For, for the most part, I see it higher in clearest settled Weather, than in such cloudy and misty Fogs. This thick Air and Darkness hath lasted above a Week; lately more cold, and East and North-East Wind.

17. I have not yet found any such infallible Prognostick of these Changes ^{n. 10. p. 163} of Weather, which do follow a long Serenity, or settled Weather. And perchance in brighter Climates it may be constantly infallible. I have Store of Hygrosopes of divers Kinds; and I do remark them, and the Sweatings of Marble, and as many other famed Prognosticks as I can hear of; but can find nothing so nearly indicative of the Change of Weather, as this Balance. And the open Weather-Glass is known to signify nothing at Certainty, having a double Obedience to two Masters; sometimes to the Weight of the Air, sometimes to Heat, as the Service is commanded.

18. In *Jan.* 166 $\frac{1}{2}$, for many Days it continued very dark, so that all Men expected daily great Rain; and though sometimes thick Mists arose, and some small Rain fell, yet the Quick-silver held at a great Height; which did indicate to me there could then be no great Change of Weather, and I was not disappointed.

19. If the Mercury ascends to a good Height after the Fall of Rain (as sometimes, but less often it does) then I look for a settled Serenity; but if it proceeds after Rain in a descending Motion, then I expect a Continuance of broken and showry Weather.

20. That we find the Weather and our Bodies more chill, cold and drooping, when the Mercury is lowest, and the Air lightest; besides other Causes, I guess that as Air is to us the Breath of Life, as Water is to Fishes; so when we are deprived of the usual Measure of this our Food, 'tis the same to us as when the Water is drawn ebb from the Fishes.

21. The lowest Descent of the Mercury in all the Time since I have observed it, was *Oct.* 26, 1665, in the Evening; when it was very near at 27 $\frac{1}{2}$ Inches: Which I find thus circumstanced with the Weather in my Notes.

Oct. 25. Morning; Mercury at 28 $\frac{1}{2}$ Inches, great Storms and much Rain.

Oct. 26. Morning; Mercury at 28, Winds quiet, thick dark Clouds.

Oct. 26. Evening; Mercury at 27 $\frac{1}{2}$; that Day, and some Days following, the Weather was variable, frequent Rain, and, as you see, the Mercury lower than usual.

22. Over the Place where this Mercurial Cane stands, I have set a Wind-Vane, with purpose of Exactness, of a Streamer in Brass so large, and pointing to a Board indented in the Margin, that I can at a sure Level upon the Vane, take every of the 32 Points of the Wind, half Points and quarter Points, at a good Distance. It were good to have an Index of Winds, that discovered as well their Ascent and Descent, as their side Coastings.

23. By Change of Weather and Wind, the Mercury sunk since *March* 12, ^{n. 21. p. 185} more than an Inch; and this last Night of *March* 18, by Rain and South Wind, 'tis sunk half an Inch.

24. I found the Quick-silver, *Dec.* 16, 1669, higher than I dare positively affirm that it was ever since I had it in my Custody, *viz.* since *May* 28, 1664. It was compleatly and apparently above half an Inch more than 30 Inches high. It continued the 14th, and some part of the 15th; at about that Height; sometimes manifestly higher to an eighth or tenth part of an Inch. For this Baroscope I have two Glass Canes in one Vessel of stagnant

stagnant Quick-silver; and both of them agreed in this Indication. The Weather was, at first Discovery, very bright and clear, a gentle Frost, by the Sun's Heat melting. The Air was very silent, no Wind stirring, and the curious Wind-Vane noting, that the Wind was directly in the East all the first Day, viz. Dec. 13. On Dec. 14. the Wind had a short Swing from the North-west, and hastened again towards the East; yet so as to be North-east. During this Agitation, or Change of Winds, the Mercury descended a little; and after, upon the resetting of the Wind, the Mercury ascended a little higher than it had been the Day before.

My House and Study, where I keep this Baroscope, is on the Side of an Hill, on the higher Side of this Country, as I guess, near a Level with the Head of a River; which River running slowly, and falling into the *Severn* Sea about 20 or 30 Miles Westward of *Bristol*, we cannot be very much above the Level of the Sea. My Thermoscope standing close by my said Barometer, was at the just Height of ordinary dissolving Weather. In the following Days it was colder. Whether the late Summer Drought, or what else might incline this Winter Air to have more than ordinary Weight, or a stronger Spring, I must refer to the Consideration of the more Skilful.

By Dr. J.
Wallis.
n. 10. p. 169.

3. In my Baroscope I never found the Quick-silver higher than 30 Inches, nor lower than 28, (at least scarce discernibly, not $\frac{1}{2}$ of an Inch higher than that, or lower than this :) which I mention not only to shew the Limits within which I have observed mine to keep, viz. full 2 Inches, but likewise as an Estimate of the Clearness of the Quick-silver from Air. For though my Quick-silver was with good Care cleansed from the Air, yet I find that which Mr. *Boyle* useth, much better: For, comparing his with mine at the same Times, and both in *Oxford*, at no great Distance; I find his Quick-silver to stand always somewhat higher than mine (sometimes near a quarter of an Inch;) which I know not how to give a more probable Account of, than that my Quick-silver is either heavier than his, or else that his is better cleansed from the Air; (unless possibly, the Difference of the Bore, or other Circumstances of the Tube, may cause the Alteration; mine being a taller Tube, and a bigger Bore than his.) And upon like Reason, as his stands higher than mine; so another, less cleansed from Air, may at the same time be considerably lower, and consequently under 28 Inches at the lowest.

In thick foggy Weather, I find my Quick-silver to rise; which I ascribe to the Heaviness of the Vapours in the Air.

In Sun-shiny Weather it riseth also (and commonly the clearer, the more;) which, I think, may be imputed partly to the Vapours raised by the Sun, and making the Air heavier; and partly to the Heat, increasing the elastick or springy Power of the Air: Which latter I the rather add, because I have sometimes observed in Sun-shiny Weather, when there have come Clouds for some considerable time (suppose an Hour or two) the Quick-silver has fallen; and then upon the Sun's breaking out again, it has risen as before.

In rainy Weather, it useth to fall (of which the Reason is obvious, because the Air is lighten'd, by so much as falls) in showry Weather likewise, but not so much as in Rain. And sometimes I have observed it, upon a Hoar-Frost, falling in the Night.

For windy Weather, I find it generally to fall; and that more universally, and more discernibly, than upon Rain: (which I attribute to the Wind's moving the Air collaterally, and thereby not suffering it to press so much directly downwards; the like of which we see in swimming, &c.) And I have never found it lower than in high Winds.

I have divers times, upon discerning my Quick-silver to fall without any visible Cause at home, looked abroad; and found (by the Appearance of broken Clouds, or otherwise) that it had rained not far off, though not with us: Whereupon the Air being then lighten'd, our heavier Air (where it rained not) may have in part discharged itself on that lighter.

Whereas I formerly observed, that in hot Weather, the Quick-silver in the Baroscope did use to rise observably, especially in Sun-shine and the Heat of the Day; I now find (having kept the same Barometer for the Space of five Years unaltered) the Case, for these two Years last past, to be somewhat otherwise: and that in hot Sun-shiny Weather the Quick-silver doth rather subside a little; and in extreme cold and frosty Weather it riseth. I judge the Cause of these contrary Observations to be this, *viz.* That the Quick-silver, at its first putting into the Tube or Baroscope, was not so perfectly cleansed from Air, but that some small Quantity of it did remain undiscerned in the Quick-silver: Which latent Particles of Air, though so small as not to be at all discernible to the Eye by Bubbles, yet by the external Heat (adding new Strength, as it useth to do, to its elastick or springy Power) were so much expanded, as to make the Quick-silver specifically lighter, and consequently to rise somewhat higher; and upon the Recess of the external Heat, the Spring of the Air again slackning, suffered the Quick-silver to be again contracted into its former lesser Dimensions, and so to become heavier, and not to rise so high as before, when it was hotter. But now the Quick-silver having continued in the Tube for five Years and upwards, hath, by its own Weight, cleansed itself better from that little Air that was in it; and that Air, freed from its Intanglement with the Quick-silver, being got up into the void Part of the Tube above the Quick-silver, doth act contrariwise; that is, when it is by Heat (upon the strengthening of its Spring) expanded, it presseth downward upon the Quick-silver, and doth a little depress it; and on the contrary, when by Frost or very cold Weather this Air (by the Abatement of its Spring) is contracted, the Quick-silver, freed from that Pressure, riseth a little. But the rising and sinking upon this Account, (as well that formerly, when the Air was in the Quick-silver, as that now, when it is gotten above it) is not very considerable; hardly exceeding the 12th part of an Inch.

I shall add another Accident which I lately took Notice of. I observed in the late hard Frost, that a little Drop of Water (which was at first made use of for the Cleansing of the Quick-silver from the Air, and which hath ever since remained on the Top of the Quick-silver within the Tube) was frozen

frozen fast to the Glass. Whereupon I did a little shake the Tube by moving it up and down, so as to make the Quick-silver undulate and strike against it. The Noise upon these Strokes was not such a dull Noise, as Quick-silver or other Liquids use to make in the open Air, by dashing against Glass or Ice, or other such hard Bodies; but such a hard smart Noise, as hard Metals use to make by knocking one against the other; or, as if this Ice had been so knocked by a solid Piece of Iron, or other Metal of such a Bigness. Which Difference of Noise from what would have been in the open Air, (where the intermediate Air must first have been beat away, before the Quick-silver could strike the Ice, and thereby the Stroke of the liquid Body obtunded or broken) I attribute to that Voidness of Air, which was between the Ice and the distant Quick-silver.

Jan. 7. $16\frac{6}{8}$, the Baroscope was at 29, but for some Days before about $28\frac{3}{8}$, (the Weather having been windy and rainy;) and so it was in the Frost about Dec. 25, but then continued to rise till about Jan. 2, to $29\frac{3}{8}$, but had been Dec. 13. at $30\frac{3}{8}$; which is the highest I have ever known it in my Baroscope; $27\frac{7}{8}$ being the lowest, that have I ever observed it in (Oct. 26, 1665) the most usual Height being about 29, or somewhat higher.

By Mr. Boyle
II. p. 131.

4. It will be very convenient that Observers give Notice of the Situation of the Place where their Barometers stand; not only because it will assist Men to judge whether the Instruments were duly perfected, but principally because, that though the Baroscope be good (nay, because it is so) the Observations will much disagree, even when the Atmosphere is in the same State, as to Weight, if one of the Instruments stand in a considerably higher Part of the Country than the other.

To confirm the foregoing Admonition, I must now inform you, that having in these Parts two Lodgings, the one at *Oxford*, which you know stands in a Bottom by the *Thames* Side, and the other at a Place 4 Miles thence, seated upon a moderate Hill; I found by comparing two Baroscopes that I made, the one at *Oxford*, the other at *Stanton St. John's*, that, though the former be very good, and hath been noted for such, during some Years, and the latter was very carefully fill'd; yet by reason, that in the higher Place the incumbent Part of the Atmosphere must be lighter than in the lower, there is almost always between two and three Eighths of an Inch Difference betwixt them: And having sometimes order'd my Servants to take Notice of the Disparity, and divers times carefully observed it myself, when I passed to and fro between *Oxford* and *Stanton*, I generally found that the *Oxford* Barometer and the other did, as it were by common Consent, rise and fall together so, as that in the former the Mercury was usually $\frac{1}{8}$ higher than in the latter. Which Observations may teach us, that the subterraneous Steams which ascend into the Air, or the other Causes of the varying Weight of the Atmosphere, do many times, and at least, in some Places, uniformly enough affect the Air to a greater Height, than, till I had made this Trial, I durst conclude.

But as most of the barometrical Observations are subject to Exception, so I found the formerly mentioned to be. For (to omit lesser Variations)

riding

riding one Evening from *Oxford* to *Stanton*, and having before I took Horse look'd on the Baroscope in the former of these two Places, I was somewhat surpriz'd to find at my coming to the latter, that in Places no farther distant, and notwithstanding the Shortness of the Time (which was but an Hour and a half, if so much) the Barometer at *Stanton* was short of its usual Distance from the other near a Quarter of an Inch; though, the Weather being fair and calm, there appear'd nothing of manifest Change in the Air, to which I could ascribe so great a Variation; and though also since that Time the Mercury in the two Instruments hath, for the most part, proceeded to rise and fall as before.

The Quicksilver has been of late for the most part so high, as to invite me to take Notice of it; and about *March* 12, 166 $\frac{1}{2}$. at *Oxford*, the Quick-silver was higher than, for ought I know, has been yet observed in *England*, viz. about $\frac{1}{4}$ above 30 Inches; but upon the first considerable Showers that have interrupted our long Drought, as I foretold divers Hours before that the Quick-silver would be very low, (a blustering Wind concurring with the Rain) so I found it at *Stanton* to fall $\frac{1}{2}$ beneath 29 Inches.

It is difficult enough to settle any general Rule about the rising and falling of the Quick-silver; yet in these Parts one of those that seem to hold oftenest, is, that when high Winds blow, the Mercury is the lower; and yet that it self does sometimes fail.

5. At my first Arrival I fix'd my Weather Glass, and found the *Argentum Virum* to ascend 29 Inches, and in a Tornado 29 $\frac{1}{8}$. But a Stranger by Accident broke the Cane, so that I could make no further Trial.

6. When my Barometer was first set up, the Mercury stood one Degree below Changeable; I diligently observed it every Day, and found that in the Mornings before the Sun arose, it would be there; and as the Heat increased with the Day, it sunk to within one Degree above Rain; there it continued several Days, and never altered above 3 Degrees, though sometimes Fair, sometimes Rain, and sometimes Cloudy; and one Morning leaving open my Window, and the Sun having South Declination, it shone in on the visible Part of the Tube, and in half an Hour it sunk 3 Degrees; (which I never observed it to do with Heat in *England*) I presently shut the Window, and in one Hour it arose again to within 1 Degree of Changeable. After it had kept this Course in several Weathers, for 6 Weeks together, I began to doubt if it were well adjusted, and therefore took it down, new fill'd the Tube, turned it 3 or 4 Times up and down, to let out the Air, and put it up with great Care; and ever since it continues the same, never by one Degree to Changeable, nor down by one Degree to Rain, so that the whole Progress of the Mercury is but $\frac{3}{8}$ of an Inch.

7. *March* 3, 168 $\frac{1}{2}$, in the Evening, we had very much Thunder; and that and the next Day, the Mercury in the Barometer was much lower than ever I observed it, viz. but $\frac{1}{8}$ above 28 Inches.

8. I have found by a whole Month's Observations, Mr. *Flamsteed* was pleased to send me, the Mercury still rose and fell both at *London* and here exactly at the same Time; I always found it rather more than $\frac{3}{8}$ of an

At Cabo-Cors in Guinea; by Mr. Heathcot, n. 158. p. 578. In Jamaica, by Sir Will. Beeston, n. 220. p. 225.

The lowest Degree of the Barometer; by the Bp. of Cloyne, n. 243, p. 293. The Agreement of the Barometers at London and Townley; by Mr. Townley, n. 208. p. 56.

Inch lower here than there, by reason that we are seated, though in a seeming Valley, in respect of the Neighbouring Grounds, yet we are considerably higher than the other low Lands near the Sea, where the Standard differs little from that at *London*. In Confirmation of what I have said, I suppose you may not be displeas'd with two remarkable Observations made both by Mr. *Flamsteed* and me at the same Time, viz. Nov. 18, 1674. when finding the Mercury to descend both very fast, and very low, we watch'd it very nicely, and both of us observ'd, that at 2 in the Afternoon it was rather falling, and rather rising at 4; at which Times the Height was only here 27, 63 Inches, and at *London* $\frac{3}{8}$ higher.

*A Portable
Barometer;
by Mr. Will.
Derham, n.
236, p. 3.*

V. Provide a strong Glass Tube, let the Head of it be pinched at about an Inch from the Top, so as to make a narrow Neck, whose Orifice shall be as big almost as a Straw. This (which is Mr. *Quare's* Way) will much bridle the Blow of the Mercury against the Top, as it danceth up and down, which endangers breaking off the Top of the Tube. The Bottom of the Tube I would have ground aslant near half an Inch, that the Bottom of the Tube touching the Bottom of the Cistern, the Orifice thereof may lie about the middle of the Mercury in the Cistern; which will prevent the Air getting into the Tube, by reason the Mercury is always about the Mouth of the Tube. The Cistern must be made wide, either of Glass, or close grained Wood; round the Brim of which, on the out-side, must be a Notch to tie on the Leather that is to cover it. When the Tube is filled, cleared of Air, and plunged into the Cistern near full of Mercury, enclose the Mercury with gentle Leather tied very fast round the Tube near the Bottom, which being spread over the Cistern, tie it round that also: The Tube and Cistern, thus conjoined with Leather, must be lodged in a Case, made very fit to receive both, where they must lie very fast. Through the Case let 3 or 4 Holes be bored, to let the Air in freely to the Leather that covers the Cistern, which lying close against the Holes, will firmly enough keep the Mercury from running out at them.

*To enlarge
the Divisions
of the Baro-
meter; by
Dr. Hook,
n. 185.
p. 241.*

VI. I. To make the more minute Variations in the Air's Pressure sensible, Dr. *Hook* invented the Wheel Barometer. But this did not answer fully the designed Exactness, both for that the Mercury being apt to stick against the Sides of the Glass, would rise and fall *per saltum* all at once; and because it is very difficult to adjust the *apparatus* of this Instrument, as also, that it is exceeding apt to be out of order; for which Reasons it is at present almost wholly laid aside.

Upon this, in *June* 1668. (as appears on the Journal of the *Royal Society*) he bethought himself of another Device to do the same Thing; which was to encrease the Divisions, by putting coloured Spirit of Wine, or some other Liquors not capable of freezing, on the Mercury, which Liquor was made to rise as the Mercury fell, and fall as it rose, in a narrow Cane, so as to make the utmost Limits about two foot asunder. But yet he was not satisfied, till he had found out the Means of encreasing the Divisions of the Barometer *ad libitum*, which he produced before the *Royal Society* at their Meeting on *Feb. 3,* 1685. *st. vet.* The Contrivance whereof is this:

The

The Cylinder, *A*, may be of what Diameter you please, the bigger the better, but it need not be above 2 Inches long; the Cane, *AD*, must be so long that the upper Part of the Cylinder, *B*, may be 29 Inches \times such a Part of the Height of the other Cane, *BC*, as the Weight or specifick Gravity of the Liquor that is to fill that Cane, is to the specifick Gravity of Mercury, below the Line, *AB*, in the Cylinder, *A*. The third Cylinder, *C*, may be as high as you please above the Cylinder, *B*, but is most conveniently made, so as the Square of the Diameter of the Cane, *BC*, be to the Square of the Diameter of the Cylinders, *B* or *C*, (which must be exactly equal) as the Rise of the Mercury in the Cylinder, *B*, is to the whole Length of the Cane, *BC*; for in this Case there will be nothing superfluous, but the Divisions enlarged to the utmost Advantage. Fig. 1.

As to the Method of filling this Baroscope, though the Inventor hath not as yet declared his own Contrivance for the doing it, yet it will not be unnecessary to shew here how it may be done. One Way (and the best that occurs at present) is to leave a small Hole at the Top of the Cylinder, *A*, and another near the Top of the Cylinder, *B*; this latter being well stoppt, pour in as much Mercury at the other Hole, in *A*, as shall fill both Canes as high as the Level of the said Hole; which done, stop either by hermetically sealing it, or else by a Drop of Seal-wax (the Glass being first ground rough to make it slick) in the Hole, *A*; then opening the Hole in *B*, draw off as much of the Mercury of the Cane, *BC*, till it will run no longer; which done, stop firmly the Hole in *B* (which may be done as you please, there being no Pressure against you) and you will have the Cylinder, *A*, evacuated of Air, for your Purpose, and the Height of the Mercury will be as is usual in the ordinary Plain and Wheel Barometers. Then pour into the Cane, *BC*, as much Spirit of Wine tinged with Cochineal, and Oil of Turpentine, equal Parts of each, as shall stand above the Surface of the Mercury so many Feet as you make the enlarged Scale of your Barometer, or as is between the Middle of the Cylinders *B* and *C*; and you will find the Mercury sink in the Cane, *BC*, and rise in the other Cane, *AD*, in such Proportion, that each 13 Foot of Oil and Spirit will raise the Mercury 10 Inches: This done, you must pour on, by the Cane, *BC*, so much Mercury as may fill up the Cylinders, *A* and *B*, to such Heights, considering the present Weight of the Atmosphere, that the Surface of the Mercury in both, may at the utmost Limits (which have not in *England* been found to exceed 30, 6 and 28, 6 Inches) always fall within the Bodies of the Cylinders, and never enter into the Canes.

Here note, That these Liquors are chosen upon two Accounts; First, they are exceeding near of a Weight, and Spirit of Wine highly rectified is somewhat lighter than Oil of Turpentine, but by a very small Addition of Phlegm or Water, the Spirit will preponderate and be undermost; so that you may make them as near of a Weight as you please, and consequently a Cylinder of the Oil insensibly differing from an equal Cylinder of Spirit of Wine. Secondly, They are Liquors that will not mix; so that the Oil of Turpentine swimming on the Top, will be divided by a Line only from the tinged Spirit of Wine, which the Oil will keep from evaporating.

The Effect of this Baroscope will be, that when the Atmosphere is heavy, and the Mercury raised high in the Cylinder *A*, and retired out of *B*, the Spirit of Wine will descend into the Cylinder *B*, and the Oil of Turpentine will fill the Cane, so as to make the Partition of the two Liquors near the Cylinder *B*. But on the contrary, when the Air is light, the Mercury will sink in *A*, and rise in *B*, so as to drive the Spirit of Wine into the Cane, and the Oil of Turpentine into the Cylinder *C*, so that the Section of the two Liquors will be near *C*, and the Variation of the Height of the Mercury will be enlarged into almost the Length of the Cane, without that the Counter-pressure from the Liquors will be in the least altered, the Height and Weight of the incumbent Cylinders being always the same.

That little Alteration that may happen by the Dilatation and Contraction of the Spirit of Wine by Heat and Cold, which ought to be accounted for, may be best discovered by a Thermometer hanging by it, (containing the same Quantity of the Spirit of Wine, and whose Cane is, as near as may be, of the same Diameter with the Cane *BC*, in the Barometer) whose Descent and Ascent must be added and subtracted to reduce it to a rigorous Exactness; but it is still worth while to enquire if the Mercury itself do not shrink and swell with Cold and Heat, so as not to need this Correction.

By _____
n. 236. p. 4.
Fig. 2.

2. *A*. The Head of the Tube, with its narrow Neck, to bridle the Blow of the Mercury, as formerly directed for a portable Barometer.

B. The Bottom ground aslant.

C. The Crook.

D. D. The Weather Plates.

By bending the Tube more or less at *C*, an Inch of perpendicular Height may be made 2 or 3 Inches.

By Mr. Derham, n. 237.
p. 45.
Fig. 3.

3. *AA*. A Ruler with Teeth on one Edge of it, made to slide up and down.

b. A little Finger, fix'd to the Ruler, which must be raised or depressed till it point exactly to the Height of the Mercury.

CCCC. The Index Wheel containing just as many Teeth as there are Teeth in an Inch of the sliding Ruler; so that thrusting up and down this toothed Ruler, you may at every Inch turn round the Index once.

DDDD. A Circle, divided into 100 Parts, answering to 100 parts of an Inch on the sliding Ruler.

ee. The Index, which being fastned to the Arber of the Index Wheel, is driven round with it, and shews on the Circle, the parts of an Inch which the Mercury riseth or falleth in the Tube.

Fig. 3.
By Mr. Steph. Gray, D.
240. p. 176.
Fig. 4.

4. *A*. A long square Table: Towards one End is erected a square Column, *BB*, upon which there slides a square Socket, *C*, from one side whereof proceeds a crooked Arm, *DE*. At *D* there is a Screw-hole to receive the Screw, and at *E* a Ring to support the Tube of the Microscope, *F*. From the other side the Socket comes a short Arm *G*, having a Screw-hole to receive the long Screw, *II*, whose Length may be about 6 or 7 Inches; its lower End, by a small Hole in its Center, rests on the End of a small Screw, that comes through the Screw-hole, in the Arm *H*, which is fixed on the back-side of the Column; the upper End of the Screw is filed less than the Body of the Screw, and goes through

through the Center of the round Plate without shaking; and to prevent its doing so, either upwards or downwards, there is added a springing Plate, *n*, which keeps the Shoulder of the Screw close to the Underside of the Plate, *K*; over this Plate there goes an Index, *o*, and over that an Handle, *L*, upon the End of the Screw, which comes through the Center of the Plate, which I should before have told you, is riveted to the Top of the Column, *BB*. The Teeth of the Screw must be of that Size, as to have just 10 in an Inch. The Foreside of the Column must be divided into Inches and Tenths, beginning about the Height of the Socket, *H*, where the lower End of the Screw rests, and so continuing to the Top of the Column. The Limb of the round Plate must be divided into an 100 Parts. In the Focus of the Eye-glass of the Microscope is fixed an Hair, or very fine silver Wire, in an Horizontal Position.

When you use this Instrument, take hold of the Handle, and looking through the Microscope, turn the Screw till you have brought the Hair to touch, as it were, the Surface of the Mercury, *m*; then observe what Divisions are cut on the Column, by the upper or under Edge of the Socket, which are Tenths of an Inch. See likewise to what Parts the Index points on the Limb of the round Plate; which are Hundreds of a Tenth, or Thousand Parts of an Inch: When you perceive the Mercury varied, raise or depress the Microscope, till the Hair be brought to its Surface, as before; then by subtracting the lesser from the greater of the two observed Numbers, you will have the Variation in Inches and thousand Parts.

This Instrument becomes a Micrometer on the same Principles, though I was obliged to alter its Structure from that used with the Telescope, which was first invented by Mr. *Gascoign*, improved by Mr. *Townley*, and described by Dr. *Hook*.

Vid. Vol. I.
Chap. IV.
S. V. 1, 2.

The Thermometer is also capable of the like Improvement.

VII. 1. *May* 26, 1697, between one and two in the Afternoon, on the Top of *Snowdon Hill*, I thrice repeated the *Torricellian* Experiment, and as often found the Height of the Mercury 26, 1 Inches. And being come down to *Llanberris*, at the Foot of the Hill, about 6 that Evening, I as often found it 29, 4 Inches. The next Day, about 8 in the Evening, I found the Mercury, by a triple Experiment, to stand at 29, 9 Inches, very near the Surface of the Sea; when at the same Time, at *Llanerch* in *Denbysshire* (about 25 Miles East from *Snowdon*, and 6 from the Sea, several Foot above the Surface of it) by Mr. *Davis's* standing Barometer, it was above 29, 7 $\frac{1}{2}$: And the Air continued both before and after in the same State. Hence I conclude, That the Difference of the Air's Pressure on the Sea, and on the Top of *Snowdon*, is rather more than 3 Inches, 8 Tenths. I could have wished for one of Mr. *Hunt's* portable Barometers, which will certainly be accurate enough for taking the Levels for bringing of Water from distant Places, and certainly much less subject to Error; there being a Tenth of an Inch for each 30 Yards; which may be divided into many Parts evidently. *Snowdon* was measured by Mr. *Caswell*, with *Adam's* Instruments, to be 1240 Yards high; which abating the Height of the Mercury, 3 Inches 8 Tenths, may serve for a Standard, till a better be obtained on a higher Place.

The Height of
the Mercury
at the Top of
Snowdon
Hill; by Mr.
Halley, n.
229. p. 582.

2. This

Considered;
by Dr. Wal-
lis, n. 233.
p. 653.
At the Top of
the Monu-
ment; by
Mr. Der-
ham, n.
236. p. 2.

2. This Observation had been more useful, had it been repeated at several other perpendicular Heights in the Ascent. For from such comparative Observations, we may make a Judgment of the Height of the Atmosphere.

VIII. In Sept. 1696. I observed the Variation of the Mercury on the *Monument*; and found, by one of Mr. *Quare's* best portable Barometers, that it descended $\frac{1}{8}$ of an Inch at the Height of 80 Feet, and $\frac{2}{8}$ at 160 Feet.

But since that, finding my Observations a little different from Mr. *Halley's* on *Snowdon Hill*, I try'd it again, more nicely, in Nov. 1697. after this Manner. I provided a pretty large glass Tube, well cleaned: This I lodged in Wire, and fill'd it with well strain'd Mercury; which being clear'd of all Air, I then plung'd the Bottom of the Tube into a broad Cistern of Mercury; and then fixed both the Tube and Cistern together, in a Wire Case or Frame. On the Top I left an Eye in the Wire, to suspend the whole Barometer on a String, that it might hang pendulously, which is absolutely necessary; because if the Cistern be deeper on one Side than another, or if the Tube hang more towards one Side than the other, it will cause a great and erroneous Variation in the Mercury above, according as the Tube stands perpendicularly, or not.

My Instrument being thus (I think) very nicely prepared, I marked exactly the Height of the Quick-silver, upon 2 narrow Labels of Paper, pasted on each Side the Tube, both at the Bottom, and in my Ascent up the *Monument*. The Differences of the Mercury's Height I measured with a decimal Inch Scale of thin Brass. The Quantity of my Ascent I measured with a *Gunter's* Chain, because a String would stretch. By the nicest Observation I could make, I found that at the Height of 82 Feet, the Mercury fell $\frac{1}{8}$ of an Inch, and about 164 Feet $\frac{2}{8}$.

By tarrying above somewhat long, I perceived the Pressure of the Atmosphere was somewhat altered; so that the Mercury, in my Descent, was about 0,01 of an Inch different from my Observations in ascending. Upon which I repeated my Experiment, by ascending and descending quicker. At both which Times, my Observations agreed exactly with the first Trial. From whence I conclude, that at every 82 Feet Height, or thereabouts, the Mercury will descend $\frac{1}{8}$ of an Inch. But I am inclined to think, that the Mercury riseth or falleth, sometimes more, sometimes less, at one and the same Height. As for Instance, If the Mercury sinketh 0,1 of an Inch, at the Height of 82 Feet, when the Mercury standeth at 30 Inches in the Barometer, I query, whether it will sink so much when the Barometer is at 29 Inches.

IX. It has been shewn, by undoubted Experiments, that the specifick Gravity of the Air, near the Earth's Surface, to that of Water, was once as 1 to 840, again, as 1 to 852, and a 3d Time, in a very large Vessel, holding ten Gallons, as 1 to 860; all which, considering the Difficulty of the Experiment, agree well enough, the Mercury standing at all those Times about 29 Inches $\frac{3}{4}$; but by Reason 'twas Summer Weather, and consequently the Air rarified, when all these were try'd, we may, without sensible Error, say in round Numbers, that the Barometer standing at 30 Inches, and in a mean State of Heat and Cold, the specifick Gravity of the Air to Water, is as 1 to 800. By the like Trials the Weight of the Mercury to

Water,

n. 237.
p. 46.

The Heights
of the mercurial
Cylinder
at any Ele-
vation above
the Surface
of the Earth;
by Mr. Hal-
ley, n. 181.
p. 104.

Water, is as $13\frac{1}{2}$ to 1, or very near it; so that the Weight of Mercury to Air, is as 10800 to 1, and a Cylinder of Air of 10800 Inches, or 900 Feet, is equal to an Inch of Mercury; and were the Air of an equal Density, like Water, the whole Atmosphere would be no more than 5,1 Miles high; and in the Ascent of every 900 Feet, the Barometer would sink an Inch. But the Expansion of the Air increasing in the same Proportion as the incumbent Weight of the Atmosphere decreases, that is, as the Mercury in the Barometer sinks, the upper Parts of the Air are much more rarified than the lower; and each Space answering to an Inch of Quick-silver, grows greater and greater; so that the Atmosphere must be extended to a much greater Height.

These Expansions of the Air being reciprocally as the Heights of the Mercury, it is evident, that by the Help of the Curve of the *Hyperbola* and its *Asymptotes*, the said Expansions may be expounded to any given Height of Mercury; for by the 65th Prop. Lib. 2. Conic. Mydorgii, the Rectangles *Fig. 5.* *ABCE*, *AKGE*, *ALDE*, &c. are always equal; and consequently the Sides, *CB*, *KG*, *LD*, &c. are reciprocally as the Sides, *AB*, *AK*, *AL*, &c. If then the Lines, *AB*, *AK*, *AL*, be supposed equal to the Heights of the Mercury, or the Pressures of the Atmosphere, the Lines *CB*, *KG*, *LD*, answering thereto, will be as the Expansion of the Air under those Pressures, or the Bulks that the same Quantity of Air will occupy; which Expansions being taken infinitely many, and infinitely little (according to the *Method of Indivisibles*) their Sum will give the Spaces of Air between the several Heights of the Barometer; that is to say, the Sum of all the Lines between *CB*, and *KG*, or the Area, *CBKG*, will be proportioned to the Distance or Space intercepted between the Levels of two Places in the Air, where the Mercury would stand at the Heights represented by the Lines, *AB*, *AK*; so then the Spaces of the Air, answering to equal Parts of Mercury in the Barometer, are as the Areas, *CBKG*, *GKLD*, *DLMF*, &c. These Areas again are, by the Demonstration of *Gregory of St. Vincent*, proportionate to the Logarithms of the Numbers, expressing the *Rationes* of *AK* to *AB*, of *AL* to *AK*, of *AM* to *AL*, &c. So then, by the common Table of Logarithms, the Height of any Place in the Atmosphere, having any assigned Height of the Mercury, may most easily be found: For the Line *CB*, in the *Hyperbola*, whereof the Areas design the Tabular Logarithms, being 0,0144765; 'twill be as 0,0144765, to the Difference of the Logarithms of 30, and any other lesser Number; so 900 Feet, or the Space answering to an Inch of Mercury, if the Air were equally prest with 30 Inches of Mercury; and every where alike, to the Height of the Barometer in the Air; where it will stand at that lesser Number of Inches: And by the Converse of this Proportion may the Height of the Mercury be found, having the Altitude of the Place given. From these Rules I derived the following Tables.

<i>Given Heights of the Mercury.</i>	<i>Altitudes.</i>		<i>Given Altitudes.</i>	<i>Heights of the Mercury.</i>
Inches	Miles	Feet	Feet	Inches
30		0	0	30, 00.
29		915	1000	28, 91.
28		1852	2000	27, 86.
27		2844	3000	26, 85.
26		3863	4000	25, 87.
25		4922	5000	24, 93.
20		10947	Miles 1	24, 67.
15		18715	2	20, 29.
10		29662	3	16, 68.
5		48378	4	13, 72.
1		91831	5	11, 28.
0,5		110547	10	4, 24.
0,25		129262	15	1, 60.
0,1	29 or	154000	20	0, 95.
0,01	41 or	216169	25	0, 23.
0,001	53 or	278338	30	0, 08.
			40	0, 012.

Upon these Suppositions it appears, that at the Height of 41 Miles, the Air is so rarified as to take up 3000 Times the Space it occupies here; and at 53 Miles high it would be expanded above 30000 Times; but 'tis probable, that the utmost Power of its Spring cannot exert itself to so great an Extension, and that no Part of the Atmosphere reaches above 45 Miles from the Surface of the Earth.

This seems confirmed from the Observations of the *Crepusculum*, which is observed commonly to begin and end when the Sun is about 18 *Deg.* below the *Horizon*; for supposing the Air to reflect Light from its most rarified Parts; and that as long as the Sun illuminates any of its Atoms, they are visible to an Eye not intercepted by the Curvity of the Earth, it will follow, that the Proportion of the Height of the whole Air, to the Semi-diameter of the Earth, is much about as 1 to 90, or as the Excess of the Secant of about $8\frac{1}{2}$ *Deg.* to Radius. For if *E* be the Eye of the Observer, *S*, a Place where the Sun sets at the End of Twilight in *E*, and the Arch *EGS*, or *TCA*, be found 18 *Deg.* the Excess of the Secant of Half thereof, *ECH*, would be the Height of the Air, *viz.* *GH*: But the Beam of the Sun, *ASH*, and the visual Ray, *EH*, do each of them suffer a Refraction of about 32 or 33 *Min.* whereby, being bent inwards from *H*, towards *G*, the Height of the Air need not be so great as if they

they went straight; and having from the Angle ECS , taken the double Refraction of the *Horizontal Ray*, the half of the Remainder will be $8\frac{1}{2}$ Deg. *circiter*; whose Secant being 10111, it follows that as 10000 to 111, so the Semidiameter of the Earth, supposed 4000 Miles, to 44,4 Miles; which will be the Height of the whole Air, if the Places, E, S , whose visible Portions of the Atmosphere $ERZH$, and $SHKB$, just touch one the other, be 18 Deg. asunder.

At this Height the Air is expanded into above 3000 Times the Space it occupies here, and we have seen the Experience of condensing it into the 60 Part of the same Space; so that it should seem, that the Air is a Substance capable of being compressed into the 180000 Part of the Space it would naturally take up, when free from Pressure: Now what Texture or Composition of Parts shall be capable of this great Expansion and Contraction, seems a very hard Question; and which, I suppose, is scarce sufficiently accounted for, by the comparing it to Wool, Cotton, and the like springy Bodies.

'Tis true, the Weight of the whole Atmosphere is various, being counterpoised sometimes by $28\frac{1}{2}$ Inches of Mercury, and at other Times by no less than $30\frac{1}{2}$, so that the under Parts being pressed by about a 15th Part less Weight, the specific Gravity of the Air upon that Score, will sometimes be a 15th Part lighter than another; besides, Heat and Cold does very considerably dilate and contract the Air, and consequently alter its Gravity; to which add the Mixture of Effluvia or Steams rising from almost all Bodies, which assimilating into the Form of Air, are kept suspended therein, as Salts dissolved in Liquors, or Metals in corroding Menstrua; which Bodies being all of them very much heavier than Air, their Particles by their Admixture must needs encrease the Weight of that Air they lie incorporated withal, after the same manner as melted Salts do augment the specific Gravity of Water. 'Tis also true, that the Condensations are not possible beyond certain Degrees; for being compressed in an 800th Part of the Space it takes up here, its Consistence will be equally dense with that of Water, which yields not to any Force whatsoever, as hath been found by several Experiments tried here, and at *Florence* by the *Academia del Cimento*; nor can the Rarefaction proceed *in infinitum*; for supposing the Spring whereby it dilates itself, occasioned by what Texture of Parts you please, yet must there be a determinate Magnitude of the natural State of each Particle, as we see it is in Wool, and the like, whose Bodies being compressible into a very small Space, have yet a determinate Bulk which they cannot exceed, when freed from all manner of Pressure.

These Objections disturb the Geometrical Accuracy of these Conclusions drawn from the specific Gravity of the Air, observed at any Time; but the Method here shewn will compute, by a like Calculation, the Heights of the Quick-silver, and the Rarefactions of the Air from any assigned Height of the Barometer at the Earth's Surface, and any specific Gravity given. As to the Condensation and Rarefaction by Heat and Cold, and the various Mixtures of aqueous and other Vapours, these two Objections seem generally to compensate each other; for when the Air is rarified by Heat, the Vapours are raised most copiously, so that tho' the Air, properly so call'd, be expanded, and consequently lighter, yet the Interstices thereof being crowd-

ed full of Vapours of much heavier Matters, Bulk for Bulk, the Weight of the Compositum may continue much the same; at least a most curious Experiment made by the ingenious Mr. *John Caswel* of *Oxford*, upon the Top of *Snowdon Hill* in *Caernarvonshire*, seems to prove that the first Inches of Mercury have their Proportions of Air near enough to what I now determine; for the Height of the Hill being 1240 Yards, or very near it, he found the Mercury to have subsided to 25,6 Inches, or 4 Inches below the mean Altitude thereof at the Level of the Sea, and the Space answering to 4 Inches, by my Calculation should be 1288 Yards: And it agrees as well with the Observation in the Appendix to Mr. *Pascall's* Book, *de l'Equilibre des Liquers*, made on the high Hill in *Auvergne*, call'd *Le Puy de Dommé*. So that the Rarefaction and Vapours seem not to have alter'd considerably the Gravity of the under Parts of the Air; and much above the Height where these Experiments were made, do few Vapours ascend, and the Cold is such, that the Snow lies continually; so that for the more elevated Parts of the Sphere of Air there is much less Reason to doubt.

The Reason
of the Ascent
of the Quick-
silver; by
Dr. Lister,
n. 165.
p. 970.

X. 1. It is observed of the Barometer, that the Quick-silver is not affected with the Weather, or very rarely, let that be either cloudy, rainy, windy, or serene, in *St. Helena*, or the *Barbadoes*: and therefore probably not within the *Tropicks*, unless in a violent Storm or Hurricane. The first is affirmed by Mr. *Halley*, who kept a Glass near two Months in the Island of *St. Helena*, and the other of *Barbadoes* stands upon the Credit of our Registers.

2. In *England*, in a violent Storm, or when the Quick-silver is at the very lowest, it then visibly breaks and emits small Particles, as I have more than once observed; which Disorder I look upon as a kind of Fretting; and consequently at all Times of its Descent, it is more or less upon the Fret.

In this Disorder of the Quick-silver, I imagine it hath its Parts contracted, and closer put together; which seems probable, for that, for Example, the Quick-silver then emits, and squeezes out fresh Particles of Air into the Tube, which encreasing the Bulk of the Air, and consequently its Elasticity, the Quick-silver is necessarily depress'd thereby, that is, by an external Force or Power; and also the Quick-silver must of itself come closer together, in its own internal Parts, that is, descends, for both Reasons.

And that much Air is mixed with it, appears from the Application of a heated Iron to the Tube, as is practis'd in the purging of it that way; and also for that polish'd Iron will rust, though immers'd in it, as some Philosophers have lately observed.

Now when the Quick-silver rises in the Pipe (which it certainly does both in hot and frosty Weather) it may then be said to be in a natural State, free, open, and expanded like itself, which it seems it ever is within the *Tropicks*, and with us only in very hot and very frosty Weather. But when it descends, it is then contracted, and as it were convulsed and drawn together, as it mostly is in our Climate of *England*, and more or less, as we guess, in all Places on this Side the *Tropicks*. Which Contraction plainly appears from the concave Figure of both Superficies, not only in that of the Quick-silver in the Tube, but also (if well observed) in that which stagnates in the Pot or Dish itself.

The Difficulty seems to lie in the reconciling the same Effect of the Quick-silver's rising in the Tube, from such seemingly different Causes, as great Heat and intense Frost: and those who shall willingly assent to us in one Particular, and grant us Warmth as a probable Cause of its Restitution to its Nature, will yet be at a Stand how to imagine, that great Frost likewise should bring the Quick-silver nearer its own Nature too. I answer, that Salts liquified will coagulate or crystallize, that is, will return to their own proper Natures, both in Cold and in Heat; and therefore, tho' most Men practise the setting them in a cool Cellar for that Purpose, yet some (as *Zwelfer*) advise, as the best Means to have them speedily and fairly crystallized, to keep them constantly *in Balneo*. Thus also the Lympha of the Blood does become a Jelly, if you set it in a cool Place, and the same is by Warmth in like manner inspissated. Again, that it is no new Opinion, that Water is naturally Ice, if no Disquiet from some external Accident hinder. *Bornichius*, the learned *Dane*, has said something for it: And altho' some may think that what he hath said, was a mere Compliment to his own frozen Climate, yet I dare venture to add, in Confirmation of that Doctrine, that Salt is naturally Rock, that is, naturally fossile, not liquid; and yet this is most like Ice of any thing in Nature, not only because of its Transparency, but also for its easy Liquefaction, and the sudden Impressions and Changes which Air makes upon it, so that it is scarce to be preserved in its natural State of Crystallization. Also Salts of all sorts seem naturally to propagate themselves in a hard State, and to vegetate in a dry Form. The like is to be observed in Quick-silver, of its being a hard Rock, and also from its Willingness to embrace upon all Occasions a more fix'd State, as in its Amalgamizing with almost all sorts of Metals.

It will not be amiss by way of Corollary, to add a Note or two about healthful and sickly Seasons, more particularly as they may refer to this *Phenomenon* of great Cold and Frost. If therefore Quick-silver and Liquids are nearest their own Natures, and have less Violence done to them, in very cold and very hot Seasons, the Humours of our Bodies, as Liquids, in all Probability, must be in some measure accordingly affected. And that therefore Cold is healthful, I argue from the vast Number of old Men and Women, to be found upon the Mountains of *England*, comparatively to what are found elsewhere.

Again, the Blood itself, or the vital Liquor of Animals equivalent to it, is in most Kinds of Animals in Nature sensibly cold; for that the Species of Quadrupeds and Fowls are not to be compared for Number to Fishes and Insects; there being, in all Probability, by what I have observed, above a hundred Species of these latter Creatures, whose vital Juice is cold, to one of the former: But because we most converse with those whose vital Juice is hot, we are apt to think the same of all.

Again, I have observed, which I offer as an Argument of the little Injury intense Cold does to the Nature of Animals: I say, I have seen both Hexapode Worms (which I compare to the tender Embryo's of sanguineous Animals, because such are in a middle State) and Flies of divers Sorts, hard frozen in the Winter, and I have taken them up from the Snow, and if I

cast them against the Glass, they would endanger the breaking of it, and make it ring like so much hard Ice; yet when I put the Insects under the Glass, and set them before the Fire, they would, after a short Time, nimbly creep about, and be gone, if the Glass which I whelmed upon them, had not secured them.

2. It hath indeed been noted by a very wise Philosopher, in Contradiction to our *English* Proverb, which says, that *A green Christmas makes a fat Church-yard*; that the last Plague broke out here at *London*, after a long and severe Winter 1665. But I reply, That that was accidentally only; for that Disease is never bred amongst us, but comes to us by Trade and Infection. 'Tis properly a Disease of *Asia*, where it is Epidemical. And therefore, by the Providence of God, we are very secure from any such Calamities as the natural Effect of our Climate. But we are not to judge or prognosticate of the Salubrity or Sickliness of a Year, from foreign Diseases, but the raging of such as are natural to the Men of our Climate.

By Mr Edm.
Halley, in
181. p. 110.

2. To account for the different Heights of Mercury at several times, 'twill not be unnecessary to enumerate some of the principal Observations made upon the Barometer.

The first is, That in calm Weather, when the Air is inclined to Rain, the Mercury is commonly low.

2. That in serene good settled Weather, the Mercury is generally high.

3. That upon very great Winds, tho' they be not accompanied with Rain, the Mercury sinks lowest of all, with relation to the Point of the Compass the Wind blows upon.

4. That, *Ceteris Paribus*, the greatest Heights of the Mercury are found upon Easterly, and North-easterly Winds.

5. That in calm frosty Weather the Mercury generally stands high.

6. That after very great Storms of Wind, when the Quick-silver has been low, it generally rises again very fast.

7. That the more northerly Places have greater Alterations of the Baroscope than the more southerly.

8. That within the *Tropicks*, and near them, those Accounts we have had from others, and my own Observations at *St. Helena*, make very little or no Variation of the Height of the Mercury in all Weathers.

Hence I conceive, that the principal Cause of the Rise and Fall of the Mercury, is from the variable Winds, which are found in the *Temperate Zones*, and whose great Unconstancy here in *England*, is most notorious.

A second Cause is the uncertain Exhalation and Precipitation of the Vapours lodging in the Air, whereby it comes to be at one Time much more crouded than at another, and consequently heavier; but this latter, in a great measure, depends upon the former. Now from these Principles, I shall endeavour to explicate the several *Phænomena* of the Barometer, taking them in the same Order I laid them down. Thus,

1. The Mercury's being low, inclines it to Rain, because the Air being light, the Vapours are no longer supported thereby, being become specifically heavier than the Medium wherein they floated, so that they descend towards the Earth, and in their Fall, meeting with other aqueous Particles, they incorporate

corporate together, and form little Drops of Rain; but the Mercury's being at one time lower than another, is the Effect of two contrary Winds blowing from the Place where the Barometer stands; whereby the Air of that Place is carried both ways from it, and consequently the incumbent Cylinder of Air is diminished, and accordingly the Mercury sinks; as for Instance, if in the *German Ocean* it should blow a Gale of westerly Wind, and at the same time an easterly Wind in the *Irish Sea*; or if in *France* it should blow a northerly Wind, and in *Scotland* a southerly; it must be granted me that that Part of the Atmosphere impendent over *England*, would thereby be exhausted and attenuated, and the Mercury would subside, and the Vapours, which before floated in those Parts of the Air of equal Gravity with themselves, would sink to the Earth.

2. The greater Height of the Barometer is occasioned by two contrary Winds blowing towards the Place of Observation, whereby the Air of other Places is brought thither and accumulated; so that the incumbent Cylinder of Air being encreased both in Height and Weight, the Mercury pressed thereby must needs rise and stand high, as long as the Winds continue so to blow; and then the Air being specifically heavier, the Vapours are better kept suspended, so that they have no Inclination to precipitate and fall down in Drops; which is the Reason of the serene good Weather, which attends the greater Heights of the Mercury.

3. The Mercury sinks the lowest of all by the very rapid Motion of the Air in Storms of Wind. For the Tract or Region of the Earth's Surface, wherein these Winds rage, not extending all round the Globe, that stagnant Air which is left behind, as likewise that on the Sides, cannot come in so fast as to supply the Evacuation made by so swift a Current; so that the Air must necessarily be attenuated when and where the said Winds continue to blow, and that more or less, according to their Violence; add to which, that the *Horizontal* Motion of the Air being so quick, as it is, may, in all Probability, take off some Part of the perpendicular Pressure thereof; and the great Agitation of its Particles is the Reason why the Vapours are dissipated, and do not condense into Drops so as to form Rain, otherwise the natural Consequence of the Airs Rarefaction.

4. The Mercury stands the highest upon an Easterly or North-easterly Wind, because in the great *Atlantick Ocean*, on this side the 35th Deg. of North Latitude, the Westerly and South-westerly Winds blow almost always Trade; so that whenever here the Wind comes up at East and North-east, 'tis sure to be check'd by a contrary Gale, as soon as it reaches the Ocean; wherefore, according to what is made out in our second Remark, the Air must needs be heaped over this Island, and consequently the Mercury must stand high as often as these Winds blow. This holds true in this Country, but is not a general Rule for others where the Winds are under different Circumstances; and I have sometimes seen the Mercury here as low as 29 Inches upon an Easterly Wind, but then it blew exceeding hard, and so comes to be accounted for by what was observed upon the third Remark.

5. In Calm Frosty Weather the Mercury generally stands high, because (as I conceive) it seldom freezes but when the Winds come out of the Northern

Northern and North-eastern Quarters, or at least unless those Winds blow at no great Distance off; for the Northern Parts of *Germany, Denmark, Sweden, Norway*, and all that Tract from whence North-eastern Winds come, are subject to almost continual Frost all the Winter; and thereby the lower Air is very much condensed, and in that State is brought hitherwards by those Winds, and being accumulated by the Opposition of the westerly Wind blowing in the *Ocean*, the Mercury must needs be prest to a more than ordinary Height; and as a concurring Cause, the shrinking of the lower Parts of the Air into lesser Room by Cold, must needs cause a Descent of the upper Parts of the Atmosphere, to reduce the Cavity made by this Contraction to an *Æquilibrium*.

6. After great Storms of Wind, when the Mercury has been very low, it generally rises again very fast; I once observed it to rise $1\frac{1}{2}$ Inch in less than 6 Hours after a long continu'd Storm of South-west Wind. The Reason is, because the Air being very much rarified, by the great Evacuations which such continued Storms make thereof, the Neighbouring Air runs in the more swiftly to bring it to an *Æquilibrium*; as we see Water runs the faster for having a great Declivity.

Equilibre
des Liquers.

7. The Variations are greater in the more Northerly Places, as at *Stockholm* greater than at *Paris* (compared by Mr. *Pascall*) because the more Northerly Parts have usually greater Storms of Wind than the more Southerly, whereby the Mercury should sink lower in that Extream; and then the Northerly Winds bringing the condensed and ponderous Air from the Neighbourhood of the *Pole*, and that again being checked by a Southerly Wind at no great Distance, and so heaped, must of Necessity make the Mercury in such Case stand higher in the other Extream:

8. Lastly, This Remark, That there is little or no Variation near the *Equinoctial*, does above all others confirm the *Hypothesis* of the variable Winds being the Cause of these Variations of the Height of the Mercury; for in the Places above named there is always an easy Gale of Wind blowing nearly upon the same Point, *viz. E. N. E. at Barbadoes, and E. S. E. at St. Helena*; so that there being no contrary Currents of the Air to exhaust or accumulate it, the Atmosphere continues much in the same State: However, upon Hurricanes (the most violent of Storms) the Mercury has been observed very low, but this is but once in two or three Years, and it soon recovers its settled State, about $29\frac{1}{2}$ Inches.

The principal Objection against this Doctrine is, that I suppose the Air sometimes to move from those Parts where it is already evacuated below the *Æquilibrium*, and sometimes again towards those Parts where it is condensed and crouded above the mean State; which may be thought contradictory to the Laws of *Statics* and the Rules of the *Æquilibrium* of Fluids. But those that shall consider how, when once an *Impetus* is given to a Fluid Body, it is capable of mounting above its Level, and checking others that have a contrary Tendency to descend by their own Gravity, will no longer regard this as a material Obstacle; but will rather conclude, That the great Analogy there is between the Rising and Falling of the Water upon the *Flux* and *Reflux* of the Sea, and this of accumulating and extenuating the
Air,

Air, is a great Argument for the Truth of this *Hypothesis*. For as the Sea, over against the Coast of *Essex* rises and swells by the meeting of the two contrary Tides of Flood, whereof the one comes from the *S. W.* along the *Channel of England*, and the other from the North; and, on the contrary, sinks below its Level upon the Retreat of the Water both ways, in the Tide of Ebb; so it is very probable, that the Air may Ebb and Flow after the same manner; but by reason of the Diversity of Causes, whereby the Air may be set in moving, the Times of these *Fluxes* and *Refluxes* thereof are purely casual, and not reducible to any Rule, as are the Motions of the Sea, depending wholly upon the regular Course of the *Moon*.

XI. 1. The Experiment is briefly this; That a Tube being after the *Torricellian* Way filled with Mercury, and before Inversion perfectly purged of Air, doth, when inverted, remain top full, even to the Height of 75 Inches.

Mr. *Hugens*, to render a probable Cause of this strange Effect, conceiveth, That besides the Pressure of the Air which keeps the Mercury suspended at the Height of about 27 Inches, (and of the Truth of which we are convinced by a great Number of other Effects that we see) there is yet another Pressure, stronger than that, of a more subtile Matter than Air, which without Difficulty penetrates Glass, Water, Quick-silver, and all other Bodies, which we find impenetrable to Air. This Pressure, he saith, being added to that of the Air, is capable to sustain the 75 Inches of Mercury, and possibly more, as long as it works only against the lower Surface, or against that of the Mercury, in which stands the open End of the Tube: But as soon as it can work also on the other side, (which happens when striking or hitting against the Tube, or intromitting into it a small Bubble of Air, you give way to this Matter to begin to act) the Pressure of it becomes equal on both Sides, so that there is no more but the Pressure of the Air which sustains the Mercury at the ordinary Height of 29 Inches.

The Cause of the Suspension of the Mercury at an unusual Height; by Mr. Hugens, n. 86. p. 5027.

If you ask, why the Quick-silver in the Tube of this Experiment does not feel the Pressure of this Matter, even whilst that Vessel is yet full; since Mr. *Hugens* supposeth, that it pierceth without Difficulty the Glass as well as the Mercury, &c. and why the Particles of this Matter do not join together and begin the Pressure, in regard that they go and come thorough the whole Extent of the Mercury, and that the Glass does not hinder their Communication with those that are without?

To remove this Difficulty, which in Mr. *Hugens's* own Opinion is very great, he answers, That though the Parts of the Matter by him supposed do find Passage between those that compose the Glass, Quick-silver, &c. yet they there find not sufficiently large ones for many to pass together, nor to move there with that Force which is requisite to separate the Parts of the Quick-silver, that have some Connexion together. And this very same Connexion, he saith, is the Cause that though on the Side of the inner Surface of the Glass, which touches the suspended Mercury, many of its Parts be pressed by the Particles of this Matter; yet there being also a great Number of them that feel no Pressure, by reason of the Parts of the Glass, behind which they are placed, they retain one another, and they remain all suspended, because there is much less Pressure on the Surface of the Quick-silver

silver that is contiguous to the Glass, than upon that below, which is all exposed to the Action of that Matter which makes this second Pressure.

The ingenious and candid Author of this Solution acknowledges himself, That it doth not so fully satisfy him, as not to leave some Scruple behind; but then he adds, That that keeps him not from being very well assured of that new Pressure, which he hath supposed besides that of the Air, by reason as well of the Experiment already alledged, as of two others; which he subjoins, to this Effect.

First, When two Plates of Metal or Marble, whose Surfaces are perfectly plain, are put one upon another, they do so stick together, that the uppermost being lifted up, the undermost follows without quitting it; and the Cause hereof is justly ascribed to the Pressure of the Air against their two external Surfaces. He taking then two Plates, each of them but about an Inch square, being of that Matter of which anciently they made Looking-Glasses, and closing them so exactly together, that without putting any Thing between, the uppermost keeps not only up the other, but sometimes also with it 3 Pounds of Lead fasten'd to the lowermost; and thus they remain together as long as you please. Having thus joined them, and charged them with 3 Pounds weight, he suspended them in the Recipient of his Engine, and exhausted it of Air so far as that there remained not enough to sustain by its Pressure as much as an Inch Height of Water, and yet his Plates disjoined not. He adds, that he made the same Experiment by putting Spirit of Wine between the two Plates, and found that in the Recipient evacuated of Air they sustained, without being severed, the same Weight they did when it was full of Air. This he thinks shews clearly enough, that there remains yet in the Recipient a Pressure great enough, after that of the Air is thence taken away; and that there is no more Reason to doubt of it, than of the Pressure of the Air itself.

The *Second* Experiment is, That whereas the Effect of a Siphon of unequal Legs, by which you make the Water of a Vessel to run over, is no longer ascribed to *Fuga Vacui*, but to the Weight of the Air, which pressing upon the Water of the Vessel makes it rise in the Siphon, whilst on the other Side it descends by its Weight; Mr. *Hugens* found a Means to make the Water of the Siphon run after that the Recipient was exhausted of Air, and he saw that with Water purged of Air it did the Effect as well as without the Recipient. The shortest of the Legs of the Siphon was 8 Inches long, and its Aperture of two Lines. And he will not have us doubt whether the Recipient was well exhausted of Air, for he did assure himself of that, as well by finding that there came out no more Air through the Pump, as by other more certain Marks.

And this he takes for a farther Confirmation of his Supposition of a pressing Matter more subtile than the Air. To which he adds, That if you take the Pains of searching to what Degree the Force of this Pressure reacheth (which he saith cannot be better made than by pursuing the Experiment with Tubes full of Mercury, yet longer than those employed by Mr. *Boyle*) it will perhaps be found, that this Force is great enough to cause the Union of the parts of Glass, and of other Sorts of Bodies, which hold too well together, not to be conjoined but by their Contiguity and Rest, as M. *Des Cartes* would have it.

2. I have given an Account of this odd *Phænomenon* in my *Treatise de Mo-* By Dr. J. Wallis, n. 91. p. 5160
tu, Cap. 14. Schol. Prop. 13. where I hinted two Reasons (though not perfectly
 satisfied in either:) The one of my own, concerning the Spring of the Air ne-
 cessary to put heavy Bodies in Motion, not impelled by any other Force: The
 other of my Lord *Brounker*, That there might be in the Air yet a greater
 Weight or Pressure than is necessary for the Height of 29 Inches, in case there
 be nothing but the bare Weight of Quick-silver to be supported. I find Mr.
Hugens to fall in with that of my Lord *Brounker*, save that what we compre-
 hend under the Name of Air, he calls a more subtile Matter; which alters
 not the Case at all, but only the Name.

But surely there must be somewhat more than this subtile Matter, to solve
 the *Phænomenon*, notwithstanding the two Experiments now alledged by
 Mr. *Hugens* in favour of it; for, if this Matter be so subtile as to press
 through the Top of the Glass upon the Quick-silver, (and consequently
 through the Upper upon the Nether of the two Marbles) as is acknowledged
 (and without which it is no more able to precipitate the Quick-silver while
 impure, and when it is in part subsided, that when it is pure, and the Tube
 top full :) I do not see, why it should not balance itself (above and below)
 in the same manner as common Air would do, if the Tube were pervious
 to it at both Ends, and the Quick-silver, by the Preponderance of its own
 Weight fall presently. And the Answer, That though Glass be penetrated
 by it, yet not in so copious a manner as where no Glass is, doth not to me
 solve the Difficulty; because the same Obstacle doth just in the same man-
 ner remain, when the Tube is in part emptied, and when the Quick-silver
 is unpurged; the Pores of the Glass not being, by either of those, made
 more open or more pervious. And if we suppose the subtile Matter by Per-
 colation to be strained through with some Difficulty, (as Air or Water would
 be through a Cloth) this might possibly cause the Quick-silver, when it does
 sink, to sink gradually; but not (as we see it) suddenly to fall to the
 Height of 29 Inches.

The Connexion or Cohesion of the Parts of Quick-silver, either each to
 other, or to the Sides of the Glass, which Mr. *Hugens* supposeth to require for
 their Separation a greater Force than is in these percolated Particles, till they
 have Room made for them to combine; seems to me the less considerable,
 because it is not so necessary to separate them from each other, since they
 may unseparated slide down by the Sides of the Glass, to which it is well
 known, and visible to the Eye, the Quick-silver is not at all apt to stick, but
 doth rather decline that Contact; in like manner as we find Water not apt to
 join with Oil or Grease, though Water to Glass, and Quick-silver to Gold,
 do very readily apply themselves. So that there needs no such Force to dis-
 join the Quick-silver from the Glass, whatever there may be for disjoining its
 Parts one from another.

If therefore we should suppose the Pressure of the grosser Air down-
 wards on *AB* (the Surface of the stagnant Quick-silver) and consequently
 by means thereof upwards at *C*, sufficient only to bear up that in the
 Tube to the Height of *I*; but the superadded Weight or Pressure of the Fig. 7.
 purer Air to hold it up as high as *D*, (75 Inches or more) while it is full

and the Quick-silver well cleansed, as if so long it could not enter at *D*; but in case it be not so cleansed, or be already sunk to *H*, this purer Air would enter at *D*, and thrust it down to *I*, counter-balancing the Pressure (at *C*) of the purer, but not of the grosser Air (which I take to be the Sum of the Cause assign'd by Mr. *Hugens*;) I am yet to seek, why it may not as well penetrate *D* at first, to begin the Descent, as afterwards to pursue it; and why not as well begin the Descent when the Quick-silver is well cleansed of Air, as when it is not so; and why also, if the pure Air do freely enter at *D*, it does not presently fall; or, if not freely, why, when it does fall, it falls suddenly, and not leisurely, from *D* to *I*; especially since so small a Weight as *DH* of pure Air (for the grosser cannot enter) is very inconsiderable; if not at all, or not freely, pressed by that incumbent on *D*; and the Adhesion not considerably less, by being separated only at the Top, while it yet continues to touch the Sides.

I am apt therefore, as heretofore, to ascribe the Cause of this *Phenomenon* to the Spring that is in Air, and the want thereof in Quick-silver; for, that in Air there is a Spring or Elasticity, is now undoubted; but in Water cleansed of Air, though many Experiments have been attempted to that purpose, it has not yet been found that there is any: And I am apt to think the like of Quick-silver, though I do not know that this has been yet so rigorously examin'd. Now supposing, That Matter being at Rest will so continue till it be put in Motion by some Force; this Force may be either that of Percussion from some Body already in Motion (which is the Case when the Quick-silver falls by shaking or striking the Tube) or of Pulsion from a contiguous Body beginning to move, as by the Expansion of some adjacent Spring (which is the Case when the springy Parts of the Air, either left in unpurged, or re-admitted in the Quick-silver, by expanding themselves put the Quick-silver in Motion;) or some *Conatus* or Endeavour of its own, such as is that of a Spring, from whatever Cause it be, which I do not here enquire, but has place only in Springy Bodies; and therefore if Water and Quick-silver be not such, they will not on this account put themselves in Motion.

Gravity or Heaviness is reputed to be such a *Conatus* or Pronity to move downwards, and so to put itself in Motion; and the Wonder at present is, why it does not so here. But if this which we call Gravity should chance to be not a positive Quality or *Conatus* originally of itself, but only the Effect of some Pulsion or Percussion from without (which possibly may be the Case, and principally from the Spring of the Air about us) then while this Pulsion and Percussion is wanting (however obviated) the Bodies accounted heavy, will not of themselves begin to fall; which seems to be the present Case.

And this is the more considerable, because we cannot, at least not yet, find, what is the utmost Height at which the Quick-silver thus accumulated will remain suspended; there having been, for ought I know, no Height yet attempted, at which, if cleansed, it will not stand; and that of 75 Inches, considering the Weightiness of Quick-silver, is a very great one, being more than equivalent to 80 Foot of Water.

My

My Lord *Brounker* doth a little alter the Case from what I take to be the *Hypothesis* of Mr. *Hugens*; for he supposeth this purer Part of the Air to be of like Nature with the grosser Part (which I think Mr. *Hugens* doth not) and, though finer than the rest, so as to penetrate Glafs, which the grosser will not (there being in all sorts of Grains, some greater than others, and which will not pass so fine a Sieve) yet of a springy Nature, as the grosser Parts are; which therefore acts, not by its Weight only, but by its Spring; and therefore when once entered, though in a small Proportion, acts as effectually at its first Entrance as if the whole incumbent Air had Admission, its Spring being of a like Tensure with that of the outward Air, (as I have heretofore shewed, *Cap. 14. De Motu, Prop. 11, 12, 13.*) but Mr. *Hugens's* more subtile Matter than Air, though he must allow it Weight, for else its Entrance would be nothing to the purpose; yet whether he allow it a Spring, I cannot tell; nor doth he inform us. And when he says, this more subtile Matter than Air doth without Difficulty penetrate Glafs, Water, Quick-silver, and all other Bodies, which we find impenetrable to Air, I know not whether he mean, without any Difficulty, as the Words seem to import; or, as I conjecture by what follows, without great Difficulty, though with some.

But his *Lordship*, if I mistake not, though he allows his springy, subtile Matter to penetrate Glafs, yet not without Difficulty; and till it have some Room made, as at *HD*, wherein it may recollect itself, cannot exert its Spring; and therefore not while top full of cleansed Quick-silver, but so soon as some Room is made for it; whereas if the Quick-silver be not purged of Air, that little Air remaining doth by its Spring begin the Motion.

He thinks it also not improbable, and if it so prove, it will be a good Confirmation of this *Hypothesis*, That a large but low Tube of Glafs (shorter than 29 Inches) may stand top full of Quick-silver, though with a small Hole in the Top, as at *K*; at least if immersed in Water, in case Air be too subtile for our Mechanicks.

He might also, suitably enough to his own *Hypothesis*, have so explained himself as to allow his more subtile Parts of common Air to penetrate Quick-silver, but not Glafs; and therefore, in case of Room for it at *HD*, it might through the stagnant Quick-silver, and that at *C*, pass upwards to *HD*, and there exert its Spring.

There is yet another way of explicating the same *Hypothesis*, without allowing this subtile Matter to pierce the Glafs; which is this: Our common Air being an Aggregate of very heterogeneous Parts, we may well suppose some of them to be Springy, and others not to be so. The springy Parts we may conceive to be so many consistent Bodies, like small Hairs or springy Threads wrapped up in different Forms and variously intangled, and so as to form many Vacuities, capable of admitting (what the other Parts of the Air may be supposed to be) some fluid Matter, which may insinuate into those Vacuities (as Water in a Bundle of Rushes) without disturbing the Texture of those springy Parts; and which may press as a Weight, but not as a Spring (Of which Distinction see *Cap. 14. De Motu, Schol. Prop. 11. & Schol. Prop. 13. p. 729, 730, 732, 733.*) Now if in the *Toricellian Tube* there be

a Quantity of such springy Matter, the Spring hereof will be of equal strength with that of external Air, (and therefore able to counterbalance it, though its Weight be much less) because admitted with such a Tensure, (*ibid. Prop. 12, 13.*) But if only an unspringy Fluid (which presseth but as a Weight not as a Spring) and this defended by the Glass Tube from any other Pressure, save that of its own Weight, it will still be too weak to force its own way, till its single Weight be equivalent to that which it is to encounter; which is not only the springy Part of the Air, but also that fluid unspringy Part; which though (because fluid) it would give way to a springy Body pressing through it, yet not to this fluid, like itself, and destitute of such a Spring; and is therefore able to keep it up to a much greater Height than it could do if uncleaned of springy Air; so long, at least, till some springy Body be admitted, or some Concussion equivalent to it, put it in Motion; but being once in Motion, it will so continue (as a Bullet impelled by Gun-powder, or an Arrow out of a Bow) till stopped by some positive Force equivalent.

Vid. Inf. §.
penult.

I do not deny, but that this Explication may be subject to some Difficulties and Exceptions; but I think, fewer than that of allowing the Glass penetrable by this subtile Matter: But the best way to settle this Business is by suitable Experiments.

A Statical
Baroscope;
by M. Boyle,
n. 14. p. 231.

XII. I caused to be blown at the Flame of a Lamp some Glass-Bubbles, as large, thin, and light, as I could then procure; and chusing amongst them one that seemed the least unfit for my Turn (being of the Bigness of a somewhat large Orange, and weighing about 1 Dr. 10 Gr.) I counterpoised it in a Pair of Scales, that would lose their *Æquilibrium* with about the 30th Part of a Grain, and were suspended at a Frame. I placed both the Balance and the Frame by a good Baroscope, from whence I might learn the present Weight of the Atmosphere; then leaving these Instruments together, though the Scales being no nicer than I have expressed, were not able to shew me all the Variations of the Air's Weight that appeared in the Mercurial Baroscope; yet they did what I expected, by shewing me Variations no greater than altered the Height of the Quick-silver half a Quarter of an Inch, and perhaps much smaller than those. I had the Pleasure to see the Bubble sometimes in an *Æquilibrium* with the Counterpoise; sometimes when the Atmosphere was high, preponderate so manifestly, that the Scales being gently stirr'd, the Cock would play altogether on that side, at which the Bubble was hung; and at other Times (when the Air was heavier) that, which was at the first but the Counterpoise, would preponderate, and upon the Motion of the Balance make the Cock vibrate altogether on its side. And this would continue sometimes many Days together, if the Air so long retained the same measure of Gravity; and then (upon other Changes) the Bubble would regain an *Æquilibrium*, or a Preponderance; so that I had oftentimes the Satisfaction, by looking first upon the statical Baroscope (as for Distinction's sake it may be called) to foretel, whether in the Mercurial Baroscope the Liquor were High or Low.

If the Ground on which I went in framing this Baroscope, be demanded, the Answer in short may be; 1. That though the glass Bubble, and the brass Counterpoise, at the Time of their first being weighed, be in the Air, wherein they

they both are weighed, exactly of the same Weight; yet they are nothing near of the same Bulk, the Bubble by Reason of its capacious Cavity (which contains nothing but Air, or something that weighs less than Air) being, perhaps, a hundred or two hundred Times bigger than the Metalline Counterpoise.

2. That according to the Hydrostatical Laws, if two Bodies of equal Gravity, but unequal Bulk, come to be weighed in another Medium, they will be no longer equiponderant; but if the new Medium be heavier, the greater Body, as being lighter in Specie, will lose more of its Weight than the lesser and more compact; but if the new Medium be lighter than the first, then the bigger Body will out-weigh the lesser: And this Disparity arising from the Change of Mediums, will be so much the greater, by how much the greater Inequality of Bulk there is between the Bodies formerly equiponderant.

3. That, laying these two together, I consider'd that 'twould be all one, as to the Effect to be produced, whether the Bodies were weighed in Mediums of differing Gravity, or in the same Medium, in Case its specifick Gravity were considerably alter'd: And consequently, that since it appeared by the Baroscope, that the Weight of the Air was sometimes lighter, the Alterations of it, in Point of Gravity, from the Weight it was of at first counterpoising of the Bubble of it, would unequally affect so large and hollow a Body as the Bubble, and so small and dense an one as a Metalline Weight: And when the Air, by an Encrease of Gravity, should become a heavier Medium than before, it would buoy up the Glass more than the Counterpoise; and if it grew lighter than it was at first, would suffer the former to preponderate.

One Morning early, being told of a Mist, I sent to see whether it made the Air so heavy as to buoy up the Bubble; but I did not learn, that that Mist had any sensible Operation on it.

Though a single Bubble of competent Bigness be much preferable, by reason that a far less Quantity and Weight of Glass is requisite to comprise an equal Capacity, when the Glass is blown into a single Bubble, than when it is divided into two; yet I found that the employing of two instead of one, did not so ill answer my Expectations, but that they may, for a Need, serve the Turn instead of the other, than which they are more easy to be procured: And if the Balance be strong enough to bear so much Glass, without being injured, by employing two, or a greater Number of large Bubbles, the Effect may be more conspicuous, than if only a single Bubble (though a very good one) were employ'd.

This Instrument may be much improved by divers Accommodations. As,

1. There may be fitted to the *Ansa* (or Check of the Balance) an Arch of a Circle divided into 15 or 20 *Deg.* (more or less, according to the Goodness of the Balance) that the Cock, setting over against these Divisions, may readily, and without Calculation, shew the Quantity of the Angle, by which, when the Scales propend either Way, the Cock declines from the Perpendicular, and the Beam from its *Horizontal* Parallelism.

2. Those that will be so curious, may, instead of the ordinary Counterpoise (of Brass) employ one of Gold, or at least, of Lead; whereof the latter being of equal Weight with Brass, is much less in Bulk, and the former amounts not to half its Bigness.

3. Those

3. Those Parts of the Balance, that may be made of Copper or Brass, without any Prejudice to the Exactness, will, by being made of one of those Metals, be less subject than Steel (which yet, if well hardened and polished, may last good a great while) to rust with long standing.

4. Instead of the Scales, the Bubble may be hung at one End of the Beam, and only a Counterpoise to it at the other; that the Beam may not be burdened with unnecessary Weight.

5. The whole Instrument, if placed in a small Frame, like a square Lantern, with Glass Windows, and a Hole at the Top, for the Commerce of the internal and external Air, will be more free from Dust, and irregular Agitations; to the latter of which it will otherwise be sometimes incident.

6. This Instrument being accommodated with a light Wheel, and an Index (such as have been applied, by the excellent *Dr. Chr. Wren*, to open Weather-Glasses, and by the ingenious *Mr. Hook*, to Baroscopes) may be made to shew much more minute Variations than otherwise.

7. And the Length of the Beam, and Exquisiteness of the Balance, may easily, without any of the foregoing Helps (and much more with them) make the Instrument far exacter than any of those I was reduced to employ. And to these Accommodations divers others may be suggested, by a farther Consideration of the Nature of the Thing, and a longer Practice.

Though, in some Respects, this statical Baroscope be inferior to the Mercurial; yet in others, it has its own Advantages and Conveniencies above it.

And, 1. It confirms, *ad Oculum*, our former Doctrine, That the Falling and Rising of the Mercury depends upon the varying Weight of the Atmosphere; since in this Baroscope it cannot be pretended, that a *Fuga Vacui*, or a *Funiculus*, is the Cause of the Changes we observe. 2. It shews, that not only the Air has Weight, but a more considerable one than some learned Men, who will allow me to have proved it has some Weight, will admit; since even the Variation of Weight, in so small a Quantity of Air, as is but equal in Bulk to an Orange, is manifestly discoverable upon such Balances as are none of the nicest. 3. This statical Baroscope will oftentimes be more parable than the other; for many will find it more easy to procure a Pair of good Gold Scales, and a Bubble or two, than a long Cane seal'd, a Quantity of Quick-silver, and all the other Requisites of the Mercurial Baroscope; especially if we comprize the Trouble and Skill that is requisite to free the deserted Part of the Tube from Air. 4. And whereas the Difficulty of removing the Mercurial Instrument has kept Men from so much as attempting to do it, even to neighbouring Places; the essential Parts of the Scale Baroscope (for the Frame is none of them) may very easily, in a little Room, be carried whether one will, without the Hazard of being spoiled or injured. 5. There is not in statical Baroscopes, as in the other, a Danger of Uncertainty, as to the Goodness of the Instruments, by Reason that in these the Air is in some more, and in some less perfectly excluded; whereas in those, that Consideration has no Place. (And by the way, I have sometimes, upon this Account, been able to discover, by our new Baroscope, that an esteemed Mercurial one, to which I compared it, was not well freed from Air.) 6. It being very possible to discover Hydrostatically, both the Big-
ness

ness of the Bubble, and the Contents of the Cavity, and the Weight and Dimensions of the Glassy Substance (which, together with the included Air, make up the Bubble) much may be discover'd by this Instrument, as to the Weight of the Air, absolute or respective. For when the Quick-silver in the Mercurial Baroscope is either very high or very low, or at a middle Station, between its greatest and least Height, bringing the Scale Barometer to an exact *Æquilibrium* (with very minute Divisions of a Grain) you may, by watchfully observing when the Mercury is risen or fallen just an Inch, or a fourth, or half an Inch, &c. and putting in the like minute Divisions of a Grain, to the lighter Scale, till you have again brought the Balance to an exquisite *Æquilibrium*; you may, I say, determine what known Weight, in the statical Baroscope, answers such determinate Altitudes of the ascending and descending Quick-silver in the Mercurial. And if the Balance be accommodated with a divided Arch, or a Wheel and Index, these Observations will assist you for the future, to determine readily, by seeing the Inclination of the Cock, or the Degree marked by the Index, what P'ollency the Bubble hath, by the Change of the Atmosphere's Weight, acquired or lost. 7. By this statical Instrument we may be assisted to compare the Mercurial Baroscopes of several Places (though never so distant) and to make some Estimates of the Gravities of the Air therein. As if, for Instance, I have found, by Observation, that the Bubble I employ'd, weigh'd just a *Drachm*, when the Mercurial Cylinder was at the Height of $29\frac{1}{2}$ Inches (which in some Places I have found a moderate Altitude) and that the Addition of the 16th Part of a *Gr.* is requisite to keep the Bubble in an *Æquilibrium*, when the Mercury is risen an 8th, or any determinate Part of an Inch above the former Station: When I come to another Place, where there is a Mercurial Barometer, as well freed from Air as mine (for that must be supposed) if taking out my Scale Instrument, it appears to weigh precisely a *Drachm*, and the Mercury in the Baroscope stand at just $29\frac{1}{2}$ Inches, we may conclude the Gravity of the Atmosphere not to be sensibly unequal in both these two Places, though very distant. And though there be no Baroscope there, yet, if there be an Addition of Weight, as for Instance, the 16th Part of a Grain, requisite to be added to the Bubble, to bring the Scales to an *Æquilibrium*, it will appear, that the Air, at this second Place, is at that Time so much heavier than the Air of the former Place was, when the Mercury stood at $29\frac{1}{2}$ Inches.

But in making such Comparisons, we must not forget to consider the Situation of the several Places; if we mean to make Estimates, not only of the Weight of the Atmosphere, but of the Weight and Density of the Air. For though the Scales will shew, as has been said, whether there be a Difference of Weight in the Atmosphere at the two Places; yet if one of them be in a Vale or Bottom, and the other on the Top, or some elevated Part of a Hill, it is not to be expected, that the Atmosphere, in this latter Place, should gravitate as much as the Atmosphere in the former, on which a longer Pillar of Air does lean or weigh.

And the Mention I have made of the differing Situation of Places, puts me in Mind of something that may prove another Use of our statical Baroscope;

roscope; namely, that by exactly poising the Bubble at the Foot of a high Steeple, or Hill, and carrying it in its close Frame to the Top, one may, by the Weight requisite to be added to the Counterpoise there, to bring the Beam to its *Horizontal* Position, observe the Difference of the Weight of the Air at the Bottom, and at the Top; and in Case the Hill be high enough, at some intermediate Stations: And, perhaps, when duly improv'd, it may assist Men to estimate the absolute or comparative Height of Mountains, and other elevated Places of the Earth.

*The Use of
Barometers;
by _____
n. 122. p.
593.
Thermome-
ters and Ob-
servations
made with
them; by Dr.
J. Beal, n.
55. p. 1114.*

XIII. By accurate Baroscopes we may regain that Knowledge which still resides in Brutes, and we forfeited by not continuing in open Air, as they do for the most Part, and by Intemperance corrupting the Crasis of our Senses.

XIV. 1. *Dec. 26, 1669.* in the Morning, the Weather was colder than ever I found it, since I could take it by the Measure of a Thermometer; that is since these 5 or 6 Years. It was very cold, and freezing quick some Days before and after: And yet, in this Time the Mercury hath sometimes fallen more than an Inch, without any other Change of Weather than some Gusts of Winds, some Sprinklings of Snow at several Times, in all scarce enough to cover the Ground; and some Abatements of Cold, more especially when the Sun was up. To note this Degree of Cold more particularly, I must acquaint you, that in my stanch Thermometer, on the said 26th of *December*, the Liquor was at $3\frac{1}{2}$ Inches: Whereas, in ordinary brisk Frosts, it is at 7 Inches. Yet here I must observe, that sometimes the Frost dissolves, when it is at the 7th Figure; and sometimes I find it at the 8th Figure, in a smart Frost. 'Tis warm *May* Weather when 'tis at the 10th Figure; and 'tis not much above the 12th Figure in the hottest Weather of *June, July,* and *August*.

I think it remarkable, that the 7th Inch, and sometimes the 8th, in my Thermometer, should abide freezing, and the Frost increase, till the Liquor descend $4\frac{1}{2}$ Inches; and yet that it should not ascend from the 8th Inch more than $4\frac{1}{2}$ Inches in our hottest Summer, being hung in the same Place, within 18 Inches of the Glass Window, facing the North-west, and in a little Writing Room, in the 2d Row of Buildings. But now I am strongly persuaded, that the Degrees of Heat and Cold are not exactly indicated by the inclosed Spirit of Wine: For when the Snow melted, and the Frost was first dissolved, without Sun-shine, the Liquor was not above the Height of $5\frac{1}{2}$ Inches; possibly it retains some Part of the Cold a while after the ambient Air becomes more tepid.

*By Dr. J.
Willis,
n. 55. p.
1118.*

n. 10. p. 169.

id. p. 167.

2. My Thermoscope was first made in *Dec. 1664.* The whole Height of the small Cylindrick Glass, whose Cavity was about $\frac{1}{8}$ of an Inch Diameter, was about 28 Inches; besides a small Spherical Bowl at the Top, of about $\frac{1}{4}$ of an Inch Diameter, and a Bowl at the Bottom, which contained the Liquor (being Spirit of Wine tinged with Cochineal) of about 2 Inches Diameter: The Space above the Liquor being, at the first Composure of it, void of Air, save what it had out of the Liquor; which being warm at the first putting in, filled the whole Cavity, while the Glass was Hermetically seal'd. I plac'd it so, as never to be expos'd to the Sun, but in a Room that has a Window only in the North; and therefore it gives an Account only of the Temperature

perature of the Air in general, not of the immediate Heat of the Sun-shine: It is so nice, as that my being or not being in my Study, I find to vary its Height sometimes almost $\frac{1}{4}$ of an Inch.

The lowest Mark to which the Liquor did subside in *Jan.* and *Feb.* 1664. n. 55. p. 1118. was at $12\frac{1}{4}$ Inches: At $14\frac{1}{2}$ it was Frost certain; and sometimes at 15, and at $15\frac{1}{2}$ (yet this I often observed, that the Air by the Thermoscope has appeared considerably colder, and the Liquor lower, or sometimes when there was no Frost, than at some other Times, when the Frost hath been considerably hard:) The greatest Height in the Summer following was at 25, 26, $26\frac{1}{2}$. n. 10. p. 169.

In *Dec.* *Jan.* and *Feb.* 1665. we had at $14\frac{1}{2}$ Frost certain; sometimes at 15 or higher; and the lowest, to which it did that Winter descend, was $12\frac{1}{4}$. n. 55. p. 1118. The Height in the following Summer, 1666. was usually about 19, 20, 21; the highest of all at 25.

In *Dec.* and *Jan.* 1666. it was Frost certain, at about $13\frac{1}{2}$ (an Inch lower than the Years before; the Liquor, it should seem, becoming less spirituous) sometimes at 14 or $14\frac{1}{2}$: It was hard Frosty Weather at 12, 11, and once at $10\frac{1}{2}$; the Weather being very cold. The usual Height in the Summer following, 1667. was about 19, 20, 21, and the highest at $24\frac{1}{2}$.

The Winter following, 1667. it was scarce certain Frost at 13; but yet sometimes at 14, or a little higher: The lowest, to which it did descend that Winter (being very mild after *Christmas*) was at 12. And the following Summer, 1668. usually about 18, 19, 20; the highest of all (the Heat of that Summer being but very moderate) at 22.

The next Winter it was Frost certain, about $12\frac{1}{4}$; but sometimes at 13, or higher: the lowest of all at $10\frac{1}{4}$. And in the Summer following, 1669. the highest of all (being but a cool Summer) not much above 20.

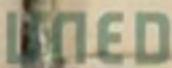
At *Christmas*, 1669. though I found it to be Frost certain about $12\frac{1}{4}$, and something higher than 13; yet hath it come sometimes lower than 8; and particularly *Dec.* 26, in the Morning, to $7\frac{1}{4}$; and did not all that Day come so high as 8 Inches: Which being so much lower than ever it had been in any of the precedent Years of my Observation, though it may, in part, be attributed to the dispiriting of the Liquor, yet principally to the Extremity of the Cold. *Jan.* 1. when the Frost seem'd to relent, it was somewhat higher than 9; and *Jan.* 7, about $13\frac{1}{2}$.

3. The greatest Height the Spirit did rise to in the Thermometer, was two Divisions below extream Hot, when we were near the *Equinoctial*.

XV. Since the same Degree of Heat does not proportionally expand all Fluids; some swelling with a gentle Warmth, and others not till they be considerably hot; some boiling with a moderate Heat, and others not at all; some capable of great Expansion, others increasing very little; it may well be concluded, that no one of them does increase and diminish in the same Proportion with the Heat, and consequently, that the Thermometers graduated by equal Parts of the Expansion of any Fluid, are not sufficient Standards of Heat or Cold.

This will be more evident from the Experiments which I made in the Months of *Feb.* and *Mar.* about 4 Years since (the Weather being reasonably cold

A Thermometer observed at Sea; by Mr. Ja. Cunningham, n. 264. p. 577. The Expansion of several Fluids, in order to ascertain the Divisions of the Thermometer; by Mr. Edm. Halley, n. 197. p. 650.



cold and not freezing) with Water, Mercury, and Spirit of Wine; wherein the following Particulars were very remarkable.

1. I took a large Bolt-head, holding about $3\frac{1}{2}$ lib. of Water, with a narrow Neck to make the Augment thereof more sensible; and having filled it with Water, and some few Inches up the Neck; I noted exactly to what Mark the Water came: Then I immersed it into a Skillet of warm Water, and let it stand so long, till I concluded the warm Water had communicated its Temper to the Water included in the Bolt-head; and I found, that though the Water were warm, much beyond the Degree of the Summer's Heat, and notwithstanding it was Winter, yet that gentle Heat had scarce any Effect in dilating the Water; so that it scarce appeared to have ascended in the Neck of the Bolt-head. Then I took the Skillet, and set it over the Fire; when it was observable, that the Water, as it grew hot, did slowly ascend in the Neck, especially at first; but after it began to boil in the Skillet, the Expansion thereof became more visible, and it ascended apace, till such Time as it stopped again; the utmost Effort of boiling Water being able to raise it no higher. Then having made a Mark at the utmost Height whereto it had arisen, I took it out, and had the Satisfaction to observe, that though it was not raised so high without a very strong boiling, yet it subsided very slowly, as retaining some Time the Space it had acquired from the Heat, even after the Heat was pass'd, and the Glas was so cool as to be touched without burning the Fingers. However, the next Morning I found it reduced to the first Mark, where it stood when at first put in, having lost nothing sensible by Evaporation, during the Experiment; which I attribute to the Length of the Neck, wherein the Vapours were condensed into Drops before they reached the Top. Then I examin'd how much Water would raise that in the Neck, to the Mark whereto it had been encreased by boiling, and found it was a 26th Part of the Bulk of the first Water; which, upon repeated Experiments, I found to be true; but it was obvious, that Water increasing so very little, with all the Degrees of Heat the Air receives from the Sun, was a very improper Fluid to make a Thermometer withal; and besides, any freezing Liquor is useless for this Purpose in these Northern Climates.

2. I took a smaller Bolt-head, with a proportional Cane or Neck, and filled it after the same Manner with Mercury; and having boiled it, as above, I observed that 125 Ounces of Mercury had increased the Space of 810 Grains, or a 74th Part of its Bulk when cold. But it was very remarkable, that whereas a gentle Heat had scarce any Effect on Water, here, on the contrary, the Mercury did sensibly ascend at first, and had almost attained its greatest Expansion before the Water boiled in the Skillet. And after it boiled, tho' I let it stand very long over the Fire, I could not discern that the most vehement boiling had any Effect on it, above what appeared when it first began to boil. The Mercury being taken out, as it cooled, subsided, and in a few Hours returned to the Mark whereto it stood before it was put into the Water. This Fluid being so sensible of a gentle Warmth, and withal, not subject to evaporate without a good Degree of Fire, might most properly be applied to the Construction of Thermometers, were its Expansion more considerable.

However,

However, small as it is, it is sufficient to disturb the precise Nicety of the Mercurial Barometers shewing the Counterpoise of the Pressure of the Atmosphere by a Cylinder of Mercury: For if Mercury be more expanded, and consequently lighter in warm Weather than in cold; it will necessarily follow, that the same Weight of Atmosphere will require a taller Cylinder in Summer, and a shorter in Winter to counterpoise it. And if the Extremity of Weather do but occasion a 15th Part of Difference, as 'tis probable it doth, the Effect thereof, on a Barometer, will be a Tenth of an Inch above the Mean, or a Fifth in all.

3. I fill'd the smaller Bolt-head with Spirit of Wine; and having set it in the Skillet of Water over the Fire, I found that it ascended gradually, as the Heat increased, but slower at first, and faster after it was well warm. At length being arrived at a certain Degree of Heat, it would fall a boiling with great Violence, emitting Bubbles, which coming into the Neck of the Bolt-head, would lift all the incumbent Spirits till they had made their Way through. And these succeeding one another very fast, would often raise the Spirit to the Top of the Neck, and spill it; so that I found I could go no further with this Liquor, than to that Degree of Heat which occasioned this boiling, and which wanted very much of that of boiling Water, being almost tolerable to the Touch. It was however very remarkable, how exactly this Degree of Heat was determined by the Expansion of the Spirit; for in the Instant it reached a certain Mark on the Neck, it began to emit its Bubbles: And having been taken out a little to cool and subside, it would certainly and constantly fall a bubbling again, when upon a second Immersion, it was arrived at the foresaid Mark. During this Experiment, it appear'd both by the Dew on the Neck, and by the Scent in the Room, that tho' the Neck were about 30 Inches long, yet the Spirit did evaporate very fast for the Smallness of the Surface of the Liquor: And I have often noted the like Evaporations condensed in Dew, within the Head of the ordinary seal'd Thermometers, in very hot Weather.

This Degree of Heat which made the Spirit of Wine begin to boil, being determined so nicely as I have said, made me conclude, that this might very properly be taken for the Limit of the Scale of Heat in a Thermometer; and the Effect thereof in the Expansion of any other Fluid being accurately noted, might be easily transferr'd to any sort of Thermometer whatsoever. Only it must be observed, that the Spirit of Wine used to this purpose, be highly rectify'd or dephlegmed; for otherwise the differing Goodness of the Spirit will occasion it to boil sooner or later, and thereby pervert the designed Exactness. And by the way, give me Leave to hint, that the sooner or later boiling of Spirits or spirituous Liquors may possibly be as good a Test of their Strength and Perfection, as their specifick Gravity, or any other yet used.

The Spirit of Wine I made use of was possibly none of the best; but I observed, that at the Point of boiling it had increased a 12th Part in bulk; which great Dilatation makes it a Liquor sufficiently adapted to our Purpose, were it not for the Evaporation thereof, and for the Difference in Goodness of the Spirit, and for that, in Length of Time it becomes as it were Effete, and loses gradually a Part of its expansive Power.

His. of Cold,
Tit. 18. §. 8.
 p. 475.

4. This expansive Power is in no Fluid comparably so conspicuous as in that rare elastick Fluid the Air; for by several Experiments that I have made, I find that the Heat of Summer does expand the ordinary Air about a 30th Part; and that late honourable Patron of experimental Philosophy, Mr. Boyle, alledges his own Trials, proving that the Force of the strongest Cold in *England* does not contract the Air above $\frac{1}{20}$ Part. So that the same Air, which in extreme Cold occupies 12 Parts of Space, in very hot Summer Weather, will require 13 such Spaces: which is as great an Expansion as that of Spirit of Wine when it begins to boil: For which Reason, and for its being so very sensible of Warmth and Cold, and continuing to exert the same elastick Power, after never so long being included, in my Opinion, it is much the most proper Fluid for the Purpose of *Thermometers*.

Now the Thermometers hitherto in Use, are of two Sorts: the one shewing the different Temper of Heat and Cold, by the Expansion of the Spirit of Wine, the other by the Air: But I cannot learn that either of them of either Sort, were ever made or adjusted, so as it might be concluded, what the Degrees or Divisions of the said Instruments did mean; neither were they ever otherwise graduated, but by Standards kept by each particular Workman, without any Agreement or Reference to one another: So that whatsoever Observations any curious Person may make by his Thermometer, to signify the Degree of Heat in the Air, or other Things (which is of constant Use in Philosophical Matters) cannot be understood, unless by those who have by them Thermometers of the same Make and Adjustment. Much less has the Way been shewn how to make this Instrument without a Standard, or to make two of them agree artificially, without comparing them together.

I shall only add, that whereas the usual Thermometers with Spirit of Wine, do some of them begin their Degrees from a Point, which is that whereat the Spirit stands when it is so cold as to freeze Oil of Anniseeds; and others from the Point of beginning to freeze Water: I conceive these Points are not so justly determinable, but with a considerable Latitude: And that the just Beginning of the Scales of Heat and Cold should not be from such a Point as freezes any Thing, but rather from Temperature, such as is in Places deep under Ground, where the Heat of the Summer, or Cold in Winter, have (by the certain Experiment of the curious Mr. Mariotte, in the *Grottoes* under the *Observatory* at *Paris*) been found to have no Manner of Effect.

Hygrosopes;
 by ——— n.
 127. p. 650.
 Fig. 8.

XVI. 1. The *Hygroscope* I make Use of, I thus contrived. I took two Pieces of Deal-board (*Poplar* would have been better) each about two Foot long, and a Foot or more in Breadth, *AB*. These I got well plained and shotten, that their Edges might meet even together. Of these two, set Edge by Edge, I fastned each End between two Ledges of Oak, *CC*, of 2 Inches broad, and long enough to reach athwart both Boards (but one Ledge, if it be thick enough, might be made to serve each End, by making hollow Furrows or Gutters in it to receive the Ends of the Boards) and so I fix'd both Boards in, as Pannels are set in Wainscot. This done, supposing $\frac{1}{4}$ of an Inch to be the utmost Distance that

that

that these two Boards would shrink afunder in driest Weather (for it matter'd not much, though it should be somewhat more or less) I took a thin piece of Brass, *D*, of two or three Inches long and $\frac{1}{4}$ Inch broad; and upon one edge, towards the end, I measured $\frac{1}{4}$ of an Inch (which was the utmost Distance I supposed the two Boards would gape afunder (which Space *dd*, I divided into five equal Parts, and with a small File made them into so many fine Teeth, like those of a Watch Wheel; this piece of Brass I placed flat, across the Juncture of the two Boards, nailing its one end, by means of two small Holes, *bb*, to the Board *A* only, and leaving the other End, which is the toothed one, free, and reaching to a competent Distance over the Board *B*, to which it had no Coherence; next I made a Pinion (consisting of as many Teeth as the Brass had) *e*, upon the end of a Piece of thick Iron Wire; this Axle, *F*, with its Pinion *e*, I so fastened to the other Board *B*, by means of the Brachiolum *E*, and so adapted to the Teeth of the Brass-plate, that when the Boards do shrink afunder, the Brass being drawn a little away, must needs turn this Axle (by means of its toothed Pinion) more or less; and so if ever it happens, that the Boards gape but a Quarter of an Inch afunder, this Axle, will have made one intire Revolution: Wherefore I put a long Index *G G*, upon the Extremity of this Axle, and made a Circle round it with the usual Graduations, number'd from what Point I pleased; and the Motion of the Index back or forward, shews me the Degrees of the Drought or Moisture of the Air. Now this Axle may be made to come through a round Plate of Wood or Metal that hides the Contrivance, all but the Hand and Figure, as in a Clock or Watch. 'Tis to be noted, moreover, that the Boards must be fastned to the Ledges, only at the outer Edges, as at *aaaa*, that they may have the more liberty of swelling and shrinking afunder. Tho' the *Hygroscope* which I make use of be none of the best Workmanship, nor exactly made after the Description I have here given you (the Boards having not liberty of gaping above $\frac{2}{3}$ of an Inch) yet I have oftentimes the Pleasure of seeing the Index turn 10 or 20 Degrees in an Hour or two, and when the Air is changed, will return as swiftly, by the shrinking and swelling of the Boards.

2. *AAAA*, is a Frame of Wood for two Pannels of Deal to play loose in at top and bottom, to which at the two ends they are fastned. *BB*, the two Pannels of slit Deal, three foot Deep and three foot Broad apiece, with a distance left in the middle for the Scope of the Motion. *C*, the Hand placed or fastned by the Axle-tree to the Plate, and also with Nail-holes which are to fasten it to the middle of the Pannel within half an Inch of the Scope for Motion; at the lower or shorter End of which Axle-tree there is, by a Wire like an *S*, fastned a small Silver Chain within a Straw's breadth of the Axle-tree; which Chain is to be carried and placed cross the Distance between the two Pannels, and fastned to the Pannel opposite by a brass Noose, through which it is to slip, so as that it may be taken up or let down at pleasure. *D*, the Roller with a Weight annexed, which by a String is fastned to the lowest End of the Hand *C*; so that as the Relax gives way, the Weight will adjust the Motion of the Hand to the Index *E*. *E*, the Index of Paper,

By Mr. Co-
niers, n. 129.
p. 715.
Fig. 9.

parted

pasted upon the opposite Pannel to the Hand, and so as it is in this Figure, placed near the Top, for the better Advantage of the Hand's Motion; and this Index being but a Quarter of a Circle, is divided into Inches more or fewer, according to the Scope which the Pannels Hand requires for their Motion; but when the Relax shall require more room for the Hand, then the Chain is to be taken up one Link more, and so you will be ready for more play upwards and downwards; which taking up, may yet be again repeated when there is occasion, or the Time of Year requires it.

Now, if the Chain be placed near the Axle-tree, the Motion will be the nicer and larger; if farther off, then it will be less: For Example, the Motion of 2 more than that of 3, and 3 than that of 4, &c. as you may perceive by the Figures 2, 3, 4, 5, 6; which are placed in this Figure by the lower end of the Hand near below the Axle-tree thereof.

From this Contrivance it was, That I have for this 5 or 6 Years past made these following Observations.

1. That these Pannels of Deal-wood will move by shrinking most in Summer, and swelling most in Winter Seasons; but will vary from this, according to the Change, to the then more or less Heat or Cold, Moisture or Drought, that the Temper or Season of the Year, such as Spring and Fall, do produce; it being then more apt to swell or shrink on the sudden, but not attaining then to the highest shrinking or swelling, as in Summer and Winter it doth.

2. That for the most part, especially in the Spring and Summer Time, this Motion happens only in the Day Time; for then generally all Night it rests, and moves very seldom.

3. That one Kind or Manner of this Motion happens in dry, fair Weather, but sometimes in the forepart of the Forenoon, and sometimes not until the latter part of the Forenoon, and then at that Time it relaxes or swells the Deal for about two or three Hours; more, seldom; less, often; and then all the Afternoon after shrinks; nay, sometimes even when a small Rain hath newly fallen, or is then falling; and this not so often, but more seldom in Winter, or cold moist Weather.

4. This Shrinking is gradual very often, or for the most part a little after a moist Time (*viz*) the first Day after Moisture it shrinks a little; the second Day, more, and so yet more, according to the then Time of the Year; and as it is then inclined to Moisture or Drought, and Alteration of the Wind, and the then Heat or Cold.

5. The Winds being in the North, North-east, and East, Winter and Summer, for the most part at that Time the Deal shrinks, in the Night also as well as in the Day, but not so much; which is a sign of drying Weather, and sometimes of Frost or Cold in Winter, Heat or Scorching in Summer, in a clear Day. But on the contrary, the South Winds blowing, or the West and South-west, the Deal then always relaxes that Day, or at least is at a Stay, provided this happen in the Day Time; for then if in the Night, not so much; and so this will do some considerable Time before Rain.

6. By a constant Observation of this Experiment of the Deals Motion and Rest, you may be able to know or guess at the Wind's Situation without a Weather-cock, provided you have by you a common and a seal'd Thermometer.

7. Also you may know the Time of the Year: For in the Spring it moves quicker, and more than in Winter; in Summer it is more shrunk than in the Spring; in Autumn less in Motion than in the Summer.

I shall only add, that to find whether the Moisture was rarified out of the small Cylinder-like Ends of the Wood only, or out of the Sides also, I took two Pieces of a season'd Deal; the Ends of the one Piece I clos'd up with Diachylon Plaster, but the Sides of this Deal I did not so close up, but left these Sides with the other Piece without Diachylon. Both being expos'd to the open Air, they were found the next Day both of them alike to have increased in proportion of Weight; which seems to prove that the Sides also do take in and let out Moisture.

In a second Contrivance, *AAAA*, is the Frame of Wood for the Pannels Fig. 10. of Deal to play loose in, at the Top and Bottom. *BBBB*, the Crosses of Deal or Iron fastened to the Frame on each side; to which is annexed the Circular Index divided into 12, in the Center of which the Axle-tree *b*, for the Hands, is placed. *CC*, the two Pannels of slit Deal, 3 Foot deep, and 3 Foot broad apiece, fastned at each End of the Frame, with a Distance left in the middle for the Scope of the Motion.

The inward Work is thus contrived. *AA*, the two Hands. *BB*, the two Fig. 11. brass Pullies or Rollers, the one bigger, the other less; to the bigger a flat leaden Weight is fastned with a Cat-gut String; to the smaller is fastned a small silver Chain, which is by the Noose or Loop of the Brass *C*, to be fastned to the Pannel under the middle of the Cross, near the Gap or Scope for the Motion; and in that Noose the Chain to have a fastning to be taken up or let down at pleasure. *D*, the Roller or Pulley to be placed on the other Pannel opposite to the Noose, and near the Gap or Scope, betwixt the two Pannels; over which Roller the small Chain, upon its return to the Axle-tree, is to be placed. *E*, the Axle-tree, upon which the two Rollers or Pullies, *Bb*, are to be fastned, and the two Hands, *AA*, for the Index. *F*, the Weight annexed to the biggest Roller or Pulley *B*; and the String or Cat-gut to be moved, is to have the contrary Posture for Motion to the small Roller or Pulley upon which the silver Chain is fastned: So that as the Shrinking of the Pannel moves the Axle-tree one way, the Relaxing may give to the moving the Hands or Axle-tree the other way by the Power of the Weights drawing; which contrary Postures will give the nicest Account of this Motion.

The Circumference of the smallest Pulley or Roller, *b*, is to be no bigger than just so much Scope or Distance as the two Pannels make by the Extremity of their utmost Swelling or Shrinking; and so one full Revolution of the Hand upon the Index may answer the fullest Shrinking and Swelling in the Year, and the Distance between the two Rollers or Pullies fix'd upon the Axle-tree, must be the Thickness of your Pannels; so that the Weight is to play or move on the one side of the Pannel, and the Chain

on the other, without Disturbance, or rubbing against the Sides of the Pannel or the Cross, between which, out of sight, in the Middle, they are to be placed.

This way was so contrived 1675. some Years after the former; and so with Chain and Pullies to avoid the shaking that would happen by applying the Work of Pinion and Teeth to move the Hands; which was then also propounded to Mr. *Tompion* the Watch-maker, but by him rejected; though I think that way may be used also, with a Weight added to regulate the Motion.

The Deal Board should be of the finest straightest grain'd, *Drum Deal*, laid a drying in your House two or three Years.

By Mr. Mo-
lyneux, n.
172. p. 1032.
Fig. 12.

3. *AB*, is a Whipcord about four Foot long, tied fast to the End of the Hook, *A*. At the End of this Whipcord there hangs the Weight, *C*, about a Pound, or something more; this Weight is so fitted at the End as to receive and carry the Index, *D*. Under these there is placed a graduated Circle on the Board, *EF*, fix'd by a Bragget against the Wall.

All Things being thus adapted, the Moisture of the Air twists the Rope, and gives a Motion to the Index over the Divisions in the graduated Circle; and again, as the Air grows more dry, the Cord untwists and brings back the Index by a contrary Motion. The Reason of this is plain, for the little Particles of the Moisture insinuating and soaking into the Cord are like so many Wedges which must needs shorten the Rope, as a Bladder is shortned by being blown up, and will lift a great Weight; but the easiest Way for the Rope, *AB*, to shorten and lift up the Weight, *C*, is to do it by way of a Screw, for itself is a Screw, the Strands thereof being twisted (and each particular Thread in it (Screw-wise, and consequently must give a circular Motion to the Index.

To make an Experiment of this, I wetted a Cord and hung it up with the Weight at the end of it, and I perceived as it dried it untwisted, and that too very quick, so as to be perceived by the Eye; after the Cord had so far untwisted, as I thought it had come to that Degree of Driness, that the present Constitution of the Air would permit, I took a Basin of warm Water, that sent out a Steam and Fume, and placed it under the Cord; immediately the Cord began again to twist very quick, and so continued till the Water ceased fuming, or was removed, and then immediately it began to return its Twists. I then tried to breathe upon it gently with my Breath, and found, according to my Expectation, that 8 or 10 Breathings would twist it 5 Degrees of a Circle. I then permitted it to the Air only, and I find it to obey the Alterations thereof most nicely; there falls not the least Shower, at which it does not presently twist; and when by rising Clouds a fair Day becomes overshadowed, the Cord is immediately sensible thereof, and again as sensible of their Vanishing and Alteration to fair Sun-shine. So that I repute it to be the nicest *Hygrometer* that has ever yet been used, and I am sure is as cheap and plain as any.

One of the grand Defects of most (indeed I think of all) *Hygrometers* hitherto invented, is, that they grow weak with Age, and do not so nicely obey the Alterations of the Air, when long kept, as when first made; but whether our present Invention be subject to the same Fault, I leave to Time to determine.

The

The Alterations also of the Air may give this kind of *Hygrosopes* more than one Turn; now this being inconvenient, and the Dublication of the Turn hard to be registred, as Mr. *Hook* proposes in his *Micrography*, concerning the Beard of a wild Oat; I have thought of a Way for remedying this, for it being in our Power to increase the Diameter of our graduated Circle as large as we please, what need have we of more than one Turn, from the greatest Degree of Moisture to the greatest Degree of Drought? Now suppose I find this *Hygroscope* to have two compleat Revolutions (this is to be founded by Observation throughout a whole Year) I say then the way of rectifying it is thus: The Index *D* has two compleat Turns, the Point *A*, as being fix'd, has no Turn or Motion, therefore the middle Point, *G*, has but one Turn; and consequently if I hang it up at the Point *G*, or no longer than *GD*, half the former length, the Index *D* will have but one Turn. What is here said of two Turns, and the middle Point *G*, may be accommodated to any other Number of Turns and Parts, and Points in the Rope.

If a Candle, or heated Iron, be apply'd nigh the Rope, it makes it twist very quick, contrary to Mr. *Hook's* Oat-Beard.

We may in this Experiment perceive something that may help us in the Consideration of the Strength and Motion of the Muscles of Animals; for take a Cord able to sustain an hundred Pound weight, by the weak Fume or Steam of warm Water this Weight shall be lifted up; for if this Steam turn the Weight (as most certainly it will do, if the Rope be of any moderate Length) the Weight is as certainly lifted up thereby as by a Screw, as is evident to any one that considers it. If therefore such mighty Performances can be produced by the Application of such mean Agents, as we all know and are conversant with, what shall we think is too great for those Parts which God has contrived and framed in the Bodies of Animals?

4. It is observed, that when *Oil of Vitriol* is satiated in the moistest Weather, it afterwards retains or loses its acquired Weight as the Air proves more or less moist. Thus one Grain, after its full Encrease, often vary'd its *Equilibrium* so sensibly, that the Tongue of the Ballance of $1\frac{1}{2}$ Inch long described an Arch of Variation to $\frac{1}{4}$ of an Inch Compass (which Arch would have been $2\frac{3}{4}$ Inches, had the Tongue been but one Foot in length) even with that little Quantity of Liquor; so that if more Liquor expanded under a large Surface be used, the minutest Alteration of Weather must needs very much more affect it, and a bare Pair of Scales will afford an *Hygroscope* as nice, perhaps, as any yet known.

This Balance may be contrived two Ways, either such whose Pin should be in the middle of the Beam, with a very slender tapering Tongue, of a Foot, or one Foot and a half long, pointing to the Divisions on a broad arched Plate, fix'd above in the Handle; or else the Scale with the Liquor may be hung to a Point of the Beam very near the Pin, and the other Extream made so long as to mark a large Arch on a Board plac'd conveniently for that Purpose. The Scale in either may be a Concave Glass of four or five Inches diameter. Lastly, On the Division of the Arches should be inscrib'd the different Temperature of the Air shewn by the Liquor.

By Mr. Will.
Gould, n.
156. p. 504.

Vid. inf.
Cap. III.

Fig. 13.

Fig. 14

I have Reason to think that Oil of Sulphur per Campanum, as alio Oil of Tartar per Deliquium, and the Liquor of fix'd Nitre, &c. may succeed as well.

Another
by
Mr. Will.
Gould, ib.
p. 509.
Fig. 25.

5. Another Hygroscope may be made of a Viol-string running upon Pullies, and suspending a Bullet fix'd to the shorter End of an Index, whose other Extremity is so long as to describe a long Arch, by the falling and rising of the Bullet upon the stretching and shrinking of the String; which would be more nice, were the Index fastned to the Center of the last Pully.

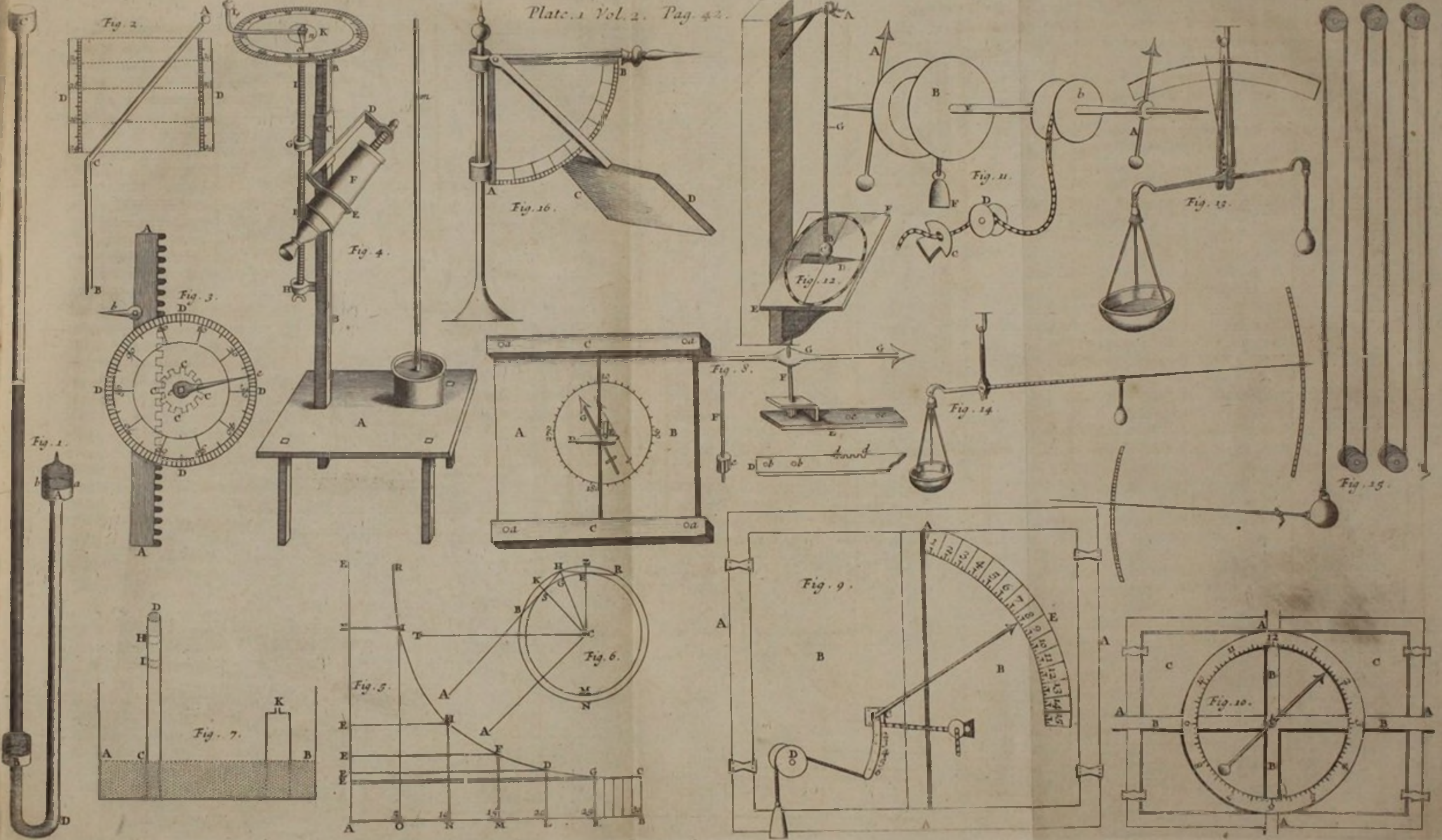
To observe
the Strength
of Winds;
by --- n.
24. p. 444.
Fig. 36.

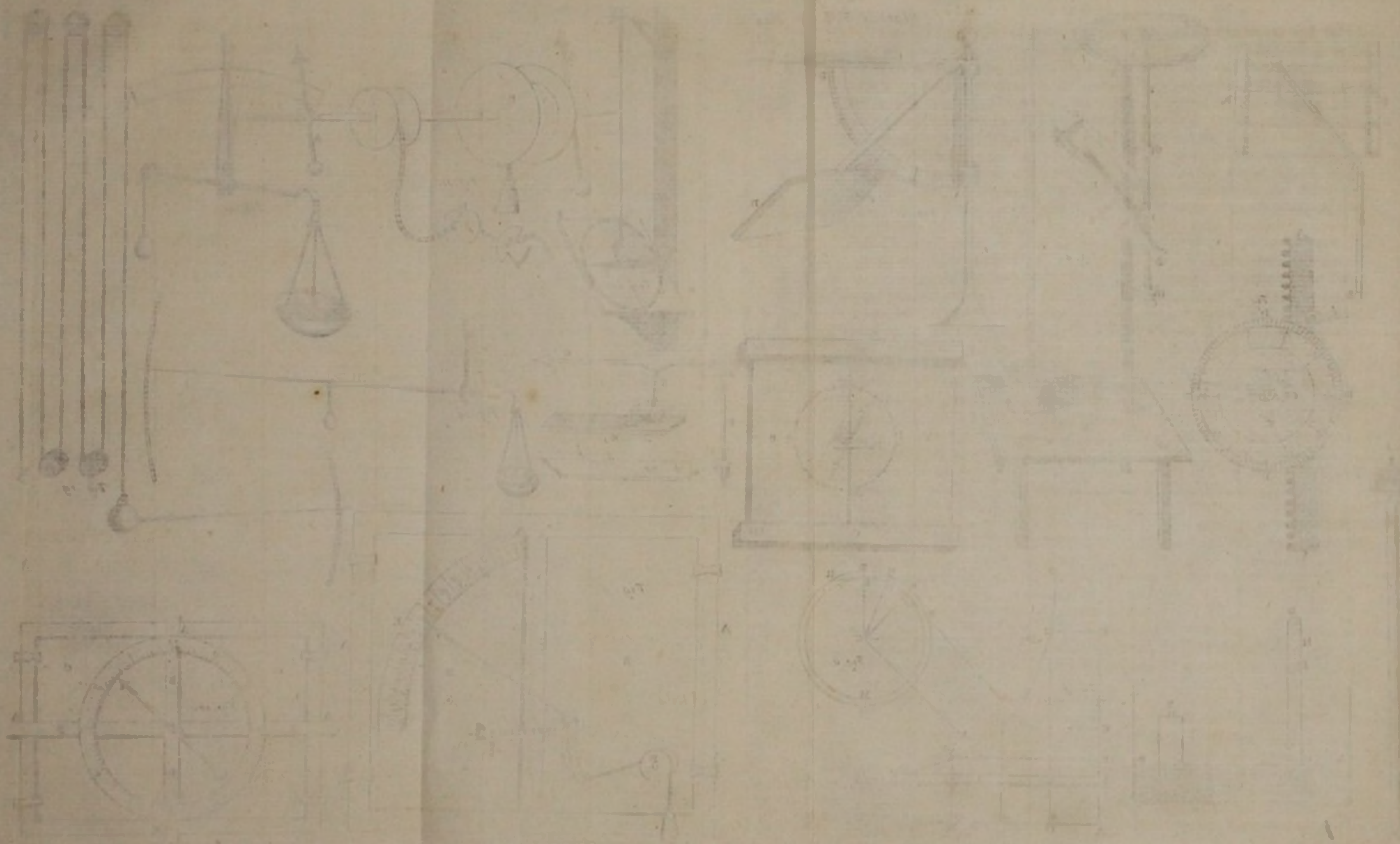
XVII. Expose the Instrument, *A B C D*, to the Wind, so as the flat Side *CD*, may be right against it; the Number of Degrees upon the Limb, *AB*, to which the Wind blows up, or raises that flat Side, shews the Force or Strength of the Wind, in Proportion to the Resistance of the flat Side of the Instrument.

Remarks
concerning
the gradual
Alteration
of the Tem-
perature of
the Air in
America,
and in Ire-
land; by
--- n. 127.
p. 648.

XVIII. That in *America* (at least as far as the *English* Plantations are extend- ed) there is an extraordinary Alteration, as to Temperature, since the *Euro- peans* began to plant there first, is the joint Assertion of them all. This Change of Temperature is, and not without some Reason, generally attri- buted to the cutting down of vast Woods, together with the clearing and cultivating of the Country. But that *Ireland* should also considerably alter, without any such manifest Cause, doth very much invalidate that Reason. For if it be true, as some compute, that this Kingdom was better inhabited and husbanded before the late bloody War, than at present, it should, ac- cording to the Reasons alledg'd for the Change of Temperature in *America*, be rather grown more intemperate, viz. for want of Cultivation: But the contrary is observable here, and every one almost begins to take Notice, that this Country becomes every Year more and more temperate. Now whether there were more Inhabitants in *Ireland* before the late War than at present, I shall not here insist upon, neither do I think it an easy Matter to determine; yet sure I am, that there has been no such Increase of People here within these sixteen or twenty Years, nor such Improvements as to be accountable for the great Change of Temperature that is of late observed. Within less than the Time newly mentioned, 'twas not unusual to have Frost and deep Snows of a Fortnight and three Weeks Continuance; and that twice or thrice, sometimes oftner in a Winter; nay, we have had great Rivers and Lakes frozen all over; whereas of late, especially these two or three Years last past, we have had scarce any Frost or Snow at all. Neither can I impute this ex- traordinary Alteration to any fortuitous Concourse of ordinary Circumstances, requisite to the Production of fair Weather; because it is manifest, that it hath proceeded gradually, every Year becoming more temperate than the Year preceding. And I observed particularly, that all the Winter, 1678, was very mild, and warmer than could be well expected from such a Season, and but very little Rain; having in the whole Month of *February* not rained above twice or thrice (at least in that Part of the Country where I then was;) infomuch that many took upon them to predict, that such unseasonable Wea- ther would certainly be the Cause of some Dearth or Pestilence the ensuing Summer, or Autumn; but their Predictions proved as false as the following Harvest was extraordinary both for Health and Plenty.

This





This Winter, 167 $\frac{1}{2}$, now newly ended, I have kept an exact Account of Wind and Weather, being well provided with a *Barometer*, *sealed Thermometers*, *Hygrosopes*, &c. To transcribe my Journal here would be too tedious; let it suffice therefore to tell you, that it hath been a very fair and warm, or rather no Winter at all; that we have not had above five or six frosty Mornings this Winter, and none that lasted longer than till Noon; that we had Snow but thrice; the first before *Christmas*, the second upon the eleventh, and the third upon the seventeenth of *January*: This last, which was the longest Snow we had this Winter, continued not forty eight Hours, but thawed. All this Winter we never had two Days of Rain together, nor above two or three that could be well called Rainy Days. *March* 14, we had a Shower of Rain and Hail together; the Wind being South-west and calm. The Mercury in my *Barometer* (which is very slender, but carefully fill'd, and conveniently placed) is for the most Part about 29 $\frac{1}{8}$ Inches high, above the Surface of the stagnant Quick-silver; but yet doth very sensibly and frequently vary its Height, according to the Difference of the Atmosphere's Gravity. *Jan.* 17, (which was the Day it last snowed here) the Mercury was subsided to 28 $\frac{1}{8}$ Inches. The next Day it was 28 $\frac{1}{8}$, being towards Night somewhat blustering, and the Snow thawed. *Jan.* 19, being fair, but very foggy, the Mercury was at 28 $\frac{1}{8}$, which is the lowest Station it was ever at yet with me; the Wind was Westerly and calm. The next Day it was up again to 29, and afterwards higher. *Feb.* 15, in the Morning, being cloudy, the Wind Westerly and blustering, the Mercury was at 29 $\frac{1}{8}$; and about eleven that Night, being fair, clear and calm, it was risen to 30 $\frac{1}{8}$ Inches. The next Day being still fair, and calm, it was at 30 $\frac{1}{8}$ Inches; which is the utmost Height I have yet seen it at. Next Day it fell a little beneath 30, and kept, as before, for the most Part about 29 $\frac{1}{8}$ or $\frac{1}{8}$ to this present; only on the eleventh of *March* it was at 30 again. Though it be observed, that frosty and snowy Winters make early Springs, and for as little as we have had of either this Winter, yet there hath not, within the Memory of any now living happened a forwarder Spring in *Ireland*; since this Place could produce some Store of ripe *Cherries* in the midst of *April*. The Wind keeps, for the most Part, here between the North-west and the South, seldom at East, and yet seldomer at North or North-east; inso-much that many here dont scruple to affirm, that for at least $\frac{1}{2}$ of the Year, the Wind is Westerly; and we have sometimes known Passengers wait at *Chester* and *Holy-Head* no less than three Months for a fair Wind to come hither.

XIX. I fixed a round Tunnel of twelve Inches Diameter to a Leaden Pipe, which could admit of no Water, but what came through the Tunnel, by reason of a Part solder'd to the Tunnel itself, which went over the Pipe, and served also to fix it to it, as well as to keep out any wet that in stormy Weather might beat against the under Part of the Tunnel; which was so placed, that there was no building near it that would give Occasion to suspect that it did not receive its due Proportion of Rain that fell through the Pipe, some nine Yards perpendicularly, and then was bent into a Win-

Observations
of the Wea-
ther in Ire-
land, 1675.
ib. p. 649.

To measure
the Quantity
of falling
Rain; by
Mr. Town-
ley, n. 208.
p. 51.

dow near my Chamber, under which convenient Vessels were placed to receive what fell into the Tunnel; which I measured by a Cylindrical Glass, at a certain Mark containing just a Pound or twelve Ounces *Troy*, and had Marks for smaller Parts also. By the Help of this Cylindrical Glass I thus kept my Account of what Rain fell, and generally twice or thrice a Day; when I took several other Observations, both of the *Thermometer*, *Barometer*, Winds, &c. What Rain I found in the Receivers, if not more than made what was left in the Cylindrical Glass a full Pound, I again left in it; but if there was more than that Quantity, I filled it just to the Pound Mark, which I threw away, and did the like with the remaining Water as often as it would allow, still keeping an Account chiefly of the Pounds thrown away, and noting also the Parts of a Pound remaining in the Glass; by the Help of which latter, and the Parts remaining at any Time before, but numbering the Pounds and subtracting the Parts at the End (for Example, of one Month) from the Pounds thrown away, and the Parts remaining at the End of another, I find the Quantity of Rain fall'n betwixt these two Times, and that so as to assure me, that I erred no more in the Quantity of Rain of another Year, than by the Mistake in the Differences of the Parts of a Pound in the first and last Observation; whereas should I still write down the Rain that falls between two Observations, I might be subject to make as great a Mistake in every one of them, and consequently be much more uncertain of the Quantity of Rain fall'n in many of those added together: Besides, this Addition is longer in performing and giving the Quantity sought, than the Method I make use of. I have added these Particulars to shew you how little Trouble there is in this Task.

Observations
of the Rain,
falling
Monthly for
15 Years; by
Mr. Town-
ley, *ib.* p. 53.

	1677	78	79	80	81	82	83	84	85	86	Sum.
Jan.	472	371	43	512	53	986	238	32	110	472	3289
Feb.	270	371	161	492	363	135	245	483	42	20	2582
March	245	250	202	413	235	237	305	87	185	572	2731
April	325	170	92	222	57	308	402	370	380	305	2631
May	313	581	105	188	69	315	353	97	201	437	2659
June	516	257	298	342	397	517	468	192	410	473	3870
July	351	339	350	302	292	482	412	313	497	188	3526
August	485	145	835	502	425	385	582	338	398	870	4965
Septemb.	223	527	553	146	607	293	152	199	163	572	3435
October	333	644	616	570	170	427	330	425	325	293	4133
Novem.	432	555	127	479	235	525	192	579	522	709	4355
Decemb.	400	57	439	269	423	456	37	299	548	132	3051
Sum.	4365	4267	3821	4428	3325	5066	3716	3414	3781	5043	41227

	1689	90	91	92	93	Sum.
Jan.	333	707	197	54	218	1509
Feb.	393	171	112	168	78	922
March	875	145	476	347	298	2136
April	468	78	386	498	539	1969
May	182	244	300	330	93	1149
June	302	179	412	416	181	1490
July	120	218	285	448	112	1183
August	222	402	193	198	668	1683
Septem.	442	403	215	605	641	2306
October	740	765	165	273	514	2457
Novem.	415	717	230	148	627	2137
Decem.	368	262	169	892	261	1952
Sum.	4860	4291	3140	4372	4230	20893

All I have yet learnt from these Observations, as to the main Point, is, that here we have almost just twice the Quantity of Rain that falls at *Paris*: This County (of *Lancaster*) and particularly that Part of it (about *Townley*) where I live, being generally esteemed to have much more Rain than other Parts, and in a greater Proportion than I thought reasonable to be allowed; however it be, yet by what I have sent you, 'twould be unjust, without farther Observations of the like Nature in other Parts, that all *England* should be esteemed to abound as much in Rain as these Parts do, where, by reason of the very high Grounds in *Yorkshire*, and the Eastern Parts of *Lancashire*, the Clouds driven hither by the *S.* and *S. W.* the general Winds in this Part of the World, are oftner stopp'd and broken, and fall upon us, than such as come by an *E.* or *S. E.* Wind, which, broken by the Hills, are generally spent there, and then little affect us; and this is the Reason that *Lancashire* has often considerably more Rain than *Yorkshire*.

In the Table I have sent you the Pounds and Parts are doubled, and these I have rather sent you than those of the whole Pounds; since the same gives both the Quantity of half Pounds, and the Height in Inches, according to the general Way of estimating the Quantity of Rain; only with this Difference, that for the half Pounds, only the last Figure is a Decimal Fraction, and the other the Number of the half Pounds; and for the Height, the two last Figures denote the decimal Fraction of an Inch, and the Remainder the Height in Inches, so near the Truth, that they only fall short of it 1 Inch in 200; which Defect is easily supplied. To this I need only add, that the Numbers on the Right-hand are the Sums of all those in the same Line that is in the first Part of several Numbers for ten Years; so that the last of them shews the Sum both of the half Pounds that have fallen during that Space of Time, and the Height the Water would have been raised in that Time also. To this

this I shall only add one Example: The Sum of all the Rain in the ten first Years is 41227; and therefore according to what hath been said, 4122,7 is the Number of Half Pounds that fell in the Compass of the Tunnel during those ten Years; and 412,27 the Height it would have raised the Water during that Time. But if you desire to be more critical, if you add 206, its two hundredth Part, you will have 414,33 for the true Height, and 41,433 for the mean Height, by those ten Years Observations; and 412,17 for the mean Quantity of half Pounds. By the same Method you will have the Means for the other five, viz. of Height 41,78, and 417,8 for the mean Number of half Pounds, which Means do strangely agree, and both considered, do give for the Mean by all the fifteen Years 41,516 Inches in Height, which is about $\frac{1}{2}$ of an Inch more than double to that raised by the Water at *Paris*, which is set down in the *Memoirs for the Ingenious*, for *February* last, and is stated about 19 $\frac{1}{2}$ *French* Inches, which make 21 *English*.

My way of Gauging by Weight is grounded upon 22,7368 Cubical Inches of Rain-water, being equal in Weight to one Pound, or 12 Ounces *Troy*; so that dividing any Superficies in Inches of a Vessel, for receiving the Rain-water, by the before-mentioned Number, it will give you the Pounds and Parts that will raise the Water upon that Superficies, with upright Sides, just an Inch: And thus I found that 4,974 Pounds would fill a Cylinder equal at the Bottom to my Tunnel and one Inch high, which you see is very near 5 Pound, which you will also find will only raise the Cylinder higher by $\frac{1}{20}$ Part.

*A History of
the Weather
at Oxford,
1684; by
Dr. Plot. n.
269, p. 930.
Fig. 17.*

XX. I here give you the Observations of a full Year, made by Order of the *Philosophical Society* at *Oxford*, not only of the Rise and Fall of the Quick-silver (mark'd by the wandring prick'd Line, after *Dr. Lister's* Method) and the Weather; but also how the Wind stood each Day. If the same Observations were made in many foreign and remote Parts at the same Time, we should be enabled with some Grounds to examine, not only the Coastings, Breadth and Bounds of the Winds themselves, but of the Weather they bring with them; and probably in Time thereby learn to be forewarned certainly of divers Emergencies (such as Heats, Colds, Dearth, Plagues, and other Epidemical Distempers) which are now unaccountable to us; and by their Causes be instructed for Prevention, or Remedies. Thence too in Time we may hope to be informed how far the Positions of the Planets, in relation to one another, and to the fixed Stars, are concerned in the Alterations of the Weather, and in bringing and preventing Diseases, or other Calamities; for by this means it is, doubtless, that the Learned *Dr. Goad* of *London*, has arrived to that Pitch of Knowledge he already has in predicting Weather. This, no question was the Opinion of the Industrious *Walter Merle*, Fellow of *Merton College*, who thus observed the Weather here at *Oxford* every Day of the Month seven Years together, viz. from *January* 1337 to *January* 1344; the MS. Copy of which Observations are yet remaining in the *Bodleian Library*. And doubtless it was some such Consideration as this, that moved *Erasmus Bartholin* to make Observations of the Weather every Day through the whole Year, 1671, which are printed *inter Acta Medica Tho. Bartholini*.

Weather,

D.	Weather, Jan. 168 $\frac{1}{4}$.	D.	Winds.	Weather, Feb. 168 $\frac{1}{4}$.
1	Hard Frost, and fair.	1	N. E.	Frost and fair.
2	Frosty, but yielding a little towards Night.	2	N. E.	Frost, a little Thaw at Night.
3	Rimy Frost.	3	Due E.	Frost and fair.
4	Hard Frost and fair.	4	Due S.	Close Weather, and a little Thaw and Snow at Night.
5	Hard Frost and fair.			
6	Hard Frost and fair.			
7	Hard Frost, but a little yielding at Night.	5	S. W.	Thawing Weather, Wind and Rain at Night.
8	Rimy Frost Morning, fair all Day, windy Night.	6	Due W.	Fair, clear Weather.
9	Frost, but Snow at Night.	7	Due W.	Close, thawing, rainy Weather.
10	Cold raw Weather toward Noon, Rain toward Night.	8	N. by W.	Close Weather.
11	Moist, thawing Weather.	9	Due S.	Fair in the Morn. Rain and Snow at Night.
12	Close, thawing Weather.	10	Due S.	Close, wet Weather.
13	Moist, close Weather, a small Frost at Night.	11	Due S.	Fair Morning, wet at Night, and windy.
14	Close, frosty Weather.	12	S. S. W.	Close Morning, fair at Night.
15	Close, frosty Weather.			
16	Close, frosty Weather, at Night windy.	13	N. by W.	Close Morn. fair at Night.
17	Frost, at Night Snow.	14	W. and N.	Rainy Morn. fair at Night.
18	Snow and Wind.	15	N. W.	Fair Weather.
19	Close, sharp Weather.	16	Due S.	Rainy Morning, close at Night.
20	Close, <i>ut supra</i> , but a little yielding at Night.	17	S. W.	Close, moist Weather.
21	Mild Frost and fair.	18	S. W.	Rainy and Wind.
22	Hard Frost, Snow at Night a little.	19	Due W.	Moist Morning, fair Afternoon.
23	Hard Frost.	20	W. S. W.	Open, fair Weather.
24	Hard Frost and fair.	21	S. W.	Close Weather, windy.
25	Hard Frost and Snow.	22	W. S. W.	Close, rainy Weather.
26	Frost, a little Snow.	23	Due W.	Wet Morn. fair Afternoon.
27	Frost, a little Thaw about Noon.	24	W. by S.	Fair Morning, close Evening.
28	Frost and fair.			
29	Frost, a small Thaw all the Afternoon.	25	S. W.	Fair Morning, close Evening.
30	Hard Frost and fair.	26	S. W.	Wet Morning, close Evening.
31	Frost and fair.	27	S. E.	Wet Morn. fair Evening.
		28	N. E.	Close, frosty Weather.
		29	E. by S.	Frosty, clear Weather.

D.	Wind.	Weather, March 1684.	D.	Wind.	Weather, April 1684.
1	S. E.	Close, frosty, cold Weather.	1	N. & W.	Fair, sun-shine Weather.
2	N. E.	Close, cold Weather.	2	W. by N.	Rain in the Morning, fair Evening.
3	N. by W.	Close, frosty Weather.	3	S. by W.	Fair Morning, Wind and Rain at Night.
4	N. by W.	Close, cold Weather.	4	S. by W.	Close, moist Weather.
5	Due N.	Close Morning, Snowy Evening.	5	S. W.	Rainy Weather.
6	N. E.	Close, cold Weather.	6	Due W.	Fair Morning, wet at Night.
7	N. N. E.	Frost, fair and windy.	7	Due W.	Fair Weather.
8	N. N. E.	Frost, close and windy.	8	S. W.	Close Weather.
9	E. by N.	Frost and high Winds.	9	N. W. & N.	Close Weather, but fair.
10	E. N. E.	Close, frosty, cold Weather.	10	N. E.	Close, fair Weather.
11	N. by W.	Frost and fair, close at Night.	11	Due E.	Rain and Wind moderate.
12	Due N.	Frosty, snowy, windy Weather.	12	N. & W.	Close, cold Weather.
13	N. by E.	Frosty Morn. fair Night.	13	N. by E.	Fair, sun-shine Weather.
14	N. by E.	Frost, Snow and Wind.	14	E. N. E.	Fair Morning, close Evening.
15	N. N. E.	Snow and Wind.	15	N. E. by E.	Close, cold Weather.
16	N. N. E.	Snow and Rain.	16	E. by N.	Close, cold Weather.
17	N. by E.	Close, moist Weather.	17	E. by N.	Close, cold Weather.
18	W. by N.	Close Morn. fair Night.	18	S. & W.	Variable, dry Weather.
19	N. E.	Cold, changeable Weather.	19	Due S.	Moist Morning, wet Night.
20	N. N. W.	Snow, and cold, high Winds.	20	S. E. & S. W.	Close, warm Weather.
21	N. E.	Close, but fair Weather.	21	S. E.	Fair, sun-shine Weather.
22	N. E.	Fair Weather, but cold.	22	S. & N. & E.	Fair Morning, inclinable to Rain at Night.
23	E. by N.	Cold, fair Weather.	23	S. W.	Rainy Morning, fair Evening.
24	E. by N.	Cold, fair Weather.	24	S. W.	Fair sun-shine Weather.
25	E. by N.	Cold, fair Weather.	25	S. W.	Fair, sun-shine Weather.
26	Due E.	Cold, fair Weather.	26	Due S.	Close, dry Weather.
27	Due E.	Cold, close Weather.	27	S. W.	Fair, sun-shine Weather.
28	S. by W.	Warm, moist Weather.	28	S. W.	Close, dry Weather.
29	S. by W.	Wind and Rain.	29	S. W.	Close, dry Weather.
30	S. by W.	Close, fair Weather.	30	Due S.	Rainy Morning, fair Evening.
31	Due S.	Fair, calm Weather.			

D.	Wind.	Weather, May 1684.	D.	Wind.	Weather, June 1684.
1	S. S. W.	Variable Weather.	1	S. W.	Close Morning, fair E- vening.
2	Due W.	Fair Weather.	2	Due W.	Close Morning, rainy E- vening.
3	S. S. W.	Close, fair Weather.	3	Due W.	Fair Morning, rainy E- vening.
4	W. S. W.	Close, fair Weather.	4	Due W.	Close, fair Weather.
5	W. S. W.	Moist Morning, fair E- vening.	5	Due W.	Close, fair Weather.
6	W. S. W.	Close, fair Weather.	6	Due W.	Close, fair Weather.
7	W. S. W.	Close Morning, Rain at Night.	7	W. and N.	Close, fair Weather.
8	S. S. E. S. & W.	Fair, warm Weather.	8	Due N.	Fair, sun-shine Weather.
9	N. W.	Close, fair Weather.	9	Due N.	Close, fair Weather.
10	Due W.	Close, fair Weather.	10	N. E.	Fair, sun-shine Weather.
11	Due W.	Close, fair Weather.	11	Due E.	Fair, sun-shine Weather.
12	Due W.	Misty Morning, fair E- vening.	12	Due E.	Fair, sun-shine Weather.
13	S. & W.	Wet Morning, fair E- vening.	13	E. S. E.	Fair sun-shine Weather.
14	S. W.	Close Weather, some Rain.	14	E. S. E.	Fair, sun-shine Weather.
15	Due N.	Close, fair Weather, some Wind.	15	E. S. E.	Fair sun-shine dry Wea- ther.
16	N. N. E.	Windy Morning, close Evening.	16	E. S. E.	Fair sun-shine hot Wea- ther.
17	N. E.	Close, dry Weather.	17	E. S. E.	Fair sun-shine hot Wea- ther.
18	N. E.	Close, fair Weather.	18	E. by N.	Sun-shine Morning, clou- dy Evening.
19	N. E.	Fair sun-shine Weather.	19	E. by n. S. f. w.	Sun-shine hot Weather.
20	E. by N.	Close, fair Weather, some Wind.	20	S. by W.	A little Rain, cloudy.
21	N. E.	Warm Morning, close E- vening.	21	S. e. E. S. E.	Lowring, some Rain.
22	N. E.	Close, fair and windy.	22	N. E.	Fair, hot Weather.
23	N. E.	Close, fair and windy.	23	N. E.	Hot, a muddy Sky.
24	N. E.	Close Morning, fair sun- shine Evening.	24	N. E.	Sun-shine, clear.
25	N. E.	Close, fair Weather.	25	N. E.	Sun-shine, fair Weather.
26	S. E.	Fair sun-shine Weather.	26	N. E.	Sun-shine, dry Weather.
27	N. E.	Close, fair Weather.	27	N. E. E.	Very dry.
28	E. by N.	Fair sun-shine Weather.	28	E. S. E.	Hot, lowring Evening.
29	S. W.	Wind and Rain.	29	S. S. W.	Sun-shine, clear.
30	Due W.	Close, fair Weather.	30	S. W.	Cloudy, cool.
31	S. W.	Close Weather, a little Rain at Night.			

D.	Wind.	Weather, July 1684.	D.	Wind.	Weather, August 1684.
1	S. w. W. n. w.	Somewhat cloudy.	1	N.	Warm sun-shine Weather.
2	W.	A little Rain, fair.	2	W.	Cool, fair Weather.
3	S. W.	Fair, but cloudy.	3	S. W.	Warm fair Weather.
4	S. W. W.	Close, some Rain.	4	Due S.	Hot sun-shine Weather.
5	S. W.	Sun-shine Morning, gloomy Evening.	5	S. W. by S.	Hot sun-shine Weather.
6	S. W.	Close.	6	S. W. by S.	Warm sun - shine Weather.
7	W. S. W.	Cool, close.	7	Due S.	Rainy Morning, fair Evening.
8	S. W.	Hazy, some Rain.	8	Due S.	Close, fair Weather.
9	W. N. W.	Some Rain, clear.	9	Due W.	Fair, sun-shine Weather.
10	N. W.	Clear sun-shine.	10	Due N.	Fair, sun-shine Weather.
11	S. W.	Rain.	11	S. W.	Fair Morn. inclinable to Rain at Night.
12	W.	Some Rain, fair Evening.	12	Due W.	Rainy Morning, the same in the Evening.
13	W.	A Shower or two.	13	Due W.	Fair, sun-shine Weather.
14	W. S. W.	Cool, close Weather.	14	Due W.	Fair, sun-shine Weather.
15	W. S. W.	Rain.	15	W.	Fair, sun-shine Weather.
16	W.	Cool, close Weather.	16	W. N.	A Shower, sun - shine Weather.
17	W.	Cool, close Weather.	17	N. W.	Sun-shine Morning, cloudy Evening.
18	N. W.	Fair sun-shine Weather.	18	N. n. w. N.	A muddy Sky in the Morning, sun-shine Evening.
19	W. S. W.	Lowring, cool Weather.	19	N. S. W.	Fair sun-shine Weather.
20	W. N. W.	Fair sun-shine Weather.	20	S. S. W.	Hot sun-shine Weather.
21	W.	Fair sun-shine Weather.	21	S. S. W.	Hot sun-shine Weather.
22	W.	Hot sun-shine Weather.	22	S. W.	Fair sun-shine Weather.
23	W. S.	Hot sun-shine Weather.	23	S. W.	Hot sun-shine Weather.
24	S. E.	Hot sun-shine Weather.	24	S. W.	Hot sun-shine Weather.
25	E. by S.	Hot sun-shine Weather.	25	N.	Rain all Day.
26	E. by S.	Hot, a little Rain towards Night.	26	S. W.	Rain at Night.
27	W. N.	Hot sun-shine Weather.	27	N. W.	Close, some Rain.
28	W.	Hot, Thunder, Rain.	28	S. W.	Close Weather.
29	N. N. E.	Cloudy, some Rain.	29	S. S. W.	Close, Rain at Night.
30	N. N. E.	Fair sun-shine Weather.	30	Due S.	Variable Weather.
31	N. E.	Hot sun-shine Weather.	31	S. by E.	Close, some Rain.

D.	Wind.	Weather, Septemb. 1684.	D.	Wind.	Weather, October 1684.
1	S. by E.	Close, some Rain.	1	N. W.	Moist Weather, some Rain.
2	Due S.	Close, some Rain.	2	W. by S.	Close Weather, but fair.
3	S. E. W.	Close, Rain, Thunder.	3	S. W.	Close Morning, fair Evening.
4	S. E. S. W.	Close, some Rain.	4	S. by W.	Close all Day, Rain at Night.
5	Due E.	Close Morning, rainy Afternoon.	5	W. N. W.	Rainy Morning, fair Evening.
6	S. S. E.	Close, some Rain.	6	Due W.	Rainy, windy Weather.
7	N. W.	Fair sun-shine Weather, Rain at Night.	7	S. by W.	Rain all Day.
8	N. W.	Fair, close, dry Weather.	8	N. N. W.	Rainy Morning, fair Evening.
9	N. W.	Sun-shine Morning, close Evening.	9	N. N. n. w.	Close, fair Weather.
10	N. W. N. E.	Sun-shine Morning, some Rain.	10	N. W.	Fair Weather.
11	W. by N.	Fair Morning, close Evening.	11	S. W.	Windy, rainy Morning, fair Evening.
12	N. W. N.	Fair Morning, some Rain at Night.	12	S. S. W.	Close, and some Wind.
13	N. N. W.	Rainy Weather.	13	S. S. W.	Close, some Rain.
14	Due N.	Fair sun-shine Weather.	14	S. S. W.	Rain and Wind.
15	N. by E.	Fair sun-shine Weather.	15	S. by E.	Wind and Rain.
16	Due N.	Close, fair Weather.	16	S. S. W.	Fair sun-shine Weather.
17	N. W.	Close and windy.	17	S. W.	Fair sun-shine Weather.
18	Due N.	Fair Morning, some Rain, fair again.	18	W. by N.	Fair Weather.
19	Due N.	Fair Morning, close Evening.	19	N. W.	Close Morning, fair sun-shine Evening.
20	Due S.	Fair sun-shine Weather.	20	N. W.	Fair Weather.
21	S. by E.	Fair sun-shine Weather.	21	Due W.	Fair sun-shine Weather.
22	Due S.	Fair sun-shine Weather.	22	Due W.	Close, fair Weather.
23	S. by W.	Fair Morning, close Evening.	23	Due W.	Fair Morning, Wind and Rain at Night.
24	Due W.	Fair sun-shine Weather.	24	N. W.	Wind, Snow, and Rain.
25	S. by W.	Changeable Weather.	25	N. W.	Close, cold and windy.
26	Due S.	Changeable Weather.	26	N. W.	Fair, Frosty Weather.
27	Due S.	Rainy Weather.	27	N. E.	Frost and Snow.
28	Due S.	Close, moist Weather.	28	S. W. N.	Frost and Snow.
29	S. W.	Close, moist Weather.	29	N. W.	Frosty, cold Weather.
30	N. W.	Close Morning, sun-shine Evening.	30	N. W.	Snow and Wind.
			31	Due N.	Cold Thaw in the Morning, clear, frosty Evening.

D.	Wind.	Weather, Novemb. 1684.	D.	Wind.	Weather, Decemb. 1684.
1	S. by W. N.	Thaw, Snow, Frost.	1	N. N. E.	Frost, sun-shine.
2	N. W. W.	Frosty Morning, Thaw Afternoon.	2	N.	Frost, sun-shine.
3	S. by W. W.	Thawing weather all Day.	3	W. S. W.	Snow, much small Rain.
4	N. W.	Close and windy.	4	S.	Cloudy, some Rain.
5	N. W.	Close and windy, little Frost.	5	S.	Warm, sun-shine Wea- ther.
6	Due W.	Fair Weather, little Frost.	6	S. e. E. N. E.	Misty, thick, moist Air.
7	N. S.	Fair Morning, rainy E- vening.	7	E. N. E.	Frost, sun-shine Wea- ther.
8	E. by S.	Small Rain all Day.	8	E. N. E.	Moist, cloudy Air.
9	S. E.	Misty, moist Weather.	9	E. N. E.	Moist, cloudy Air.
10	Due W.	Rainy, misty Weather.	10	E. N. E.	Thick, moist Air.
11	N. W.	Cloudy, moist Weather.	11	E. N. E.	Fair, but cloudy.
12	S. W.	Cloudy, moist Weather.	12	E. N. E.	Close.
13	S. W.	Cloudy, some Sun-shine.	13	E. N. E.	A moist, close Air.
14	S. W.	Close, Mist at Night.	14	E. S. E.	Frost, clear sun-shine.
15	N. W.	Frosty Morning, close E- vening.	15	E. W. S. W.	Frost, cloudy.
16	N. W.	Close Morning, clear frosty Evening.	16	N. W. N.	Frost, cloudy.
17	N. W. N.	Hard Frost and clear.	17	W.	Frost, cloudy, a little Snow.
18	N.	Hard Frost, sun-shine.	18	N.	Frost, sun-shine.
19	S.	Close, Snow, Rain.	19	W.	Thaw, cloudy.
20	S.	Much Rain.	20	N. N. W.	Rain, Hail, Snow.
21	W.	Warm sun-shine Weather.	21	W.	Frost, sun-shine.
22	S.	Frost, Rain.	22	N.	Frost, sun-shine.
23	S. W.	Fair, somewhat warm.	23	E.	Hard Frost, windy.
24	W. S. W.	Some Rain.	24	N. E.	Frost, sun-shine.
25	W. N. W.	Close, fair.	25	N.	Frost, cloudy, much Snow.
26	W.	Fair, warm, close.	26	N.	Hard Frost, sun-shine.
27	N. W.	Some Rain.	27	W.	Frost, sun-shine.
28	N.	Cold, cloudy, Rain.	28	N. W.	Rain all Day.
29	N. E.	Fair, but cloudy.	29	N. W.	Frost, Rain at Night.
30	N.	Fair.	30	W. N. W.	some Rain, fair Even- ing.
			31	E.	Fair, cloudy.

XXI. At *Cape Corse* in the Latitude of 4. 49' N. An. 1866. Nov. 24 and 25, Clear and hot. 26, About two *a. m.* a Storm of Rain with Thunder for half an Hour. 27, At the same Hour, Rain which lasted somewhat longer. 28, About five *a. m.* some Rain, afterwards misty, and about ten extream hot. 29, About two *a. m.* a great Storm of Rain slackning often, but renewing again, it lasted about an Hour; the Day after, clear.

*The Wra-
ther at Cape
Corse, 1686
and 1687,
by Mr. J.
Hillier, n.
232. p 693.*

Thence to Dec. 7, clear; then cloudy in the Morning, between twelve and one *p. m.* a Shower lasting about half an Hour: thence clear and hot. 10, A little Mist in the Morning, otherwise very clear and hot; so till 15.

15, And some Days after, somewhat thick, especially in the Morning. 19 and 20, We had a dry North and North-easterly Wind, call'd an *Hermitan*, and it overcame the *Sea-Breeze*; found very ill for the Eyes, and most Men complained of a feverish Temper; it was parching, but rather colder than ordinary. 21, It ceased; a clear Air and very hot.

23, We had the *Hermitan* again, but the Morrow it ceased: Then and 25, some Clouds, but no rain. Thence to 29, clear and hot. 29, The *Hermitan* returned, but did not continue. Thence Clouds sometimes, but no Rain till Jan. 2.

This Month we had three Funerals, one being sick of the Flux laid violent Hands upon himself, through Impatience of the Pain, the third Day. The second, upon the twenty fifth died convulsively, not having been sick above one Day. The third, Dec. 17. Died of a Dropsy, which had succeeded a tedious Flux.

An. 1687, Jan. 2. About five *a. m.* Rain for half an Hour, between seven and nine for an Hour, from half an Hour past nine to one *p. m.* the rest cloudy. 5, At two *a. m.* about half an Hour. 8, At one in the Morning about an Hour, the Days between somewhat cloudy: Thence to 12, extream hot.

12 and 14, Somewhat cloudy, otherwise the Heat continued. 17, At seven *p. m.* a *Tornado* for above half an Hour, and about twelve at Night another; but the Heat very little abated.

22, Between five and six *p. m.* began a *Tornado*, which lasted above an Hour very violent, with great Claps of Thunder and Lightning. Tank fill'd one Foot. 23, In the Morning a great Mist, after eight clear and extream hot.

The latter End of *January*, and the Beginning of *February*, commonly misty in the Morning; after extream hot.

Feb. 10. Somewhat cloudy and cool, till then we were troubled with Coughs, for the most part; about this Time they ceased. So the eleventh towards Night, Thunder a far off, and Expectation of a *Tornado*; but it fail'd. 12, Extream hot. 13, A stronger Wind than ordinary from Sea-ward. 14. Something like an *Hermitan*, but not from its usual Quarter; clear and hot till about two *p. m.* then cloudy, but no Rain. Thence to 22, extream hot and clear. From 22 to *March* 1, some flying Clouds without Rain; sultry hot and unwholesom.

24, Some Shew of a *Tornado*, but it pass'd away.

This Month we had two Funerals.

The

The Beginning of *March* as the latter End of *Feb.* 5, From six *a. m.* for an Hour and half a violent *Tornado*; the Day after cloudy. 6, Clear. 7, At Night Lightning and Clouds afar off; but nothing followed. Thence to the eleventh, clear and hot.

11, About five *a. m.* a violent Rain for almost half an Hour. 12 and 13, Cloudy. 14, About four *a. m.* a gentle Shower, but lasted not long. 15, Between six and seven *a. m.* a few Drops, and likelihood of more, but nothing followed; both Days cloudy. 16, Extreame hot. 17, Somewhat cloudy. Thence to 20, extreame hot.

20, Cloudy; about ten *a. m.* some few Drops. 21, very hot. 22, In the Morning hot; about twelve a violent Rain for a Quarter of an Hour. 23, Clear. 24, About two *a. m.* Rain for about half an Hour; the Day after clear. Thence to *April* 3, clear and extreame hot.

No Funeral.

April 3, At three *p. m.* a violent *Tornado*, but only some few Drops of Rain; at five *p. m.* a little Rain. 4, Cloudy by Fits, otherwise very hot. 5, Hot and clear. 6, In the Morning hot, about two *p. m.* cloudy; about three some Drops of Rain, in the Evening the Clouds dispersed. 7, Clear and hot. 8, Between twelve and one in the Morning, a violent Rain for near an Hour; after two, one somewhat longer; the Day after there appear'd to have been much Rain; Tank fill'd two Foot and somewhat more. 9, About seven *a. m.* some Drops, cloudy all Day.

10, Cloudy about eleven *a. m.* a small Mist. 11, Presently after Midnight it began to rain, and lasted till six *a. m.* a great Part of the Time very violently, it began with a strong *Tornado*; Tank above three Feet. The Day after some Clouds, otherwise extreame hot. So also 12 and 13. 14, About five *a. m.* a Shower for half an Hour, between six and seven *p. m.* another of the same Continuance, the Day between extreame hot. So 15, 16, A Shower for half an Hour; it began with a violent *Tornado*, the Rain not much, afterwards cloudy. 17, 18, Clear. 19, Clear also, about seven *p. m.* a considerable Wind, and Drops of Rain.

20, Clear, but windy. 21, Between twelve and two moderate Rain for near an Hour. 22, About two *a. m.* moderate Rain almost an Hour; at eleven *p. m.* a short Shower and gentle; the Day between extreame hot. 23, Cloudy, about ten *a. m.* some Drops. 24, Extreame hot. 25, About one *a. m.* Rain for near an Hour; the Morning after hot; afternoon cloudy; most Part of the Night Thunder and Lightning, but no Rain. 26, At seven *a. m.* strong Rain for half an Hour, after that a little Mist; Afternoon from twelve to three it rained unequally, but the most part moderate. 27, Extreame hot. 28, About twelve somewhat cloudy, at three *p. m.* it began to rain, and lasted about an Hour and an half; after, cloudy and some Drops, in the Night a Shower or two. 29, Cloudy. Thence to *May* 6, sometimes cloudy; but for the most part violent hot.

This Month we had three Funerals; one on the third of a Fever, another on the nineteenth of I know not what Pains in the Guts; another on the twenty-fourth of the Flux.

The fifteenth, and some Days following, there settled upon the Castle Walls certain Swarms of winged Ants, a little bigger than Bees; they would bite very severely, and were blown up with Powder.

May 6, in the Morning a little cloudy, Afternoon some Wind, followed by gentle Rain, which lasted till three *p. m.* after, Cloudy. 7, Hot. 8, Cloudy; about ten *a. m.* a gentle Shower for three Quarters of an Hour; about eight *p. m.* a very violent Storm of Wind and Rain, but it quickly grew moderate, and lasted in all not above half an Hour. 9, Clear. 10, About Noon a violent Shower for a Quarter of an Hour; after eight *p. m.* another as long, but not so violent; past nine, another shorter.

11, Clear. 12, Clear; past nine *p. m.* a very violent *Tornado* with Rain, which lasted somewhat more than two Hours. 13, Between twelve and one in the Night a short Shower; about nine *a. m.* some Drops; so also in the Afternoon, but nothing considerable; cloudy all Day. 14, Cloudy; at nine *a. m.* a violent Rain for a Quarter of an Hour; after, gentle for above an Hour; about three *p. m.* some Drops. 15, About three *a. m.* Rain for half an Hour; between four and five, another; after, foggy and cloudy, with some few Drops; about seven *p. m.* a violent *Tornado* with Rain for near an Hour. 16, About four *a. m.* Rain for an Hour; after eight, for a Quarter of an Hour; after six *p. m.* Rain and Wind, but both moderate, for half an Hour; past eight, about as much. 17, About four *a. m.* a short Shower; after clear. 18, Clear. 19, Cloudy; about ten *a. m.* some Drops.

20, Cloudy; between eight and ten *a. m.* a Shower; first violent, after more moderate, till it ended in a kind of Mist; it lasted in all about an Hour and half; the Day after clear. 21 and 22, Clear. 23, In the Afternoon cloudy; about six *p. m.* some Drops; the Night after, a Shower not considerable. 24, Hot, about ten *p. m.* a little Shower. 25, Clear. 26, In the Night, some little Rain. 27, Held up. 28, At nine *p. m.* a short Shower. 29, At five *a. m.* Rain till near seven; a little past seven till nine, after cloudy. 30, Cloudy; the Night after some Rain. 31, About eight *a. m.* Rain for half an Hour; from nine till twelve it rained for the most part very violently; before one, another Shower for half an Hour; from a little after two till five, with very great Thunder.

One Funeral on the twenty fifth, after but three Days Sickness.

The Beginning of this Month we had an extraordinary Number of Toads, which after some time were not to be seen. The fourteenth we had winged Ants as before.

24, Was the first Corn, the Seed-time having been the middle of *March*.

June 1, About four *a. m.* Rain for an Hour; past one *p. m.* for half an Hour; the rest cloudy and misty. 2, From two *a. m.* till five, continual Rain, 'tis said there was some before; from nine *a. m.* till half an Hour past six *p. m.* continual Rain, sometimes very fierce; from half an Hour past nine at Night, Rain till past ten. 3, From six to a little past seven *a. m.* a very gentle Rain, from thence till one *p. m.* most commonly very fierce; thence for a little while, more moderate; but it rained hard again till six *p. m.* then it dropped but slowly, and so continued till about seven; in the Night some little

little Rain. 4. About eight *a. m.* some Drops, thence clear. 6 and 7, Clear, except some few flying Clouds. 8, After three *a. m.* gentle Rain for near an Hour; then cloudy, and some Drops, after ten *p. m.* a Shower. 9, At five *a. m.* a gentle Shower, lasted till past seven; thence a very violent Rain till almost nine; some Drops after that; about three *p. m.* it began, and rained till past ten somewhat moderately. 10, Clear and hot.

11, Cloudy; about eight *p. m.* a few Drops. 12, From about two *a. m.* till near five, Rain, but not violent; a little before six, a furious Storm of Rain, but little Wind, it lasted till half an Hour past seven. About three *p. m.* a moderate Rain till a little past four; and from thence to six somewhat more than a Mist, the Night after it rained a little. 13, Cloudy, in the Afternoon it dropp'd a little. 14, About eight *a. m.* a few Drops. 15, Somewhat cloudy. 16, Extream hot, towards Night cloudy, about five *p. m.* a violent Shower for half an Hour; from a little before eight till past ten it rained continually. 17, From four *a. m.* till almost six, gentle Rain; so from a little past six till past seven, thence till past three *p. m.* cloudy, and now and then some Drops, then a violent Shower for half a Quarter of an Hour; half an Hour after four it rained again, and continued till past ten, for the most part very furiously; with some little Intermision it rained all Night. 18, At three *a. m.* it rained very fiercely; about half an Hour after six it held up, but cloudy still; from eight *a. m.* till past three *p. m.* it rained, but moderately; then it held up a little, but rained after till past six, all Day cloudy, and at Night a great Fog. 19, About nine *a. m.* some Drops; from one till past three *p. m.* very gentle Rain.

Thence to the first of *July* foggy Morning and Evening, sometimes hot, but for the most part cloudy, and more temperate than could be expected from the Climate.

Two Funerals, one the ninth, of an Asthma; the other the twenty first, of a Fever.

We saw some sorts of Insects not usual here, whether monstrous or not I cannot tell; the most notable, a kind of Spider about the Bigness of a Beetle, the Form nearest that of a Crab-Fish, with an odd kind of Orifice visible in the Belly, whence the Web proceeded.

July 1, Extream hot. 2, Foggy in the Morning; about nine *a. m.* a few Drops; after, clear. 3, In the Morning a great Fog; about nine *a. m.* it rained small Rain for near an Hour; towards Night more foggy than ever before; about six *p. m.* small Rain for a little time, from eight till past nine somewhat more brisk Rain, after that it cleared up. 4, From nine *a. m.* to three *p. m.* small Rain, the rest foggy; between ten and eleven *p. m.* some Rain. 5, From two, *a. m.* till past eight, constant Rain, sometimes very fierce, sometimes moderate; about ten *a. m.* some Rain; between two and three *p. m.* it began to rain, but continued not long; from eight *p. m.* to ten, Rain. 6, From about two *a. m.* to six, Rain; after, fair. 7, Foggy and cloudy, between seven and eight *a. m.* some Drops. 8, Foggy in the Morning, otherwise clear and hot. 9, About one *a. m.* a smart Shower; between three and five some more Rain; the Day after foggy. 10, Very dull and cloudy; from three *p. m.* till Night, a very great Mist. 11, Tole-

11, Tolerably clear, and very hot, yet somewhat foggy Morning and Evening. 12, Cloudy; thence to 15, in the Morning and Evening foggy, else very hot. 15, Cloudy; about ten *a. m.* some Drops; from half an Hour past two till four, moderate Rain; about seven, some Drops; cloudy, several times it dropped a little, but nothing considerable. 17, A little before Day a short Shower; after, cloudy; thence to 20, foggy Morning and Evening, and the most part cloudy.

20, Very clear all Day, and extream hot. 21, Not foggy at all; yet somewhat cloudy, but about Mid-day it cleared up. 22 and 23, Very clear and extream hot. 24, Cloudy in the Morning; after, as the two last. 25, Cloudy, but not misty nor foggy; sultry hot. 26, In the Morning cloudy; after, extream hot. 27, Hot and clear. 28, Thin Clouds, through which the Sun shone very hot. 29 and 30, Cloudy. 31, About three *a. m.* two short Storms of Rain; the Day after, clear and hot.

Two Funerals; one the seventeenth drowned, the other the twenty-first of a Fever.

Aug. 1 to 5, Clear, for the most part in the Mornings cloudy; but without Fogs, sometimes very hot. 5, About five *a. m.* a Shower near an Hour long; about seven, another for half an Hour; till ten, some small Rain; thence cloudy till one; about seven *p. m.* a few Drops. 6, Cloudy all Day, sometimes it dropp'd a little. 7, About two *a. m.* violent Rain with Wind for above half an Hour; the Day after, cloudy. 8 and 9, Cloudy and foggy. 10, More foggy than ordinary; about ten *a. m.* a great Mist, or small Rain for the most part of the Day after.

11, Foggy, as the former, and misty; between eight and nine *a. m.* a Shower of small Rain; Afternoon, clear. 12, Small Rain in the Morning; after, as 11. 13, Clear and hot, the *Land Breeze* very strong. 14, Cloudy all Day, the *Land Breeze* turn'd to a kind of *Hermitan*, but not troublesome, nor continued beyond this Day. 15, Cloudy, several Times very misty, and some small Rain. 16, Cloudy, but no Mist; Afternoon, clear: Thence to 22, clear and hot; but the Nights colder than at other Times.

22, At six, *p. m.* Cloudy, a Wind *Tornado*, but moderate, with some Drops of Rain very large. 23, Clear and hot. 24, Cloudy and misty at first; about ten *a. m.* clear and hot. 25, Clear and hot. 26, Very foggy, Morning and Evening; for the rest, hot. 27, From five to ten *a. m.* it rained smartly; thence cloudy; about two *p. m.* it cleared up for a while; about nine *p. m.* a sharp Rain for half an Hour. 28, Between twelve and three *a. m.* it rained about two Hours; about seven some few Drops; after, cloudy; in the Middle of the Day it cleared a little, but quickly overcast again. 29, In the Night some Rain; at seven, *a. m.* Rain for half an Hour; till past twelve, a very thick Mist; about three *p. m.* clear; at Night a very thick Mist. To the End, cloudy and misty.

Three Funerals; 6, one of a Fever; 7, another of a Consumption; 29, a third of a Fever.

Sept. 1 and 2, as the last. 3, Some few Drops: Thence to 8, cloudy also and misty. 8, About six *p. m.* some small Rain; between eight and ten *p. m.* for

an Hour pretty brisk Rain. 9, In the Morning cloudy and misty. 10, About ten *p. m.* a little Rain.

11, Extream hot and clear; in the Night considerable Rain for several Hours. 12, About ten *a. m.* some small Rain, the Morning very foggy, Afternoon clear. 13, Clear and hot. 14 and 15, In the Morning extream cloudy, and some Drops of Rain. 16, Clear and extream hot. 17, Moderate; about seven *p. m.* some Drops; at Night also some Rain, not considerable. 18, Cloudy; in the Morning about twelve, some Drops; all this Week, Morning and Evening, foggy and thick. 19, 20, 21, Extream hot; the fogs ceased.

22, About one *a. m.* some Rain; the Day after cloudy. 23, 24, 25, in the Morning cloudy; after, very hot. 26, At Night also somewhat misty, with many Flashes of Lightning, but no Thunder. The like Flashes most Nights to the End of the Month, also often cloudy; at other Times extream hot.

Two Funerals; one the nineteenth of a Fever; the other the twenty-sixth, whose Disease I do not know.

October 1, About three *a. m.* a very fierce Rain for near an Hour, milder towards the End; the Day after, some flying Clouds. 2, About four, *a. m.* a little Rain, the Day after, as before; from eight *p. m.* till ten, moderate Rain. 3, Cloudy; about ten *a. m.* Rain for somewhat more than an Hour. 4, Cloudy; between eight and ten *p. m.* a very smart Rain for above an Hour. 5, About nine *a. m.* a little Shower. 6, About five, *a. m.* a little Shower; another past six: The Day after, and the seventh, extream hot: 8, Hot in the Morning; Afternoon, a Shew of a *Tornado*, with Thunder, and a considerable Wind, but no Rain.

Thence to 16, some flying Clouds, but generally hot. 16, About four *p. m.* a little Rain, the Sun shining then, and the whole Day, very hot; about eight *p. m.* a very strong *Tornado*, Wind and Rain for about half an Hour, afterward the Rain continued, but more moderate, for near two Hours. 17, Clear and hot. 18, So too, except that about three *p. m.* there was a very short Shower. 19 and 20, Somewhat cloudy.

21, About seven *a. m.* a few Drops; after, clear and extream hot, but quickly cloudy again; at eleven *a. m.* a violent *Tornado*, with very strong Rain and Thunder for near an Hour; thence all the Time till Night, thick and misty; till two *p. m.* Rain. 22, Cloudy. 23, Clear and hot. 24, Somewhat cloudy; at seven *p. m.* a little Rain. 25, Cloudy; about eleven *a. m.* Expectation of a *Tornado*, with some Thunder, but it ended in a few Drops of Rain about one *p. m.* 26, About two *a. m.* a very violent *Tornado*; and after the Wind, Rain not very fierce, which lasted till eight *a. m.* the Day after cloudy. 27, About ten *p. m.* a violent Wind with Rain, but it lasted not long. 28, About three *a. m.* a strong Rain for near an Hour, the Day after extream hot. 29 and 30, Hot, yet with some Clouds. 30, Half an Hour after eleven *p. m.* began a very furious *Tornado*, the Wind was quickly over, but the Rain lasted with extream Violence about two Hours. 31, In the Morning very hot, about two *p. m.* a violent *Tornado*, with Rain and Thunder very near,

it

it ceased sometimes, but beginning again, lasted till near four *p. m.* afterward cloudy.

Three Funerals, all upon the sixth Day; two of Fevers, the other I know not.

Nov. Clear and extream hot till the sixth. 6, About half an Hour past one in the Morning, a very violent Rain for more than Hour.

Thence to 14, except that the eleventh at Night there were some few Drops, very hot.

14, Extream hot, about nine *p. m.* a little Shower; the same Night about one, a smart Rain for an Hour and half. 15, Hot; toward Night cloudy and foggy: Thence to 19, very hot. 19, Some likelihood of a *Tornado*, but nothing followed.

20, About one *p. m.* a short Shower; about a Quarter past two, another not much longer; till Night cloudy. Thence to 26, no Rain, but cloudy and somewhat cooler; yet some Days extream hot. 26, About ten *p. m.* a short Shower. 27, About two another, the rest clear. 30, About two *a. m.* fierce Rain for about half an Hour.

This last Year has been the wettest and most cloudy of any that can be *ib. p. 691.* here remembred; yet the Air has been clearer than it uses to be in *England* one Day with another.

A *Tornado* is a violent Storm of Wind, followed commonly by Rain, but *ib. p. 692.* not always; the Wind ceases not presently upon the Rain, but after, sometimes it does: In this Place it comes (as does an *Hermitan*) most frequently from the North, taking in the next Points, whether to the East or West, but chiefly the East, tho' I have seen both that and an *Hermitan* from other Points; so the Account is not without Exception. There are in it short uncertain Blasts from all Quarters, which I believe reach not many Yards; but the general Wind (for ought that I see) is not so unconstant: Vessels that go to Windward are helped by them, when they are not over-strong, for they are opposite to the *Sea-Breeze*, and they can steer by them a regular Course; which sure they could not do, if they were very irregular. They never fail to give Warning before-hand, tho' sometimes after that Warning they do not follow; there is a very black Cloud appears afar, in which if there be a kind of white Spot, the Wind will be most; if not, the Rain: this the Sailors say. Sometimes there is that Mark, sometimes not; though I doubt the Prediction from it is not very certain; as neither are any perhaps of that kind.

XXII.
The Rain at
Gresham
College,
1695 and
1696, n.
223. p. 357.

M.	D.	lb	Oun.	gr.	M.	D.	lb	Oun.	gr.	M.	D.	lb	Oun.	gr.
August	19	2	6	216	Jan.	6	4	10	105	May	4	4	10	45
	26	4	6	246		13	0	1	12		11	7	6	0
Septemb.	2	0	4	96		20	1	10	450		18	5	2	105
	9	3	10	397		27	1	5	82		25	1	7	60
	16	0	1	204	Feb.	3	6	11	372	June	1	0	0	99
	23	0	6	336		10	4	9	242		8	6	6	150
	30	4	1	444		17	0	6	291		15	0	2	120
October	7	2	3	96		24	0	2	180		22	7	5	285
	14	0	2	60	March	2	0	9	12	29	1	5	84	
	21	0	1	234		9	0	2	459	July	6	0	1	120
	28	0	0	458		16	0	0	396		13	16	1	0
November	4	0	0	207		23	4	4	263		20	1	7	240
	11	1	11	65	30	1	5	285	27		6	1	256	
	18	1	1	309	April	6	2	4	375	August	3	1	10	120
	25	0	9	285		13	1	0	294		10	1	11	90
Decemb.	2	0	8	126		20	2	2	000		12	0	0	0
	9	3	7	324		27	0	7	390					
	16	1	3	435										
	23	0	1	60										
	30	5	8	93										

This Account of the Quantities of Rain fallen in one Year in *Gresham College, Lond.* per Month, begun *Aug. 12, 1695*, and the Rain was weigh'd every *Monday Morning* till *August 12, 1696*, by Pounds, Ounces and Grains, Troy Weight: The Diameter of the Vessel which receives the Rain being 11,4 Inches, whose *Area* is a little more than 102,1 Inches.

lb. Oun. gr.

The Sum amounted to 131 7 113, which is equal to 29,11 Inches in a Cylinder of the aforesaid Diameter, viz. 11,4 Inches.

Fig. 18.

ABCD is a Frame to support the Glasses. *E* is a large Bolt-head, with a Neck of twenty Inches long, and capable of holding above two Gallons. *F* is a Funnel, whose Diameter is eleven Inches and $\frac{4}{10}$ from *G* to *H*. *I, K*, are two Stays, or Pack-Threads which are strained by two Pins, *L, M*, to hold the Tunnel steady against the high Winds. *N*, the Pipe of the Tunnel, at *N* being no wider than $\frac{1}{2}$ of an Inch, through which the Evaporation can be but little.

JANUARY,

JANUARY, 1697.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	8	Frost	W.S.W.	30 07			8	Frosty	N.	30 02	
1.	12			30 07		17.	12	Cloudy	N.N.W.	30 02	
	9	Fair		30 04			9	Calm		30 04	
2.	8			30 05			8	Frost	W.	30 09	
	12	Misting	S.	30 00		18.	12	Fair	S.W.	30 10	
	9			30 05			9			30 10	
3.	8	Fog	S. by W.	30 07			8				
	12	Cloudy	S.	30 11		19.	12				
	9			30 15			9				
4.	8			30 18	0 50		8	Fair			
	12	Misting	S.	30 18		20.	12	Frost			
	9			30 18			9	Cloudy	S.w.b.w.	30 20	
5.	8	Calm		30 22			8				
	12	and	W. by S.	30 23		21.	12				
	9	cloudy	S.W.	30 26			9				
6.	8	Fog		30 22			8	Cloudy	W.	29 95	
	12	Warm	W.	30 00	0 30	22.	12	Thaw	W.byN.	29 90	0 08
	9	Misting		30 14			9	Rain		29 95	
7.	8		N. by W.	30 05			8	Frost	N.W.	29 90	
	12	Cloudy	N.W.	30 05		23.	12	Snow	N.W.	29 80	0 30
	9						9	Fair	N.N.W.	29 68	
8.	8		N.W.	29 94			8	Snow	N.w.byw.	29 64	
	12	Cloudy	N.W.	29 90		24.	12	Storm	N.	29 67	0 20
	9			29 82			9	Snow	N.E.	29 78	
9.	8	Sun-shine		29 51			8	Frost	N. by E.	29 95	
	12	Rain	S.	29 38		25.	12	Fair	E.	29 95	
	9	Snow		29 10	1 20		9		E. by N.	29 97	
10.	8	Frost	S.W.	29 02			8	Sharp	N.E.	29 96	
	12	Thaw	S.	29 00		26.	12	Frost	N. by E.	29 96	
	9	Rain	S. by E.	28 95	0 70		9		N.N.E.	29 86	
11.	8	Cloudy		29 46			8			29 77	
	12	Fair	N.	29 00		27.	12	Frost	N.E.	29 77	
	9			29 77			9			29 74	
12.	8		N.	29 83			8	Cloudy	S.	29 65	
	12	Sleet				28.	12	Frost	N.E.	29 65	
	9						9			29 60	
13.	8						8	Snow	S.	29 47	
	12	Cloudy				29.	12	Thaw	S.W.	29 31	0 08
	9			29 91			9			29 29	
14.	8		N.E.	29 96			8	Frost	S.W.	29 41	
	12	Snow	N.E.	29 96	0 20	30.	12	Fair	W.	29 50	
	9		E.N.E.	29 98			9		W. by S	29 54	
15.	8	Frost	E.N.E.	29 94			8	Frost	W.	29 77	0 05
	12	Cloudy	E.	29 92		31.	12	Fair	N.N.W.	29 86	
	9			29 90			9		N. by W.	29 95	
16.	8	Frost	E.N.E.	29 90						Total	3 61
	12	Cloudy	N.e.b.N.	29 91							
	9			29 94							

XXIII.
The Weather
1697 at Up-
minster in
Essex; by
Mr. Will.
Derham, n.
237. p. 47.

FEBRUARY, 1697.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	7					7		Rain		29 50	
1.	12	Frost				17.	12	Fair	S.	29 52	0 20
	9			30 06		9		Rain		29 52	
	7	Cloudy		30 05		7		Cloudy	S. by E.	29 3	
2.	12		N. E.			18.	12	Blustring	S.	29 20	
	9	Frost		29 95		9		Fair		29 42	
	7	Cloudy		29 75		7		Rain	E. by S.	29 30	
3.	12	Frost	N. E. b. E.	29 60		19.	12		S.	29 33	0 05
	9	Calm	E.	29 50		9		Fair		29 39	
	7	Cloudy		29 30		7			S. E.	29 46	
4.	12	Thaw	E. by S.	29 26	0 02	20.	12	Frost	E. by S.	29 46	
	9	Sleet		29 20		9			E.	29 40	
	7	Snow		29 20		7				29 36	
5.	12	Fair	E.	29 20	0 05	21.	12	Fair	E.	29 37	
	9	Frost		29 19		9				29 45	
	7	Frost	N. by E.	29 05		7		Rain		29 47	
6.	12	Cloudy		29 02	0 03	22.	12		E.	29 48	0 03
	9	Snow	N.	28 90		9		Fair		29 52	
	7	Snow		28 86		7		Hoar-Fr.	E.	29 52	
	12	Cloudy	W. by S.	28 83	0 01	23.	12	Fair	S.	29 54	
	9		S. by W.	28 83		9		Rain	S.	29 60	
	7	Fairer		28 82		7				29 66	
8.	12	Sleet	S. W.	28 84	0 01	24.	12	Fair	S. by W.	29 75	0 04
	9			28 97		9		Rain		29 81	
	7	Thaw		29 10		7		Cloudy		29 84	
9.	12	Frost	S. W.	29 18		25.	12	Blustring	S.	29 85	
	9			29 25		9		Fair		29 88	
	7	Frost	S. W.	29 43		7		Fair	S.	29 88	
10.	12	Fair	S. w. b. w.	29 52		26.	12	Cloudy		29 62	0 10
	9			29 61		9		Rain	S. W.	29 62	
	7	Snow	S. by E.	29 65		7		Misting	S.	29 93	
11.	12	Rain	S. E.	29 70	0 27	27.	12	Fair	S. by W.	29 97	
	9	Fair	E.	29 91		9		Calm	S. S. W.	29 98	
	7	Cloudy	E. by S.	30 08		7		Cloudy		30 01	
12.	12	Frost		30 08		28.	12	Fair	S. W.	30 01	0 03
	9			30 08		9		Cloudy		30 40	
	7	Thaw		30 00							
13.	12	Warm	S.	30 00							
	9	Cloudy		29 95							
	7	Calm	S.	29 88							
14.	12	Rain	S. by W.	29 87	0 40						
	9		S.	29 80							
	7	Mitt	N.	29 85							
15.	12	Warm	N. W.	29 86	0 30						
	9	Rain	E.	29 80							
	7	Cloudy	S. by E.	29 54							
16.	12		W. S. W.	29 62	0 28						
	9	Fair		29 60							
										Total	1 80

MARCH, 1697.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	7	Cloudy		30 15			7	Frost		29 16	
1.	12		S. W.			17.	12		N. W.	29 30	
	9	Fair		30 20			9	Fair		29 32	
	7	Cloudy	W. S. W.	30 18			7	Frost	S.	29 10	
2.	12	Warm	S. W.	30 19		18.	12	Snow	N. W.	29 10	
	9	Spring		30 14			9		W.	29 16	
	7	Fog	S.	30 02			7	Frost	W. by S.	29 27	
3.	12		W.	29 95		19.	12	Fair	N. W.	29 41	
	9	Fair	W. by S.	29 88			9		S. W. b. S.	29 43	
	7	Milt		29 75			7	Frost	S.	29 42	
4.	12	Rain	S. W.	29 69	0 13	20.	12	Snow	S. S. E.	29 37	0 52
	9	Fair		29 65			9	Fair	S. E.	29 25	
	7	Fair	S. W.	29 71			7	Blutring	E. by N.	29 07	
5.	12	Colder		29 70		21.	12	Cloudy	E. by N.	29 10	
	9		S.	29 46			9	Hazy	N. N. E.	29 24	
	7	Rain	S. W.	29 20			7				
6.	12	Blutring	W.	29 12	0 85	22.	12				
	9	Fair		29 21			9				
	7	Fair	W.	29 48			7				
7.	12	Colder	W. by N	29 57		23.	12				
	9	Blutring	W.	29 60			9	Frost	N. E.	29 40	
	9	Frost	N. W.	30 01			7	Frost	N.	29 46	
8.	12		N.	30 11		24.	12		N. N. W.	29 54	
	9	Fair	N. by E.	30 15			9	Fair	N. by E.	29 70	
	7	Frost	E.	30 15			7	Frost	N. by E. 1	29 78	
9.	12		W.	30 14		25.	12		S.	1 30 02	
	9	Fair	S. W.	30 08			9	Fair	S.	0 30 11	
	7	Milt	S. W.	29 95			7	The	E.	0 30 11	
10.	12		S. w. by S.	29 90		26.	12	same	S. e. by E. 1	30 10	
	9	Fair	S. by W.	29 76			9			30 04	
	7	Milt	S.	29 65			7			29 97	
11.	12	Frost	W. by S.	29 64		27.	12	Same	E.	0 29 98	
	9	Cloudy		29 60			9			30 07	
	7	Rain	N. W.	29 47			7	Same	E.	0 30 13	
12.	12	Fair	W. S. W.	29 35		28.	12	Hazy	E.	0 30 15	
	9	Rain	W. by N.	29 21			9		E.	1 30 20	
	7		N. by W.	29 18			7	Cloudy	n. e. b. n. 0	30 14	
13.	12	Rain	N.	29 25	0 32	29.	12	Cold	N. N. e. 1	30 12	
	9		N.	29 35			9			30 12	
	7	Frost	N.	29 59			7	Cloudy	N.	1 30 12	
14.	12	Fair	W.	29 60	0 02	30.	12	Warmer	N. N. E.	30 12	
	9	Cloudy	W.	29 48			9			30 05	
	7	Fair		29 40			7	Cloudy	N.	1 29 96	0 02
15.	12	Blutring	W.	29 48		31.	12		N. by E.	29 88	
	9	Storms		29 28			9	Rain			
	7	Fair		29 04						Total	2 68
16.	12	Hail	W.	29 04	0 82						
	9	Snow		28 93							

APRIL, 1697.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
1. 6	Cloudy		29 83		6		N. b. w. 1	29 96	
1. 12	Warm	N. E. 0	29 83		17. 12	Fair		29 96	
9	Fair		29 84		9		N. 1	29 94	
2. 6		N. 1	29 88		6	Fair	N. 0	29 91	
2. 12	Fair	N. E. 2	29 88		18. 12	Hot	E. N. E.	29 93	
9			29 87		9	Day		29 95	
3. 6	Fair	N. e. b. e. 1	29 83		0			29 93	
3. 12	Want of	E. 1	29 82		19. 12	The	E. 1	29 80	
9	Rain		29 82		9	same		29 80	
4. 6	Misting	N. 0	29 75		6	The	E. 0	29 69	
4. 12	Cloudy				20. 12	same	S. 1	29 60	
9	Fair		29 68		6		S. 0	29 52	
5. 6	Cold		29 68		6	Cloudy	E. by S. 0	29 35	
5. 12	Fair	N. by E.	29 68		21. 12	Fair	E. by S. 1	29 21 0	43
9	Misting		29 74		9	Rain	S. by E. 1	29 10	
6. 6	Frost		29 73		6	Cloudy	E. 1	29 08	
6. 12		E.	29 71		22. 12	Rain	S. 1	29 05 0	30
9	Fair		29 68		9	Fair	S. E. 0	29 15 0	62
7. 6	Frost		29 66		6	Fair	E. 0	29 20	
7. 12	Dry Sea-	E.	29 67		23. 12	Rain	S. by E. 1	29 22 0	06
9	son		29 70		9	Fair	S. E.	29 27	
8. 6	Frost		29 71		6	Rain	S. E. 1	29 31	
8. 12		E.	29 70		24. 12		N. N. W.	29 32 1	24
9	Warmer		29 71		9	Thunder	E.	29 34	
9. 6	Fog	W.	29 66		6	Showers	E. by N.	29 28	
9. 12	Fair	W.	29 64		25. 12		E.	29 27 0	75
9	Cloudy		29 64		9	Fair	E. 0	29 18	
10. 6	Warm	E. 0	29 61		6	Cloudy	S.	29 14 0	65
10. 12	and	E. by S. 1	29 61		26. 12				
9	Fair		29 60		9				
11. 6	Fair	E. 0	29 60		6				
11. 12	Warm	E. 1	29 63		27. 12				
9	Cloudy	N. by E. 2	29 64		9				
12. 6	Fair	N. N. E. 2	29 65		6				
12. 12	Cloudy	N. by E.	29 67		28. 12				
9	Rain		29 70		9				
13. 6	Cloudy		29 72		6				
13. 12	Rain	N. E.		2 38	29. 12				
9			29 78	0 30	9				
14. 6		N. n. e. 0	29 75		6				
14. 12	Fair	E. by N. 0	29 76		30. 12				0 80
9			29 76		9				
15. 6	Fair		29 77						
15. 12	Warm	E. 1	29 77						
9	Spr. Day		29 73						
16. 6	Fair	E. 0	29 73						
16. 12			29 75						
9	Cloudy	N. 0	29 86						
								Total	7 53

M A Y, 1697.

D.	h.	Weather.	Winds.	Barom.	Rain.
	6	Cloudy			
17.	11	Mistling		29 65	3 0
	9	Blustering	S. W.	29 55	
	6	Rain	W.	29 57	
18.	12	Fair	W.b.n.	29 65	0 19
	9			29 74	
	6		W.b.S.	29 79	
19.	12	Fair	E.	29 85	
	9			29 92	
	6	Fair	E.b.N.	29 99	
20.	12		N.	30 02	
	9	Cool	N.b.E.	30 07	
	6	Cloudy	N.	30 08	
21.	12	Cold	N.b.E.	30 08	
	9	Fair	N.b.E.	30 11	
	6	The	N.b.E.	30 07	
22.	12	same	N.b.E.	30 07	
	9		E.	30 02	
	6	Cloudy	E.	29 98	
23.	12	less Cold	N.b.N.	29 93	
	9	Fair	E.b.N.	29 88	
	6	The	N.b.E.	29 85	
24.	12	same			
	9		E.	29 88	
	6	Mist		29 88	
25.	12	Hot and	E.		
	9	Dry		29 85	
	6	The	E.	29 83	
26.	12	same	E. W.	29 80	
	9		E.	29 73	
	6	Fair	N.	29 65	
27.	12	Little	N.	29 65	0 01
	9	Rain		29 75	
	6	Fair	N.	29 82	
28.	12	Warm			
	9		S.	29 74	
	6	Fair	S.	29 79	
29.	12	Hot	E.	29 75	
	9		E.	29 73	
	6	The	E.	29 73	
30.	12	same		29 76	
	9		S.	29 80	
	6	The		29 80	
31.	12	same	S.		
	9			29 75	
				Total	3 80

JUNE, 1697.

D. k.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
1. 6	Fair		29 66		6	Cloudy	N.	29 90	
1. 12	Hot	S. 0			17. 12	Fair	W. 1	29 92	
9	Rain		29 56		9	Sultry	W. 0	29 94	
2. 6	Rain	S. 0	29 42		6	Very	W.b.S. 0	29 98	
12	Shine	S. 1	29 29	0 44	18. 12	drough-	W.b.S. 1	30 00	
9	Rain	S. 1	29 10		9	ty	S.W. 0	30 00	
3. 6	Fair	S.b.W.	29 08	0 79	6	Hot	f.w.bw. 2	29 93	
12		S. 1	29 04		19. 12		W.b.e. 1	29 91	0 22
9	Showers	S. 1	29 02	1 37	9	Rain	N. E. 0	29 93	
4. 6		S. W. 2	29 18		6	Cloudy	N.b.E. 0	29 92	
12	Cloudy		29 38		20. 12			29 92	
9		S. 1	29 58		9	Cooler	N. 1	29 96	
5. 6	Cloudy		29 72		6	Cloudy	N. 0	30 00	
12	Sultry	S.b.W. 1	29 83		21. 12	Much			
9	Hot		29 85		9	cooler	N. E. 1	30 02	
6	Thunder	E. by S.	29 85		6		N. 0	30 01	
12	Rain	E. 0	29 82	1 13	22. 12	Fair	E. 1		
9	Thunder		29 74		9		n.e.b.n.c	29 90	
6	Fog	S. by W.	29 70	0 02	6	Cloudy	N. 0	29 80	
12	Fair	S. W. 1	29 71		23. 12	Rain	E. 1	29 79	
9	Hot	S.w.b.w.	29 72		9	Fair		29 79	
6	Fair	S w.b.w.	29 70		6	Great	n.e.b.e. 1	29 77	
12					24. 12	Drought	E. 1	29 78	0 10
9	Cloudy	S. 0	29 56		9			29 78	
6		S. by E. 0	29 50		6	Cloudy	n.e.b.e. c	29 74	
12	Fair	S. 1	29 48		25. 12	Dry	N. E. 1	29 73	
9	Rain	S. c	29 51		9		E. 1	29 71	
6		S by E. 0	29 60		6	Sultry		29 71	
10. 12	Fair	S.b.W. 1	29 68	0 01	26. 12		E. 0	29 71	0 05
9		S. c	29 75		6	Day		29 73	
6		S. 0	29 75		6	Mist	E. c	29 74	
11. 12	Fair	S. 0	29 65		27. 12	Rain	E. by S.	29 73	0 29
9		E. c	29 65		9	Thunder	S. 0	29 74	
6	Cloudy	N. W. 1	29 60		6	Mist		29 81	
12. 12	Fair	N.w.b.w	29 55		28. 12	Hot and	S. 1	29 83	
9		N.W. 0	29 49		9	Dry		29 86	
6		W. 0	29 40		6	Dry	E. c	29 85	
13. 12	Fair	S. W. 0	29 34		29. 12	Burning	E. 1	29 85	
9		S. W. 0	29 28		9	Day	S. 0	29 87	
6	Fair				6	Fair	S. W. 0	29 88	0 97
14. 12					30. 12			29 88	
9	Rain	E. 0	29 38		9	Rain	S. 1	29 08	0 31
6	Misty	E. 0	29 45						
15. 12	Fair								
9	Hot	N.b w. 4	29 64						
6			29 78						
16. 12	Cloudy	N. 1.		0 01					
9			29 90						
								Total	4 91

JULY, 1697.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
	6	Rain	S. S. W.	29 75			6	Fair	W. b. n. o	29 91	
1.	12		S. W. 1	29 72		17.	12	and	N. o	29 93	
	9	Fair	S. W. o	29 70	o 24		9	Cool	N. N. w o	29 93	
	6		S. W. o	29 67			6	Fair	N. W. 1	29 95	
2.	12	The same	S. W. 1	29 59	o 22	18.	12	Cloudy	N. 1	29 98	
	9		W. b. n. 1	29 64			9	Rain	N. 1	29 98	
	6			29 75			6	Misting	N. 1	29 98	
3.	12	Fair	S. W. o	29 84		19.	12		W. n. w. 1	30 02	o 62
	9						9	Cloudy			
	6	Cloudy	S. o	29 85			6				
4.	12	Fair	S. W. 1	29 85		20.	12	Showry			
	9	Hot	S. W. 1	29 85			9		W. b. S. 1	29 88	
	6	Fair	W. o	29 87			6	Rain	W. f. w. 1	29 75	
5.	12	Cool	W. 1	29 90		21.	12	Fair	W. b. n. 1	29 11	
	9	Breezes	W. o	29 95			9	Misting	W. 1	29 60	
	6	Hot	W. b. S. 1	29 91			6	Misty	S. w. b. w.	29 48	
6.	12	Dry		29 90		22.	12	Rain	S. W. b. S.	29 50	o 43
	9	Day	W. b. n. o	29 86			9	Fair	S. b. W. o	29 50	
	6	Fair	W. b. S. o	29 79	o 12	23.	12	Cool	S. 1	29 48	
7.	12	Hot	S. w. 1	29 68			9	Day	S. o	29 48	
	9	Rain	S. W. 2	29 60			6	Fair Thun	S. 1	29 50	
	6	Misting	S. S. W. 1	29 44	o 32	24.	12	great Sh.	W. & N.	29 56	
8.	12	Rain	S. W. 1	29 42	o 75		9	with Hail.	& S.	29 60	1 02
	9	Cloudy	S. W. 1	29 43			6	Fair	W. o	29 65	
	6	Rain	w. n. w. o	29 47	o 77	25.	12	Pleasant	N. W. 1	29 72	
9.	12	Cool	W. b. n. o	29 58			9	Day	W. S. w. o	29 77	
	9	Fairer	W. 1	29 71			6	Fair		29 76	
	6	Fair	n. w. b. w.	29 83		26.	12	Cloudy	W. b. S. o	29 76	
10.	12	and		29 85			9	Misting		29 69	
	9	Cool	S. W. 1	29 85			6	Cloudy	S. b. W. o	29 63	
	6	Rain		29 93	o 50	27.	12	and	S. e. f. b. w.	29 60	
11.	12	Warmer	S. W. 1	29 93			9	Cool	E. b. N. 1	29 60	
	9		S. w. b. w.	30 00			6		N. N. e. 2	29 58	
	6					28.	12	The same	E. b. N. 2	29 62	
12.	12						9			29 69	
	6	Fair					6	Fair	N. 1	29 70	
13.	12	and	S. o	29 98		29.	12	Cool	N. 2	29 76	
	9	Hot	S. o	29 90			9	Day		29 90	
	6	Fair	S. b. W. 1	29 88			6		N. b. w. o	29 77	
14.	12		S. W. 1	29 84		30.	12	The same	W. b. n. 1	30 00	
	9	Cloudy					9			30 00	
	6	Rain	N. b. w. 1	29 84			6	Cloudy	S. b. E. 1	29 90	o 20
15.	12	Cloudy	W. 1	29 85	o 48	31.	12	Warmer	S. S. E. 1	29 86	
	9	Fair	N. W. o	29 90			9	Rain	S. 1	29 79	
	6	Cooler	W. 1	29 95							
16.	12	Rain	n. w. b. w.	29 94							
	9	Thunder		29 92	o 42						
										Total	6 05

AUGUST, 1697.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	6	Cloudy	S.b.E. 1	29 73			6		S. 0	29 48	
1.	12	Cloudy	S.b.E. 1	29 72		17.	12				
	9	Rain	S.b.F. 2	29 65			9				
	6	Fair	S.b.E. 0	29 63	0 51		6				
2.	12	Showers	W.b.S. 1	29 65		18.	12				
	9	Fair		29 68	0 40		9				
	6	Rain	S.by E. 2	29 19			6				
3.	12	Cloudy	W. 3	29 71		19.	12				
	9	Fair		29 78	0 05		9				
	6	Rain	S.w.b.f. 1	29 69			6	Fair, great	S.b.W. 2		
4.	12	Fairer	S.b.W. 2	29 65		20.	12	Storm Thun-			
	9	Rain	W. 1	29 60	1 00		6	der Rain.		29 60	1 88
	6	Rain					6	Cloudy		29 60	
5.	12	Fairer	S. W. 2	29 50		21.	12	Rain	S. 1	29 60	
	9	Fairer	S. W. 1	29 49	0 79		9	Cloudy		29 61	0 13
	6	The	S.b.W. 0	29 47			6	Cloudy	W.b.S. 0	29 74	
6.	12	fame	S. 1	29 48		22.	12	Misling	W. 1	29 84	
	9			29 49	0 22		9	Fair	W. 1	29 90	
	6	Cloudy	S.b.E. 0	29 51			6	Fair	W.b.S. 0	29 92	
7.	12	Rain	E.b.N. 1	29 55		23.	12	Cloudy	W.b.S. 2	29 88	
	9	Fairer	E.N.E. 1	29 58	0 07		9	Cloudy	S. W. 2	29 84	
	6		N. 2	29 50			6	Fair		29 83	
8.	12	Rain	N. 1	29 48	0 00	24.	12	Sultry	S. W. 1		
	9	both	N. 2	29 39	0 91		9	Cloudy		29 78	
	6		W. 2	29 37			6	Cloudy	S.w.b.f. 1	29 70	
9.	12	Days	W.b.S. 1	29 42	0 50	25.	12	Fair	S.w.b.f. 2	29 67	
	9			29 42	2 20		9	Fair	S b W. 2	29 54	
	6	Cloudy	W. 1	29 60	0 39		6	Rain	S. 3	29 21	
10.	12	Rain	N.W. 2	29 66		26.	12	Fair	W.b.S. 3	29 31	
	9	Fairer	N. 1	29 75	0 07		9	Fair		29 54	0 53
	6	Fair	W. 0	29 77			6		S. W. 1	29 81	
11.	12	Pleasant	W. 1	29 80		27.	12	Fair	W.b.S. 2	29 93	
	9	Day	W.n.w. 1	29 82			9			29 98	
	6	Cloudy	W.b.n. 0	29 82			6		S.S.W. c	29 94	
12.	12	Fair	W.b.n. 0	29 82		28.	12	Fair	S.S.W. 2	29 94	
	9		N. 0	29 85			9			29 90	
	6	Mist	N. 0	29 88			6	Cloudy	S. W. c	29 95	
13.	12	Cloudy	W.b.S. 1	29 89		29.	12	Sultry	E. 0	29 99	
	9	Rain	S.b.W. 1	29 83	0 33		9	Very l.		30 03	
	6	Cloudy	S. W. 2	29 75			6		N. E. c	30 03	
14.	12	Fair	W. 2	29 83		30.	12	Fair			
	9		W. 2	29 88			9				
	6	Cloudy	S.W. 1	29 84			6	Fair			
15.	12	Little	W.b.S. 2	29 81		31.	12	and			
	9	Rain	S.w.b.w. 1	29 75			9	Sharp Air		30 01	
	6	Cloudy		29 70							
16.	12	Fair	S. 1	29 62							
	9	Cloudy		29 53							
										Total	13 98

SEPTEMBER, 1697.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
	6	Fair	E.b.N. 1	29 98			6	Fair	W. 1	29 45	
1.	12		N. E. 2	30 00		17.	12	Cool			
	9	Cool		30 9 ^h			9		0	29 75	
	6		N.e.N. 3	29 93			6		E.byS. 0	29 55	
2.	12	The	N. E. 2	29 92		18.	12	Rain	S.S.W. 2	29 34	3 10
	9	fame		29 90			9		S. W. 2	29 10	1 60
	6	Hot Sun	E.byN. 0	29 88			6	Fair	W.b.n. 0	29 38	
3.	12	but	E. 1	29 89		19.	12	Cloudy	S. W. 1	29 50	
	9	Cool Air	E. 1	29 89			9	Rain	S. 1	29 32	0 56
	6	Fair	E. 0	29 84			6	Rain	S. W. 3	29 05	
4.	12	Warmer	E. 2	29 84		20.	12		W.f.w. 3	29 02	
	9	Air		29 80			9	Fair	3	29 21	0 14
	6	Fair	E. 1	29 78			6	Cloudy	W f.w. 3	29 35	
5.	12		E. 0	29 80		21.	12	Rain	S. 1	29 31	
	9	Hot		29 83			9	Cold	S. W. 1	29 98	
	6	Mitt	E. 0	29 83			6	Fair	S. W. 2	29 24	
6.	12	Fair	S.b.E. 0	29 86		22.	12	Shower			
	9	Hot		29 87			9			29 38	0 09
	6		S. 0	29 85			6	Fair	S. W. 1	29 51	
7.	12	The	E. 2	29 83		23.	12				
	9	fame	E. 0	29 80			9	Rain	W.N.w. 2	29 74	
	6		E. 0	29 73			6		S. W. 0	29 87	
8.	12	The				24.	12	Fair	N.		
	9	fame		29 70			9	Rain		29 87	
	6	Fair	E.b.N. 1	29 68			6		E. 0	29 66	0 08
9.	12		E.b.N. 2	29 66		25.	12	Cloudy	S. E. 2		
	9	Cooler		29 56			9	Misting		29 38	0 30
	6	Cloudy	E. 1	29 43			6	Fair	N. E. 0	29 38	
10.	12		S. 2	29 39		26.	12	Rain	E. 1	29 40	
	9	Rain		29 40	0 10		9	Cold		29 30	0 24
	6		S.b.E. 0	29 38			6	Fair	E. 0	29 27	
11.	12	Showers	W.S.w. 1	29 40		27.	12	Cloudy	E.byN. 1	29 25	
	9			29 60	1 59		9	Rain		29 30	0 84
	6	Fair	S. 0	29 76	0 07		6	Fair	N. E. 1	29 38	
12.	12		S.b.w. 2	29 77		28.	12	Cold	N.byE 3		
	9	Cloudy		29 70			9	Day		29 56	
	6	Rain	S. 2	29 49			6	Hoar-Fro.	N.byw. 1	29 65	
13.	12		S. 3	29 38		29.	12		N.byw. 1	29 70	
	9	Fair		29 63	1 54		9	Fair		29 78	
	6		S. 0	29 67			6	Ice	N.byw. 0	29 80	
14.	12	Rain	S. 2	29 50		30.	12	Fair		29 82	
	9		S. 4	29 32	3		9	Cloudy		29 83	0 22
	6	Fair	S. W. 1	29 46						Total	10 47
15.	12			29 30							
	9	Rain		29 30							
	6	Fair	S. W. 4	29 28							
16.	12	Cool	W.b.S. 6	29 32							
	9	Cloudy		29 34							

OCTOBER, 1897.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
1.	7	Cloudy	N. W. c	29 79		17.	7	Same	N.b.w. o	30 27	
	12	Misty	S. 1				12	Same	N.b.E. 1	30 30	
	9	Warm	S. o	29 78			9			30 34	
2.	7	Rain	S. o	29 77	o 10	18.	7	Cloudy	N.byE. o	30 32	
	12	Cloudy	S.b.E. o	29 75			12	Fair		30 33	
	9	Warm		29 70			9	Colder	E.byS. o	30 27	
3.	7	Cloudy	S.b.E. o	29 51		19.	7	Hoar-Fro.	S. W. o	30 22	
	12	Rain	S. 1	29 40			12	Mist	N.byE. o	30 28	
	9	Rain		29 31	o 72		9	Fair		30 30	
4.	7	Fair	S.w.bw. 1	29 50		20.	7	Fog-Fr.	N. W.	30 28	
	12	Cold	S. W. 2	29 52			12	Cool	S. W.	30 26	
	9	Rain		29 28			9			30 23	
5.	7	Rain	S. 4	29 00	1 12	21.	7	Cloudy	W.S.w. 1	30 15	
	12	Rain	S.b.w. 2	28 9 ^s			12	Fair	W.b.S. 1	30 10	
	9			29 13	o 57		9			30 20	
6.	7	Rain	S. 1	29 10		22.	7	Fog	W.b.S. o	30 25	
	12	Stormy	E. & W.	29 07			12	Fog	S. W. o	30 25	
	9	Fairer	S. & 6	29 2 ^s	1 30		9			30 25	
7.	7	Rain	S.b.E. 1	29 08		23.	7	Cloudy	S. S. W.	30 22	
	12	Fair	N. 1	29 13			12	Fair		30 15	
	9	Fair	W. 1	29 51	2 52		9	Cloudy		30 15	
8.	7	Rain	S. 2	29 61		24.	7	Cloudy	S. W. o	30 06	
	12	Cloudy	S. W. 4	29 64	o 10		12	and			
	9	Stormy	5	29 44			9	Warm		29 94	
9.	7	Stormy	S. W. 8	29 39		25.	7	Same	S. W. 2	29 80	
	12	Cloudy	W.f.w. 4	29 51			12	Same	W.S.w. 2	29 78	
	9	Fairer Fair	2	29 66			9			29 74	
10.	7	Fair	S.w.bw. c	29 88		26.	7	Cloudy	S. W. 2	29 60	
	12	and	W.b.S. c	30 00			12	Warm	S. W. 6	29 52	
	9	Pleasant		30 15			9	Rain		29 27	
11.	7	Frost	W.b.S. o	30 20		27.	7	Fair	S. W. 2	29 37	1 52
	12	and		30 21			12	Rain	S.w.bw 5	29 34	
	9	Misty	S. W. c	30 18			9	Stormy		29 80	o 21
12.	7	Frost	S.w.bw c	30 17		28.	7	Frost	S. W. o	30 00	
	12	Fair					12	Fair			
	9	Fair					9	Rain		29 89	
13.	7	Fair				29.	7	Warm	S. W. 4	29 78	
	12	Fair	W. 1	30 20			12	Small			o 02
	9						9	Showers		3 29 74	
14.	7	Fair	W.b.S. c	30 18		30.	7	Cloudy	W byS. 5	29 48	
	12	and	W.n.w. c	30 18			12	Fair	W. 6	29 54	
	9	Warm		30 16			9	Fair		29 75	
15.	7	Cloudy	W.b.S. c	30 12		31.	7	Fair	N. o	30 04	o 01
	12	Warm	N. W. c	30 12			12	and	N. E. 2	30 17	
	9	Misting		30 10			9	Cool		30 26	
16.	7	Cloudy	W. c	30 00							
	12	Fair	N.n.w. 2	30 08	o 14						
	9	Cold	N.byW. 3	30 20							
										Total	8 39

NOVEMBER, 1697.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
1.	8	Misting	S.	30 19		17.	8	Same	N.b.w. 2	30 03	
	9	Misty		30 15			9		N.b.w. 3	30 02	
2.	8	Fair	S.S.W. c	30 11		18.	8	Same	N.n.w. 1	29 92	
	9	Warm Pleasant	W.b.S. c	30 07			9		N.n.w. c	29 76	
3.	8	Fair	W. o	30 04		19.	8	Snow	S.S.w. 2	29 26	
	9	Colder Fog	W.b.S. o	29 99			9	Sleet		28 83	20
4.	8	Cloudy	S.w.b f. o	29 94		20.	8	Cloudy	N.b.w. 2	82	
	9	Cold Day		29 81			9	Sleet	N b.w. 3	82	
5.	8	Rain	S. W. 2	29 73	50		9	Cold		30 93	01
	9	Fair	W.b.S. 2	29 75		21.	8	Cloudy	N. W. 2	28 93	
6.	8	Rain	W b n. 1	29 87			9	Snow	W.b.r. 1	28 90	18
	9	Fair		30 00		22.	8	Frost	N. c	28 95	
7.	8	Cold	E. c	29 93			9	Fair	N. 1	28 98	09
	9	Cloudy Day	E.S.E. c	29 91		23.	8	Sleet		28 09	
8.	8	Frost	E.byS. c	29 90			9	Frost	N. W. 2	29 11	13
	9	Fair	E.S.E. c	29 99		24.	8	Snow			
9.	8	Hard		30 10			9	Fair		29 36	
	9	Frost	E. c	30 10		25.	8	Hard	S. c	29 36	
10.	8	Cloudy	N. E. c	30 08			9	Frost	S. 1	29 37	
	9	Frost		30 04			9	Dripping		29 35	
11.	8	Rain	W.b.S 1	29 73		26.	8	Rain	S.e.b.S. 2	29 21	01
	9	Fairer	N. 2	29 72	78		9	Fairer	S. E. 2	29 08	
12.	8	Rain	N.b.w. 2	29 70	02		9	Rain		29 00	33
	9	Frost	N. 1	68		27.	8	Fair	S.b.W. c	29 11	20
13.	8	Rain	N. 1	29 63			9	Thaw	S. 1	29 18	
	9	Cloudy		29 62	09		9	Rain		29 00	
14.	8	Snow	N. E. 2	29 40	82	28.	8	Cloudy	S. o		41
	9	Sleet all Day	N. 1	29 38			9	Warmer		29 10	
15.	8	Frost	W.b.S. o	29 64			9	Rain		29 10	
	9	Frost		29 56		29.	8	Frost	S.S.w. c	29 15	18
16.	8	Hard Frost					9	Fair		29 19	
	9	Fair	N.b.w. 2	29 04		30.	8	Small Fr. and	W. 1	29 40	
							9	Fair	W.b.n. 1	29 54	
										29 77	03
										Total	5 63

DECEMBER, 1697.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	8	Hard	W.b.n. 0	29 86			8	Frost		29 57	
1.	12	Frost &	W.b.n. 2	29 87		17.	12	Cloudy	E. 0	29 56	
	9	Fair		29 89			9	Fairer		29 62	
	8		N. 1	29 90			8			29 64	
2.	12	Same	N. 0	29 94		18.	12	Mist	E. 0		
	9			29 99			9			29 72	
	8		N. 0	30 05			8	Cloudy		29 70	
3.	12	Same	N.N.E. 0	30 08		19.	12	Warm	E. 1	29 68	
	9			30 06			9	Day		29 63	
	8	Cloudy	N.W. 1	29 97			8	Fog	N.W. 2	29 50	
4.	12	Snow	W.n.w 1	29 89		20.	12	Cloudy			
	9	half Inch		29 96			9	Colder		29 44	
	8	Cloudy	N.b.E. 2	30 00			8	Rain		29 45	0 23
5.	12	Fair	N.N.E. 1	30 06		21.	12	Cloudy	E. 1	29 51	
	9			30 09			9	Cold		29 62	0 17
	8	Snow	N.w.b.n. 3	29 98			8	Rain		29 75	0 02
6.	12	Fair	N.w.b.n. 1	29 99		22.	12	Cloudy	E. 1		
	9	Sn. 1 inch		29 00			9	Fair		29 90	
	8	Snow 6	N. W. c	29 93			8		S.by E. 1	29 83	
7.	12	Snow 8	S. c	29 71		23.	12	Cloudy	S. 1	29 76	
	9	Inches		29 68			9			29 64	
	8			29 84			8		S.by W. 2	29 52	0 40
8.	12	Fair	E. 0	29 87		24.	12	Rain	S. 2	29 40	
	9			29 85			9	Stormy		29 34	0 56
	8	Snow		29 64			8	Fair	W. 3	29 25	
9.	12	Sleet	S.by E. 1	29 55		25.	12	and	S.W. 2	29 40	
	9	Thaw		29 42			9	Warm		29 61	0 03
	8	Frost	E.N.E. 0	29 55			8	Cloudy	W.S.w. 2	29 62	
10.	12	Thaw	E. 0	29 57	3 62	26.	12	Fair	W.b.S. 2	29 70	
	9	Snow		29 45			9	Warm		29 87	
	8	Rain	E.S.E. 2	29 09	2 76		8	Cloudy	W.S.w. 2	29 90	
11.	12	Warm	S.b.W. 1	29 10		27.	12				
	9	Thaw		29 24	0 90		9	Misting		29 82	
	8	Thaw	S.by E. 2	29 14			8	Cloudy	S.by W. 0	29 66	
12.	12		S. 2	29 04		28.	12	Rain	W.b.S. 3	29 56	
	9	Rain		29 11	0 42		9	Fair		29 75	0 08
	8	Fair	S. W. 3	29 33			8	Fair	W. 2	29 90	
13.	12	Warm	W.S.w. 3	29 50		29.	12	Cloudy	W.b.n. 2	29 97	
	9	Pleasant	S. W. 1	29 61			9	Rain		29 97	
	8	Cloudy	S. W. 1	29 68			8	Fair	N. E. 1	30 10	0 05
14.	12	Warm	W.S.w. 1	29 57		30.	12	Cloudy	N. E. 1	30 15	
	9	Day	W.S.w. 0	29 65			9	Fair		30 20	
	8	Misty	E. 1	29 64			8	Frost	E. 0	30 18	0 01
15.	12	Warm	N.by E. 0	29 64		31.	12	Cloudy	E.by S. c	30 15	
	9	Day		29 65			9	Fair		30 08	
	8	Frost								Total	9 31
16.	12	Fair	E.b.N. 1	29 58							
	9			29 59							

In this Table, the Quantity of Rain, which fell through a Tunnel of twelve Inches Diameter, is set down in Pounds and Centesimals; and I measured it with a Cylindrical Glass, after Mr. Townley's Method.

Where only one sort of Weather is noted upon one Day, that was the Weather of all the Day; especially if the Barometer be noted three times. The same observe also in the Column of Winds.

In the Column of Winds, 0 signifies a Calm; 1, 2, 3, &c. denotes the Strength of the Wind: wherefore 5, or 6, is a little Storm; 7, or 8, a great Storm.

I have noted in the Column of Weather, the Depth of the Snow upon the Ground.

The whole Quantity of Rain that fell through my Tunnel last Year, was 77,60 l. which is less than fell from the Beginning of *March* (at which time I began my Rain Observations) till the End of *December*, 1696. In which ten Months there fell here, at *Upminster*, almost 115 l. and at *Townley* in *Lancashire* (according to Mr. Townley's Observations) above 172 l. and in the whole Year at *Townley* 203,76 l.

XXIV. The Quantity of Rain which fell through my Tunnel this Year, 1698, was 122,32 Pounds. I find foggy Weather makes the Mercury rise, as well as the North Wind; as may be observed in the following Table, in the Month of *December*, at which Time the Mercury was very high, although the Wind was in the Southerly Points. I submit it, whether the Cause be not the Increase of the Weight of the Atmosphere, by an Addition of those Vapours of which the Fog consists, which are manifestly as heavy as the Air, because they swim in it without ascending. These filling up many of the Vacuities of the Air, without extruding much the Parts of Air (as I judge Clouds do) do add considerably to the Weight of the Atmosphere, and so cause the Mercury to ascend.

The Weather
1698, at
Upminster;
by Mr. Will.
Derham, n.
249. p. 45.

The greatest Range I have ever observed the Mercury to have, is no more than 2,12 Inches; it being here never higher than 30,40 nor lower than 28,28 Inches. The lowest it ever was, within my Observations, was *Jan.* 24, about two of the Clock in the Afternoon; about which Hour Mr. Townley observed his Barometer to fall to 27,80 Inches, which, he says, was remarkably low.

Faint grid lines and text are visible, likely representing a table or data points related to the weather observations mentioned in the text.

JANUARY, 1698.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
1.	8	Frost	S. E. 0	29 95		17.	8	Sn. with	N. W. 0	29 57	
	12	Fair	S. by E. 1	29 90			17.	the former	E. i. n e. 2	29 60	
	9	Hard Fr.		29 82			9	5 Inches	N. by E. 1	29 65	
2.	8	Cloudy	S. by E. 1	29 63			8	Little	N. 1	29 68	
	12	Frost	S. by E. 2	29 48		18.	12	snow very	N. 2	29 69	
	9	Snow		29 26			9	Cold	N. by E. 2	29 71	
3.	8	Snow	W. by S. 0	29 15			8	Sn. 2 Inc.	E. 0	29 62	
	12	1 Inch.				19.	12	more, Clo.	E. by S. 2	29 59	
	9	Rain		28 64	55		9	all Day		29 59	
4.	8	Rain, Sleet	E. 0	28 80	99		8	Cloudy	E. by N. 3	29 65	
	12	Sn. 4 Inch.	E. 0	28 88		20.	12	very cold	E. by N. 3	29 70	
	9	Cloudy		29 18	98		9	Day		29 84	
5.	8	Frost	W. 0	29 44	20		8	Hard Fro	E. by N. 2	29 90	
	12	Fair	W. S. w. 1	29 53		21.	12	and Cloud.	E. by N. 2	29 95	
	9	Cloudy		29 64	33		9	as before		29 95	
6.	8	Rain	E. 1	29 49	20		8	Fairer	E. by S. 0	29 82	
	12	Fair	E. by N. 1	29 50		22.	12	very	E. 1	29 68	
	9	Cloudy		29 78	23		9	Cold	E. 3	29 30	
7.	8	Frost	N. b. W. 1	29 98			8	Sn. 5 Inch	E. by N. 0	29 00	
	12	Fair	N. 1	30 04		23.	12	Cloudy	N. E. 1	29 00	
	9	Showers		30 14			9	Snow. Day		29 07	
8.	8	Frost	N. by E. 1	30 18			8	Sn. 3 Inch.	E. b. S. 1	28 73	
	12	Showers of	N. N. E. 2	30 18		24.	12	Sleet	S. E. 2	28 28	
	9	Snow		30 16			9	Thaw	S. W. 1	28 31	07
9.	8	Cloudy	N. E. 2	30 07			8	Thaw	S. 2	28 38	30
	12	Cold	N. e. b. n. 2	30 04		25.	12	Showers of S.		28 40	
	9	Day		30 00			9	Rain		28 56	32
10.	8	Frost	N. E. 1	29 90			8	Rain	S. 0	28 72	28
	12	Cloudy		29 89		26.	12	Thaw with		28 94	06
	9	Day					9	Showers			
11.	8	Same	N. E. 0				8	Fairer	S. by W. 0	29 03	00
	12	but less		29 79		27.	12	Rain	S. b. E. 1	29 00	
	9	Cold		29 73			9	Rain		28 81	39
12.	8	Cloudy	N. E. 0	29 61			8	Frost and	W. b. S. 0	28 98	14
	12	Fairer	S. b. W. 1	29 53		28.	12	Fair	S. S W. 1	28 88	
	9	Fair		29 31			9	Rain	S. e. b. f. 1	28 68	28
13.	8	Frost	S. 0	29 21			8	Same	S. W. 2	28 90	
	12	Fair		29 18		29.	12	with Bluff.	S. S. E. 4	28 67	
	9	Snow	W. 0	29 11			9	Snow		28 53	76
14.	8	Sn. 3 Inch.	N. n. w. 1	29 23			8	Frost	W. b. S. 1	28 92	48
	12	Cloudy	N. n. w. 1	29 29		30.	12	Fair, plea-	W. 2	29 06	
	9	Fair	N. 1	29 40			9	sant Day		29 51	
15.	8	Hard	N. b. W. 1	29 52			8	Fair	N. W. 0	29 70	30
	12	Frost	N. 1	29 65		31.	12	Wet Af-	S. W. 1	29 71	
	9	Fair	N. 0	29 79			9	ternoon		29 58	
16.	8	Same	N. b. W. 0	29 77							Total 10 9.
	9		N. 0	29 74							

FEBRUARY, 1698.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
1.	7	Misting	S. W. 2	29 48		17.	7	Cloudy	E. by N. 2	29 42	
	9	Warm					9	Cold	E. by N. 1	29 38	
2.	7	Fair				18.	7	Fairer Cl.	E. 0	29 46	0 14
	9	Misting	4	29 11			9	Rain	E. by N. 1	29 50	
3.	7	Fair	W. by S. 3	23 97	0 34	19.	7	Cloudy	E. 2	29 51	0 15
	9	Cloudy	W. S. W. 4	29 06			9	Rain	E. by N. 2	29 55	
4.	7	Frost	S. W. 0	29 36		20.	7	Fairer	E. by N. 2	29 68	
	9	Pleasant	W. 1	29 42			9	Freezing	E. by N. 3	29 71	
5.	7	The same	N. 1	29 80		21.	7	Frost	E. by N. 1	29 81	
	9		N. E. 1	30 06			9	Pleasant	E. by N. 2	29 84	
6.	7	Frost and	E. b. N. 1	30 08		22.	7	Same	N. E. 0	29 85	
	9	Cloudy	E. 1	30 08			9		E. by N. 1	29 88	
7.	7	Frost	E. b. N. 0	30 01		23.	7	Frost and	E. by N. 0	29 94	
	9	Warm	W. 1	29 96			9	Cl. warm	E. 1	30 00	
8.	7	Frost	E. b. N. 0	29 88		24.	7	Cloudy	E. 0	29 96	
	9	Cooler	E. 0	29 89			9	Fair	E. 1	29 97	
9.	7	Same	E. by N. 0	29 83		25.	7	Milt Frost	E. by N. 0	29 95	
	9		E. N. E. 1	29 84			9	Warmer	E. 0	29 95	
10.	7	Cloudy	N. E. 1	29 99		26.	7	Frost	E. 0	29 88	
	9	Fair	N. E. 2	30 02			9	Cloudy	E. 1	29 88	
11.	7	Frost and	N. E. 1	30 08		27.	7	Fr. & Fair	E. 0	29 79	
	9	Fair	E. by N. 2	08			9	Cloudy	E. 1	29 78	
12.	7	Fair Cl.	N. E. 1	30 11		28.	7	Rain	S. W.	29 70	
	9	Frost	E. N. E. 1	29 90			9	Thaw	S. W. bl. 1	29 00	0 24
13.	7	Frost Cl.	N. E. 2	29 87							
	9	Cold	2	29 85							
14.	7	Snow	E. N. E. 3	29 84							
	9		N. E. 4	29 86							
15.	7	Snow half	N. E. 3	29 86							
	9	Cold	N. e. bn. 4	29 81							
16.	7	Snow one	N. e. be.	29 63							
	9	Cold	E. N. E. 3	29 56							
				29 53							
										Total	1 31

MARCH, 1698.

D. b.	Weather.	Winds.	Barom.	Rain.	D. b.	Weather.	Winds.	Barom.	Rain.
6	Fair				6		S. W. 1	29 80	
1. 12	warm and Pleasant				17. 12	Same	S. W. 2	29 68	
9			29 60		9	Rain	S. b. W. 3	29 43	
6	Fair	S. S. E. 0	29 39		6	Fairer	W. b. S. 4	29 24	0 23
2. 12	Warm	S. b. w. 1	29 38		18. 12	Hail and Cooler	W. b. S. 7	29 35	
9	Rain	n. w. b. w. 1	29 60	0 32	9		1	29 50	0 09
6		N. W. 1	29 74		6	Hoar-Fr.	S. W. 0	29 60	
3. 12	Cloudy	N. 2			19. 12	Fair	W. 2	29 74	
9			30 00		9	Rain	0	29 78	
6	Cloudy	N. 1	30 05		6	Cloudy	w. f. b. w. 2	29 76	0 01
4. 12	Colder Day	N. b. E. 2	30 10		20. 12		S. W. 3	29 78	
9			30 19		9	Warmer		29 78	
6	Cloudy	N. E. 1	30 16		6		S. S. W. 2	29 68	
5. 12	Cold Winds	E. by N. 2	30 10		21. 12	Same	S. W. 3		
9			30 05		9			29 58	
6	Frost	N. E. 0	29 92		6	Cloudy	S. S. W. 1	29 59	
5. 12		N. E. 1	29 90		22. 12		W. 1	29 73	
9	Fair		29 83		9	Fair	N. W. 0	29 98	
6	Frost	N. E. 2	29 72		6	Frost	N. b. w. 0	30 11	
7. 12	Cloudy Cold	N. a. s. e. 3	29 74		23. 12	Fair and Pleasant	S. 1	30 14	
9			29 74		9		S. W. 0	30 14	
6	Frost	N. E. 0	29 70		6		S. b. E. 0	30 09	
3. 12	Cloudy Warmer	N. e. b. e. 1	29 71		24. 12	Same	E. by S. 1	30 08	
9			29 80		9			30 00	
6	fr. fair & shp	S. e. b. e. 0	29 81		6	Frost	E. by N. 0	29 90	
7. 12	Snow Rain	S. 1	29 76		25. 12	Fair	E. 1	29 88	
9			29 68		9	Fair		29 83	
6	Cloudy	S. 0	29 51	1 49	6	Fair very	E. 0	29 77	0 38
10. 12	Showers	W. 2	29 54		26. 12	Warm	E. b. S. 1	29 77	
9	Fair		29 71	0 10	9	Lightning		29 71	
6	Showers	S. 1	29 63		6	Misty	S. W. 0	29 73	
11. 12		S. S. W. 2	29 42		27. 12	Fair	S. 1	29 75	
9	Fairer	S. W. 2	29 61	0 70	9	Cloudy		29 60	
6	Rain	S. S. W. 3	29 42	0 20	6	Rain	S. 2	29 42	0 28
12. 12	Warm	S. W. 5	29 35		28. 12	Cloudy	S. b. W. 4	29 34	
9	Showers	S. W. 3	29 39	0 98	9	Cooler		29 46	0 05
6		S. w. b. w. 2	29 63		6	Fair	W. S. w. 1	29 63	
13. 12	Fair	S. w. b. w. 2	29 69		29. 12		W. b. S. 2	29 70	
9		W. S. w. 2	29 78		9	Showers		29 79	0 06
6	Warm	S. w. b. w. 2	29 74		6	Hoar	S. 0	29 70	
14. 12	Cloudy Day	S. w. b. w. 4	29 74		30. 12	Frost	S. W. 3	29 59	
9			29 84		9	Rain		29 46	0 34
6		S. W. 2	29 87		6	Rain	E. by N. 0	29 30	2 52
15. 12	Same	S. W. 3	29 89		31. 12	Rain	N. 2	29 49	1 52
9		W. by S. 2	29 95		9	Fairer		29 72	9 33
6		W. S. w. 2	30 02					Total	9 33
16. 12	Same								
9			30 03						

APRIL, 1698.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
1.	6		S. by E. 0	29 68		17.	6	Fair	N. b. w. 2	29 87	
	12	Rain	S. S. W. 1	29 48			12	and	N. 2	29 88	
	9			29 26	1 47		9	Cold	N. b. E. 1	29 92	
2.	6	Cloudy	W. S. w. 2	29 27	0 11				N. b. w. 1	29 90	
	12		W. n. w. 3	29 40		18.	6				
	9	Fair		29 57			9				
3.	6	Hoar-Pr.	S. W. 0	29 62			6	Cloudy			
	12	Fair	W. 1	29 71		19.	12	Warm	N. 1	29 88	
	9	Rain		29 83	0 26		9	Rain		29 90	
4.	6		E. b. N. 0	29 90	0 03		6	Cloudy	W. 1	29 80	
	12	Fair	N. E. 1	29 95		20.	12	Rain	W. S. w. 2	29 68	0 44
	9			30 00			9			29 42	
5.	6		N. N. E. 1	29 97			6	Fair and	W. 2	29 28	0 37
	12	Same				21.	12	old	W. b. n. 2	29 30	
	9						9	cloudy		29 26	
6.	6						6	Rain	N. 3	29 34	0 19
	12	Cloudy		29 88		22.	12	snow	N. n. w. 3	29 43	
	9						9	Fair		29 44	0 3
7.	6	Fair	N. N. E. 0	29 94			6	Ice, very	E. S. E. 1	29 32	
	12		E. 2	29 91		23.	12	Cold	S. E. 2	29 29	
	9	Cloudy		29 79			9	Rain		29 28	0 58
8.	6		S. b. W. 2	29 65			6	Misting	E. b. S. 0	29 31	
	12	Showers	N. W. 2	29 71		24.	12	Warmer	E. 1	29 46	
	9			29 83	0 22		9	Fair		29 68	
9.	6	Hoar-Pr.	S. W. 0	29 83			6	Showers	S. W. 1	29 70	
	12	Cloudy	S. W. 2	29 82		25.	12		W. 2		
	9	Fair	S. 0	29 81			9	Fair		29 83	0 42
10.	6		S. b. W. 2	29 75			6	Fair	W. 2	29 83	
	12	Cloudy	S. S. w. 2	29 67		26.	12	Hail	W. 3	29 80	
	9			29 64			9	Showers		29 63	
11.	6	Fair	S. W. 1	29 66			6	Snow	W. b. S. 2	29 56	0 89
	12	with				27.	12	sleet	W. 3	29 56	
	9	Showers	W. b. S. 2	29 56	0 11		9	Fairer		29 62	0 48
12.	6	Fair and	W. b. S. 1	29 60			6	Showers	N. W. 1	29 70	0 20
	12	Cool		29 68		28.	12	of hail	N. b. w. 2	29 73	
	9		S. 0	29 70			9	and Rain		29 83	0 31
13.	6	Cloudy	S. 1	29 08			6	Cold	n. w. bn. 1	29 84	
	12	Warm	S. S. W. 1	29 66		29.	12	Showers	N. W. 2	29 86	
	9	Rain	W. b. S. 0	29 62						29 81	0 43
14.	6		W. b. n. 1	29 68	0 14		6		N. r. w. 1	29 78	0 09
	12	Fair				30.	12	Rain	N. n. E. 1	29 78	
	9	Showers		29 80	0 06		9			29 80	0 25
15.	6	Cloudy	W. b. S. 2	29 50							
	12		N. n. w. 4	29 50							
	9	Showers	N. n. w. 3	29 73							
16.	6	Snow	N. W. 3	29 76							
	12		N. 5	29 85							
	9	Cloudy	N. 2	29 80	1 00						
										Total	8 00

M A Y, 1698.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
6			S. 1	29 74	0 58	17.	12	Rain	E. 0	29 66	
1.	12	Rain	N. W. 1	29 73		17.	9		E. 0	29 63	0 54
	9			29 75	0 73	18.	12	Rain	n.e.b.e. 0	29 59	0 43
6			N. 2	29 72	0 46	18.	9	Warm	S. E. 1	29 56	
2.	12	Fair	W.n.w. 1	29 75		18.	6	Fair	S.S.E. 0	29 53	0 05
	9			29 72		19.	12	Cloudy	E. 1	29 48	
6		Fair	N. 0	29 75		19.	9	Hot	E.byE. 2	29 46	
3.	12	Snow				19.	6	Fair	S. 0	29 49	
	9	Ice				20.	12	Cloudy	S.e.byE. 1	29 49	
6		Fair	N.byE 2			20.	9	Cooler	S. 4	29 50	
4.	12	Cold		29 71	0 23	20.	6	Fair	S.byW. 2	29 62	
	9	Cloudy				21.	12	showers	S.S.W. 3	29 63	
6		Cold	W. 0	29 72		21.	9	Fair	f.w.b.w. 5	29 73	
5.	12	and	S.W. 1	29 71		21.	6	Fair		29 81	0 32
	9	Fair	S.byW. 2	29 70		22.	12	showers	S.byE. 1	29 72	0 02
6		Rain	S.W. 1	29 66		22.	9	and	E.S.E. 1	29 70	
6.	12	Warm				22.	6	Cooler	f.w.b.f. 3	29 66	0 95
	9	Fair	S.byE. 1	29 78	0 76	23.	12	Rain	S.byE. 1	29 48	0 79
6		Cloudy	S.byE. 1	29 78	0 13	23.	9	Cloudy	S.byw. 2	29 47	
7.	12		S.S.E. 0	29 80		23.	6	Fair	S.byw. 0	29 45	
	9	Fair				24.	12	showers	S. 2	29 43	
6		Fair	N.byw. 1	29 80		24.	9		S.W. 0	29 46	0 49
8.	12	Warm	N.n.w. 2	29 64		25.	12	Fair			
	9	Day	N. 0	30 10		25.	9				
6			N.byw. 1	30 11		26.	12	Rain			
9.	12	Same	W.b.S. 1	30 11		26.	9	Cool	N.n.E. 2	29 53	2 73
	9			30 00		27.	12	Cloudy	E.byS. 1	29 67	0 23
6		Small	W.byn. 0	29 82		27.	9	Warm	S. 1	29 71	
10.	12	Showers	N.W. 2	29 80		27.	6	Fair	E. 0	29 78	
	9		W.byn. 3	29 81	0 08	28.	12	showers	N. 1	29 78	
6		Cloudy	N.n.w. 3	29 82	0 03	28.	9	Rain	E.byN. 1	29 77	
11.	12	Cooler	N.n.w. 2	29 85		28.	6		E. 1	29 76	0 02
	9	Rain	N.N.E. 0	29 82		29.	12	Mifling	N.byE. 1	29 69	1 60
6			N.E. 2	29 69	0 51	29.	9		E.byS. 0	29 74	
12.	12	Showers				29.	6		S. 1	29 76	0 22
	9		N.n.w. 2	29 68	0 10	30.	12	Fair	S.byW. 1	29 76	
6		Cloudy	n.w.bn. 2	29 70		30.	9		N.b.w. 1	29 70	
13.	12	Fair	N. 3	29 70		30.	6		n.w.bn. 1	29 68	0 04
	9		N. 0	29 74		31.	12	Fair	W.n.w. 1	29 65	
6		Fair	N. 0	29 75		31.	9		W.f.w. 0	29 62	
14.	12	Fair	E. 2	29 82							
	9			29 87							
6		Fair	N.E. 1	29 92							
15.	12	Fair	N.byE. 1	29 95							
	9		E.byS. 0	29 94							
6		Fair	E. 0	29 87							
16.	12	and	E. 0	29 73							
	9	Warm									
										Total	12 03

JUNE, 1698.

<i>D.</i>	<i>h.</i>	<i>Weather.</i>	<i>Winds.</i>	<i>Barom.</i>	<i>Rain.</i>	<i>D.</i>	<i>h.</i>	<i>Weather.</i>	<i>Winds.</i>	<i>Barom.</i>	<i>Rain.</i>
2.	6	Fair	W. 2	29 60			6	Fair			
	12	and		29 60		17.	12	Cloudy	N. W. 0	30 05	
	9	Hot	S. 0	29 60			9	Cloudy	N. W. 0	30 05	
	6	Fair	S.w.bf. 2	29 57			6	Fair	N. W. 0	30 04	
3.	12		W. 3	29 52		18.	12	Fair	N.n.w. 1	30 05	
	9	Rain	S. 1	29 50	0 23		9		E. 1	30 08	
	6	Cloudy	S. 1	29 51			6		E. 0	30 08	
4.	12	Thund.	N. W. 2	29 55		19.	12	Fair	E b. S. 1	30 06	
	9		N.byw c	29 72	0 46		9		E. 0	30 05	
	6	Misting	N.byw. 2	29 81			6	Fair	E.byS. 0	30 03	
5.	12	Fair and	N. 3	29 90		20.	12		E.byS. 0	30 00	
	9	Cool	E.S.E. 0	29 99	0 02		9	Hot		29 92	
	6	Fair	E.byS. c	30 01			6	Fair	E.byS. 0	29 87	
	12	Cloudy	W. 2	30 07		21.	12		S. W. 2	29 86	
	9	Fair	S. W. c	30 04			9	Cloudy	W. 0	29 86	
	6	Fair	S. W. 0	30 06			6	Misting	W.byS. 0	29 86	
6.	12	and	S.S.W. 1	30 07		22.	12		N.byw. 1	29 89	
	9	Hotter	0	30 08			9	Cloudy	E. 1	29 90	
	6	Fair	W.b.S. 1	30 09			6	Fair	E. 0	29 83	
	12	and	S by E. c	30 09		23.	12	and			
	9	Hot		30 10			9	Hot	S.byW. 1	29 73	
	6	Fair	E.byN. 0	30 08			6	Rain	S.byW. 2	29 65	
7.	12	Hot	E.byN. 2	30 08		24.	12	and	S. 3	29 61	
	9	Cloudy	N.e.bn. 3	30 05			9	Cooler	S. 2	29 58	0 08
	6	Cloudy	N.n.e. 2	30 02			6	Fair	f.w.bw. 3	29 62	0 19
8.	12	Fair	N.n.e. 3	30 01		25.	12	Rain	S.byW. 3	29 64	
	9	Cloudy	N. E. 2	29 95			9	Fairer	S. c	29 68	0 06
	6	Cloudy	N. E. 2	29 86			6	Fair	W.S.w. 1	29 76	
10.	12	Cooler		29 81		26.	12		W.b.S. 1	29 78	
	9	Rain	E. 1	29 74	2 25		9	Cloudy	W.b.S. c	29 80	
	6	Cloudy	N.byE. 0	29 68	0 17		6		S. W. 1	29 78	
11.	12	Clofe	N.byE. 1	29 66		27.	12	Cloudy	W.S.w. 3	29 75	
	9	Day		29 62			9		W b.S. 2	29 69	
	6	Much	N.n.w. 1	29 57			6			29 69	
12.	12	Rain	N.n.w. 1	29 52		28.	12	Rain			
	9		N.n.w. 1	29 47	3 02		9				
	6	Misting	N. c	29 42	0 91		6	Fair			
13.	12		W byS. 1	29 52	0 38	29.	12		W. 1	29 73	
	9		W.byS. 2	29 62	0 10		9	Cloudy	W.byS. 2	29 71	
14.	12	Cloudy	S. W. 3	29 67		30.	12	Misting	W.S.w. 1	29 74	
	9		S. W. 3	29 70			9	Cloudy		29 72	
	6		S. W. 1	29			6			Total	8 77
15.	12					31.	12				
	9						9				
	6										
16.	12										
	9										

JULY, 1698.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	6		W.n.w.1	29 78			6	Fair, fair	S. W. 1	29 74	0 06
1.	12	Cloudy	W.b.S.1	29 78		17.	12	Cloudy	S. 3	29 77	
	9		W.S.w.0	29 75			9	Rain	S.b.W. 2	29 73	
	6	Cool	N. 1	29 77			6	Misting	f.w.bw.3	29 51	0 94
2.	12	Rain	N.N.E.2	29 83		18.	12	Rain	S. W. 3	29 56	
	9	Warmer	N. 0	29 88	0 23		9	Fairer		29 75	1 12
	6	Fair	N. 0	29 88			6		W.S.w.1	29 88	
3.	12	and	S. W. 2	29 86		19.	12	Fair	W.b.n. 2	29 87	
	9	Hot		29 82			9			29 87	
	6	Cloudy	S.w.b.f.3	29 74			6		W.1.w.0	29 84	
4.	12	Misting	S. W. 3	29 67		20.	12	Hot			
	9	Rain	S. W. 3	29 61			9				
	6		S.b.W. 2	29 52	1 87		6				
5.	12	Fairer	W.S.w.4	29 50		21.	12				
	9	Rain	S. W. 3	29 56	0 05		9				
	6	Cloudy	W.S.w.1	29 66	0 05		6				
6.	12	Hot	f.w.bw.3	29 70		22.	12				
	9	Fair	W.b.S. 0	29 75			9				
	6	Fair	S.w.b.f.1	29 77			6				
7.	12	Rain		29 76		23.	12				
	9	Fair	S. W. 0	29 73			9				
	6	Misty	S. W. 0	29 73			6				
8.	12	Very	W.S.w.1	29 75		24.	12				
	9	Hot	S.byE. 0	29 78			9				
	6	Cloudy	E.byS. 1	29 79			6	Thunder &			
9.	12	Hot and	E. 1	29 78		25.	12	Rain, but			
	9	Sultry	E. 0	29 76			9	fair at Tun-			
	6		E. 0	29 73			0	bridgeWells.			
10.	12	Same	E. b. S.1	29 72		26.	12				
	9		E. 0	29 67			9	Misting	S. W. 2	29 50	4 10
	6	Thund &	E.S.E. 1	29 59	2 83		6	Fair	W.b.S. 1	29 67	
11.	12	Rain, Rain	S.S.W. 1			27.	12	and	W. 2	29 78	
	9	Fairer	S.byW. 0	29 50	0 84		9	Cooler	W.S.w.0	29 83	
	6	Cloudy	N.N.w.1	29 48			6	Fair	S.w.b.f.0	29 86	
12.	12		W. 2	29 47		28.	12	Cool and	S.b.w. 3	29 81	
	9	Rain	N. W. 3	29 47	4 49		9	Cloudy	S. 2	29 80	
	6	Cloudy	N.n.w. 1	29 54	0 01		6	Rain	S.byW. 3	29 68	0 02
13.	12		n.w.bw.2	29 61		29.	12		W.S.w.0	29 76	
	9	Fair	n.w.bw.0	29 62			9	Fair	S. W. 0	29 75	
	6	Cloudy	S.w.bw.2	29 63		30.	12				
14.	12	with some	S.w.bw.1	29 63			9	Misting	7	29 41	
	9	Fair	S byW 2	29 58			6	Fair	W.b.S. 5	29 41	0 10
	6	Cloudy	S byW.3	29 48		31.	12	Cooler	W. 4	29 52	
15.	12	Rain	S. 4	29 43			9	Cloudy		29 57	
	9	Cloudy	S. 2	29 38	0 36						
	6	Fair	N. W. 3	29 43							
16.	12	Cool	W.S.w.4	29 53							
	9	Rain		29 64	0 47						
										Total	17 03

AUGUST, 1698.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
1.	6	Fair	S. W. 2	29 51		17.	6	Fair	N. 0	30 10	
	12		W. by N. 3	29 49			12		N. E. 1	30 09	
	9	Showers		29 46	0 13		9	Cloudy		30 05	
2.	6		f. w. b. w. 1	29 43			6		E. 0	29 95	
	12	Showry				18.	12	Cloudy	E. 2	29 94	
	9		N. by E. 1	29 55	0 39		9		S. 1	29 85	
3.	6		W. b. S. c	29 60			6	Fairer	S. S. W. 0	29 82	
	12	Fair	N. W. 2	29 62		19.	12	Warm	W. f. w. 2	29 82	
	9			29 67			9	Cloudy		29 80	
4.	6	Misting	f. w. b. w. 1	29 64			6	Cloudy	S. W. 0	29 76	
	12	Fairer	W. n. w. 2	29 65		20.	12		S. W. 3	29 73	
	9	Rain		29 71			9	Fair		29 67	
5.	6	Fair	W. by N. 0	29 75	0 14		6	Fair	S. w. b. 1. 1	29 59	
	12		W. n. w. 2	29 81		21.	12		S. S. W. 2	29 58	
	9	Showers		29 87	0 40		9	Cloudy		29 55	
6.	6	Cl. Show.	W. by S. 1	29 88			6	Cloudy	S. S. E. 1	29 44	
	12	Fair	W. by S. 3	29 87		22.	12		S. 3		
	9	Cool	N. W. 2	29 87	0 05		9	Rain		29 37	0 10
7.	6	Fair	n. w. b. w. 1	29 84			6	Rain	S. 0	29 48	0 48
	12	Fair	N. n. w. 2	29 81		23.	12		S. e. b. e. 2	29 51	
	9	Fairer	N. n. w. 0	29 80	0 26		9	Thunder		29 47	
8.	6	Mitty	W. by S. 1	29 72			6	Showers	S. by E. 1	29 42	
	12	Cool	N. N. E. 1	29 72		24.	12		S. 3	29 42	
	9	Rain	N. N. E. 0	29 72	1 57		9	Fair		29 42	0 01
9.	6	Cloudy	f. w. b. w. 1	29 63	0 01		6	Cloudy	S. W. 1	29 42	
	12	Dull	S. W. 2	29 61		25.	12		W. b. n. 1	29 42	
	9	Day		29 58			9	Fair		29 42	
10.	6		n. w. b. n. 1	29 58			6		E. S. E. 0	29 42	
	12	Rain	N. 1	29 61		26.	12	Fair	N. W. 2	29 41	
	9		N. E. 0	29 63	1 40		9		N. 1	29 44	
11.	6	Cloudy	N. 1	29 63			6	Fair and	S. W. 0	29 50	
	12	Cool	N. by W. 2	29 65		27.	12	good h.	N. W. 2	29 58	
	9	Day	N. 0	29 67			9	Weather.		29 67	
12.	6		N. by W. 1	29 69			6		S. W. 1	29 75	
	12	Misting	N. 3	29 70		28.	12	Fair	S. W. 3	29 79	
	9			29 76	0 02		9	Rain		29 76	
13.	6	Fair and	N. by W. 1	29 79			6		W. 1	29 73	
	12	Cool	N. 2	29 84		29.	12	Fair	W. f. w. 3	29 70	
	9	Cold	E. by N. 0	29 90			9	Rain		29 73	0 11
14.	6		N. by E. 0	29 98			6	Some Fair	S. W. 0	29 71	
	12	Fair	E. 2	30 01		30.	12	and some	S. S. W. 3	29 75	
	9			30 00			9	Rain		29 80	0 35
15.	6	Fair	S. e. b. e. 0	29 95			6	Cool	N. W. 0	29 83	0 02
	12	and	N. E. 2	29 96		31.	12	Fair with	n. w. b. n. 2	29 85	
	9	Warm		29 98			9	Rain		29 84	
16.	6		E. 0	30 00						Total	7 02
	12	Same	E. N. E. 2	30 04							
	9			30 09							

SEPTEMBER, 1698.

D. h.	Weather.	Winds.	Barom.	Rain.	D. h.	Weather.	Winds.	Barom.	Rain.
6	Cloudy	N.n.w. c	29 80		6	Rain	E.byN. 0	29 39	
1. 12	Cool	W. 1	29 72		17. 12		E.by S. 0	29 36	
9	Day		29 64		9	Fairer		29 34	1 46
6		S. W. 1	29 52		6	Rain	E.by S. 0	29 31	
2. 12	Showers	S. W. 3	29 54		18. 12		S. E. 1	29 34	
9			29 56	0 14	9	Fairer		29 36	1 43
6		S.S.W. 1	29 48		6		E.N.E. 1	29 25	
3. 12	Rain	S. W. 5	29 45		19. 12	Showers	S. W. 3	29 25	
9			29 41	2 55	9			29 31	0 65
6	Fair	S. W. 0	29 40		6	Rain	S. W. 1		0 15
4. 12		S.byW. 2	29 37		20. 12	Cloudy	f.w.bw. 2	29 38	
9	Rain		29 16	0 20	9	Rain		29 42	
6	Fair	W.S.w. 2	29 13	1 10	6	Foggy	S. W. 0	29 46	0 55
5. 12	Rain				21. 12	Showers	W.S.w. 1	29 48	
9	Fair	S. W. 3	29 48	0 03	9	Fair		29 52	0 01
6	Rain	f.w.bw. 2	29 50		6	Floar-Fr.	f.w.bw. 0	29 47	
6. 12		S. W. 4	29 46		22. 12	Fair	S. 2	29 41	
9	Cloudy		29 47	0 09	9	Rain		29 37	0 20
6		S.byW. 4	29 41		6	Fair	S. W. 1	29 42	
7. 12					23. 12	Warm	W.S.w. 3	29 42	
9					9	Cooler		29 44	
6	Rain				6	Fair	S.S.W. 0	29 44	
8. 12					24. 12	Cooler	S.e b.e. 1	29 43	
9	Fair		29 76	0 77	9	Cloudy		29 31	
6		S. 0	29 81		6	Rain	S.S.E. 2	29 20	0 42
9. 12	Cloudy	S.byW. 2	29 80		25. 12				
9		S.byW. c	29 80		9				
6	Fog	S. W. c	29 86		6				
10. 12	Fair	S.byW. 1	29 89		26. 12	Fair		29 45	0 01
9	Cloudy	W.byS. 0	29 89		6	Fair and	S.S.E. 1	29 42	
6		S.byE. 1	29 81		27. 12	Pleasant	S. 3	29 42	
11. 12	Rain	S.byE. 2	29 70		9	Rain		29 41	0 11
9		E.byS. c	29 31	1 34	6	Fair	S. 0	29 40	0 03
6	Fair	N. 1	29 80	0 01	28. 12	Showers	S. 3	29 36	
12. 12	Warm	E. 2	29 92		9	Fair		29 26	0 01
9	Day		29 87		6	Rain	E.byS. 1	29 05	0 04
6		E.byS. c	29 70		29. 12	Rain	S.byE. 3	29 06	0 76
13. 12	Cloudy	E.byS. 1	29 61		9			29 06	
9			29 55		6	Rain	S.byE. 2	29 04	
6		E. 0	29 57		30. 12	Warm	S.S.W. 4	29 07	
14. 12	Fairer	N. E. 2	29 62		9			29 36	0 40
9			29 63					Total	12 07
6	Fair	E.N.E. 2	29 60						
15. 12	Warm								
9	Cloudy		29 51						
6	Rain	N.e.b.e. 0	29 41						
16. 12	Warm	S.byE. 2	29 44						
9	Fair		29 46						

OCTOBER, 1698.

D.	h.	Weather.	Winds.	Barom.	Rain.	D.	h.	Weather.	Winds.	Barom.	Rain.
1.	7	Misting	S. 3	29 37		17.	7	Ice and	N.N.W. 1	29 62	
	12	Warm	S.W.b.f. 4	29 45			12	Fair			
	9	Fair		29 60			9	Rain		29 57	0 34
2.	7	Cloudy	S. 2	29 69	0 20		7	Ice	S. 1	29 44	
	12	Warm &	S. 3	29 71		18.	12	Cloudy	S.W. 2	29 33	
	9	Fair		29 77			9	Fair		29 15	
3.	7	Rainy	S. 2	29 83			7	Cold	E.S.E. 2	28 08	
	12	Warm	S.S.E. 2	29 83		19.	12		S.by E. 2	28 84	
	9	Day		29 63	2 87		9	Rain		28 83	1 20
4.	7	Fair	f.w.b.w. 1	29 50	1 17		7	Cold	S.W. 2	29 01	0 41
	12	Fair		29 50		20.	12	and	W.b S. 2	29 12	
	9	Rain	W.n.w. 7	29 50	0 36		9	Cloudy		29 21	
5.	7	Cloudy	W.n.w. 2	29 82			7	Frost and	N. 0	29 23	
	12	Fair	N.b.W. 3	29 88		21.	12	Fair	N.W. 2	29 24	
	9	Cooler		29 95			9	Cloudy		29 45	
6.	7	Cloudy	f.w.b.w. 1	30 00			7	Showers	N.N.E. 0	29 50	
	12	Cloudy	W.b.N. 2	30 03		22.	12	Hail	S. 2	29 51	
	9		W.b.N. 0	30 07			9	Showers		29 57	1 41
7.	7	Cloudy	W. 1	30 07			7	Hard-Fro.	S.e.b.e. 0	29 65	
	12	Fair	W.b.N. 1	30 07		23.	12	and Fair	E.S.E. 1	29 68	
	9	Cloudy	W. 0	30 07			9	Showers		29 70	
8.	7	Fair and	N.W. 0	30 10			7	Fair	E. 0	29 62	0 04
	12	somewhat	N.b.W. 1	30 10		24.	12	Warm			
	9	Cooler	N.W. 0	30 11			9	Rain		29 58	0 10
9.	7	Cloudy	N.W. 0	30 07			7	Rain	S. 3	29 40	0 11
	12	and	W.f.w. 1	30 03		25.	12	Mild	S.by E. 3	29 24	
	9	Cooler	S.W. 3	29 88			9	Weather		29 42	
10.	7	Rain	W.b.N. 3	29 62	1 55		7	Cloudy	S.S.E. 2	29 48	
	12	Fair	W.n.w. 3	29 76		26.	12	F.&Warm	S.E.b.S. 3	29 47	
	9	Rain	S.W. 3	29 61			9	Rain		29 43	
11.	7	Cloudy	W.b.N. 3	29 35	0 63		7	Fair	S.by W. 0	29 52	
	12	Fair	W.b.N. 3	29 36		27.	12	Cloudy		29 52	
	9	Cloudy	W.b.N. 3	29 37			9	Rain		29 42	0 80
12.	7	Cloudy	W. 2	29 30			7	Milt	W. 0	29 41	
	12	and some	W. 3	29 30		28.	12	Fairer	N.N.E. 2	29 24	
	9	Rain		29 27	0 23		9	Rain		29 46	0 05
13.	7	Fair	W.by S. 0	29 14	0 02		7	Cloudy	N.by E. 2	29 41	
	12	Warm	N. 2	29 09		29.	12	Colder	N.by E. 1	29 41	
	9	Cold		29 05			9	Rain		29 41	
14.	7	Fair	W.by N. 2	29 20			7	Snow	N.by E. 4	29 62	1 23
	12	Rain	N.by E. 2	29 30		30.	12	Sleet	N. 3	29 23	
	9	Cloudy		29 42	0 07		9	Fairer		29 42	0 29
15.	7	Hoar-Fr.	n.w.b.n. 0	29 47			7	Hard-Fro.		29 62	
	12	Fair and	n.w.b.n. 1	29 47		31.	12	Cloudy			
	9	Cold		29 47			9			29 76	
16.	7	Icy Frost	N.n.w. 1	29 50							
	12	Fair and	N.b.W. 1	29 53							
	9	Cold		29 61							
										Total	13 08

NOVEMBER, 1698.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	8	Frost	S.w.b.l.2	29 68			8	Frost	S. 0	29 67	0 18
1.	12	Sleet	S. W. 2	29 62		17.	12	and			
	9	Cloudy		29 63	0 12		9	Fair		29 37	
	8	Fair	S.S.W.0	29 67	0 06		8	Rain	S.e.byf.2	29 07	
2.	12	Warmer	S.S.W.1	29 68		18.	12	Fair and	f.w.b.w2	29 16	
	9	Showers		29 64	0 03		9	Cold		29 31	0 04
	8	Fair	S. 1	29 55			8	Rain and	S.byE. 2	29 28	
3.	12	Cloudy	S byW.3	29 49		19.	12	Co. Thaw	S.w.b.f.3	29 14	
	9	Showers	S. 3	29 40			9	Fair		29 20	0 10
4.	12	Warm &	S. 3	29 30			8	Rain	S. W. 2	29 20	0 44
	9	Cloudy	S. 4	29 15	0 11	20.	12	Fair and	S. W. 4	29 27	
	8	Rain	W.S.w.5	29 9	0 19		9	Warm		29 31	
5.	12	Fair and	f.w.b.w6	29 14			8	Rain	S. W. 4	29 14	2 81
	9	Pleasant	f.w.b.w2	29 37		21.	12	Fair and	S. W. 3	29 20	
	8	Frost	f.w.b.w0	29 45			9	Warm		29 43	
6.	12	Fair and	S.byW.0	29 45			8	Frost, and	W.byS.1	29 77	
	9	Cold	S byW.0	29 41		22.	12	Fair		29 83	
	8	Rain	f.w.b.w3	29 22	0 26		9	Cloudy		29 75	
7.	12	Fair and	W.byS.4	29 28			8	Rain and			
	9	Warmer	f.w.byf.1	29 42		23.	12	Warm			
	8	Rain	S. 1	29 24			9				
8.	12	Fairer	W.byS.2	29 12			8	Rain			
	9	Fairer	W.S.w.2	29 27	2 30	24.	12	Stormy		29 75	1 15
	8	Fair	S. W. 3	29 33	0 23		9	Some	S.w.b.f.8	29 15	0 61
9.	12	Cloudy	W.S.w.2	29 22		25.	12	Fair	S.w.b.f.8	29 30	
	9	Snow	S.S.E. 1	29 27			9	Some Rain		29 52	0 15
	8	Cloudy	W.S.w.0	29 42	0 36		8		S. W. 4	29 41	
10.	12	Milly	f.w.byf.1	29 48		26.	12	Rain	f.w.b.w5	29 33	
	9	Day		29 47			9			29 30	0 07
	8	Sn. & Sleet	N.byf.1	29 48			8	Small Fr.	W.S.w.3	29 25	
11.	12	all Day.	N.byE.1	29 47		27.	12	and	W.S.w.3	29 27	
	9	Snow		29 43	2 66		9	Fair		29 53	
	8	Snow 3	N.byw.2	29 46	2 56		8		W.byS.1	29 41	
12.	12	Inches,	N.byw.1	29 54		28.	12	Same	W.byn.1	29 44	
	9	Cloudy		29 65	0 65		9			29 37	
	8	Hard-Fr.	W.byS.0	29 60			8	Snow	E.byN.1	29 13	
13.	12	and	W.S.w.1	29 58		29.	12		E.byN.2	29 09	
	9	Fair		29 62			9	Sleet		29 17	0 74
	8	Fair, Snow	W.S.w.1	29 63			8	Frost and	N.hyw.4	29 56	
14.	12	and Hard.	W.byS.2	29 61		30.	12	Fair	N.N.w.2	29 66	
	9			29 70			9	Rain		29 86	0 01
	8	Frost	N.n.w.1	29 90							
15.	12	Misty and	W.b.No	29 98							
	9	less Cold		30 01							
	8	Cloudy	S. 1	29 92							
16.	12	Fair	S. S. E. 2	29 92							
	9	Thaw		29 81							
										Total	16 83

DECEMBER, 1698.

D.	b.	Weather.	Winds.	Barom.	Rain.	D.	b.	Weather.	Winds.	Barom.	Rain.
	8	Hard-Fr.	N.byw.o	29 85			8	Rain	S.b. W.6	29 09	
1.	12	Fair	E.byS.c	29 80		17.	12	Warm	S.byW.6	29 10	
	9	Sn. 3 Inc.		29 78			9	Clou. Rain		29 22	0 42
	8		W.n.w.o	29 93			8	Cloudy	S.w.b.f.3	29 32	0 40
2.	12	Foggy	W.byN.	30 01		18.	12	and	S.w.b.f.2	29 30	
	9			30 11			9	Warm		29 34	
	8	Cloudy	W.b.S.o				8	Fair	S.byW.o	29 72	
3.	12	with gen- tle Thaw	W.b.S.o	30 15		19.	12	Cooler	S.byE. 1	29 67	
	9		W.b.S.o	30 16	1 32		9	Rain		29 35	
	8		W.b.S.o	30 09			8		S. 3	29 23	0 56
4.	12	Foggy	S.W. c	30 08		20.	12	Rain	S.byE. 5	28 58	
	9		S.w.b.f.o	30 06			9			28 68	0 24
	8	Fog and Misting	S.w.b.f.o	30 02			8	Fair and	W. 4	29 36	
5.	12		S.byW.c	30 03		21.	12	Colder	W. 3	29 52	
	9		S.byE. c	30 00	0 41		9	Rain		29 52	
	8	Fog	E. S. E. 1	29 97			8		W.byS.4	29 49	0 17
6.	12	Warm	E. 2	29 94		22.	12	Fair	W.S.w.3	29 55	
	9	Clearer	S.e.b.e. 1	29 92			9			29 66	
	8	Misty	S. E. c	29 92			8			29 81	
7.	12	Clearer	S. E. c	29 91		23.	12	Cloudy		6 29 65	
	9	Misty	E.byS. c	29 88			9				
	8	Mist	E.byS. c	29 83	0 04		8	Cloudy	S. W. 7	29 34	
8.	12	Fair	E.byS. 1	29 86		24.	12	Warm	W.b.n. 8	29 56	
	9	Fog	S.w.b.f.o	29 94	0 12		9	Fair		2 29 82	
	8	Rain	S.byW. 2	29 99	0 03		8		W byS.2	29 94	
9.	12	Cloudy & warm	S.byW. 3	29 98		25.	12	Fair	W.S.w.2	29 95	
	9		S.S.W. 4	29 91			9			30 00	
	8	Cloudy	S. 6	29 66			8	Cloudy	W.byS.3	29 93	
10.	12	Rain	W.byS.6	29 64		26.	12	and	W.byS.4	29 90	
	9	Fair	W.byS.2	29 96	0 49		9	Warm		29 77	
	8	Fair and	W.S.w.4	30 10			8	Rain	W.byS.4	29 50	
11.	12	Cooler	S. W. 3	30 14		27.	12	Colder	S.w.b.w.4	29 43	
	9	Cloudy		30 00			9	Fairer			0 21
	8	Rain	W.n.w.3	29 79	0 72		8	Frost and	S. W. 3	29 49	
12.	12	Fair		30 11		28.	12	Fair		29 40	
	9						9	Frost			
	8	Frost	S.e.b.f.c	30 10			8	Warmer	S. W. 7	28 88	
13.	12	Fair	S. S. E. 1	30 06		29.	12	Rain	S. W. 8	28 79	
	9	Cloudy		29 06			9	Colder		28 69	
	8						8	Snow	W.byS.3	28 79	0 69
14.	12	Rain				30.	12	Frost and	W.byS.3	28 89	
	9						9	Fair			
	8						8	Frost	W. c	29 23	
15.	12					31.	12	and	W.n.w.2	29 36	
	9						9	Fair		29 67	
	8	Cloudy	S.byW.2	29 60	0 01					Total	5 83
16.	12	Rain	S. 3	29 50							
	9	Warm		29 44							

XXV.

The Rain,
1697 and
1698, at
Townley;
by Mr.
Townley,
n. 249.
p. 47.

	1697		1698			1697		1698	
Jan.	10	26	12	94	July	27	00	20	74
Feb.	14	34	11	76	August	80	50	43	00
March	9	86	40	32	Septemb.	63	80	43	58
April	8	24	41	90	October	55	20	44	52
May	23	76	17	90	Novemb.	21	44	49	44
June	17	84	12	90	Decemb.	49	00	40	84
					Sum	411	24	379	84

As far as I have learned, the Mercury rises and falls much after the same Measure in most Parts of our Island; and of this you may better judge by some Observations I have here transcribed and sent you, of the very low Stations: *December 28*, about three of the Clock, Mercury 28, 17; on the twenty ninth about two Hours and an half 28, 18; and *Jan. 2*, about the same Hour, 28, 05; and this time it hardly rose before I went to Bed; and on the sixth still about three Hours 28, 19; but this time before nine at night it was got to 29, 28. What I note is, that though once I saw it lower many Years ago, yet never since I kept my Observations, did the Quick-silver descend so often to those Pitches; or when it was found very low, did it ever continue so for any considerable Time, as it hath done this Year; during which it hath never been very high, and, as I remember, generally much lower than other Years. This hath proved very unseasonable here, and so backward, that I thought I had never known the like; but examining my Observations, I find that of 1673 much what as late, tho' the Consequence proved not so fatal to these Parts of *Europe*, as this.

The Weather
1698 and
1699, at
Emuy in
China; by
Mr. James
Cunning-
ham, n. 256.
p. 323.

XXVI. At *Emuy* in *China* in the Latitude of 24°. 20'. N. An. 1698, *Octob.* From 1 to 8, the Weather was fair and clear, the Mercury's Alt. 29 $\frac{1}{2}$ Dig. From the eighth to the eleventh, close and cloudy Weather, the Mercury falling to 29 $\frac{1}{2}$ Dig.

11. Close Weather, somewhat cloudy. 12. Close Weather, blowing fresh at *N. E.* 13. and 14. Close and cloudy Weather, with much Rain, and fresh Winds from *N. E.* to *N. W.*

The *Tides*, (which commonly flow three Fathoms) did flow above half a Foot higher three Days after the Full-Moon, than it did on the Full-Moon at the *Æquinox*.

15. Fair and clear Weather, with small Gales at *N. E.* From the fifteenth to the twenty-fourth, fine, moderate, fair Weather, with small Gales at *N. E.* From thence to the thirty-first, Winds and Weather variable.

Nov. 1 to 15. Variable, close and cloudy Weather, with some Rain, and variable Gales round the Compass.

15. Fair and clear Weather, with small Gales at *N. E.* in the Morning the Mercury's Alt. 29 $\frac{1}{2}$, at Noon 29 $\frac{1}{2}$, and at ten of the Night, being cold, rising

ring to $29\frac{1}{2}$, 16. At Sun-rising very cold, the Mercury's Alt. $29\frac{1}{2}$; at Noon fair and pleasant Weather, the Mercury falling to $29\frac{1}{2}$; at Night cold, rising to $29\frac{1}{2}$; the Wind at *N. E.* 17. This Morning cold, the Mercury at $29\frac{1}{2}$, fair and clear Weather all Day, and at Night blowing somewhat fresh at *N. E.* the Mercury at $29\frac{1}{2}$. 18. This Morning cold, the Mercury at $29\frac{1}{2}$; all Day fair and pleasant Weather, the Mercury falling to $29\frac{1}{2}$, and by Noon to $29\frac{1}{2}$; the Weather fair, somewhat close and cloudy, the Afternoon Sun-shining and warm, and at Night temperate, the Mercury continuing at $29\frac{1}{2}$; small Winds at *N. E.* and almost calm.

20. A pleasant Sun-shining Morning, the Mercury at $29\frac{1}{2}$; at Noon overcast and cloudy, with little Wind at *N. E.* the Mercury falling to $29\frac{1}{2}$; in the Afternoon some Drops of Rain, with close Weather, and at Night the Mercury continuing at $29\frac{1}{2}$, with small Westerly Winds; some Rain in the Night. 21. Close and cloudy Weather, with small Gales at *N. E.* the Mercury at $29\frac{1}{2}$ in the Morning, and continuing so all Day, with some Drops of Rain in the Afternoon, the Gale freshning, and a Shower of Rain at eight of the Night, the Mercury rising to $29\frac{1}{2}$. 22. Gray and cloudy Weather all Day, with fresh Gales between *E.* and *N. E.* the Mercury at $29\frac{1}{2}$, and at Night rising to $29\frac{1}{2}$; fair Weather, somewhat cloudy. 23. A very cold Morning, fair and clear, with fresh Gales from *N. E.* to *N.* the Mercury at 30 Dig. fair and clear all Day, with a moderate Gale about *N. E.* clear and very cold all Night, the Mercury continuing at 30 Dig. 24. A fair, clear and cold Morning, the Wind at *N. E.* a moderate Gale, the Mercury continuing at 30 Dig. a clear Sun-shining Day, cold and clear all Night, the Mercury as before. 25. A sharp, cold Morning, fair and clear, with a moderate Gale at *N. W.* the Mercury falling to 29; all Day fair and pleasant, very warm, and no Wind, the Mercury falling at Noon to $29\frac{1}{2}$, and at Night being somewhat hazy and calm withal, to $29\frac{1}{2}$. 26. Temperate Weather all Night, and this Morning somewhat close and hazy, and no Wind, the Mercury at $29\frac{1}{2}$, and towards Noon growing clearer and warmer, rising to $29\frac{1}{2}$; small Breezes at *N. E.* at Night falling to $29\frac{1}{2}$, temperate Weather. 27. Fine, pleasant Weather all Day, with small, variable Breezes from the *N.* to *W.* and about to *S.* the Mercury in the Morning at $29\frac{1}{2}$, and at Noon falling to $29\frac{1}{2}$, and at Night rising to $29\frac{1}{2}$, fair Weather and calm. 28. Fine, moderate Weather, with a Gale at *N. E.* the Mercury at $29\frac{1}{2}$; in the Afternoon the Gale freshned, the Weather somewhat cloudy, and at Night the Mercury was at $29\frac{1}{2}$; blowing fresh. 29. Fair and clear Weather, somewhat cold this Morning, with a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$, fine, pleasant Weather all Day, with small Gales at *N. E.* at Noon the Mercury falling to $29\frac{1}{2}$, and at Night being clear and somewhat cold, rising to $29\frac{1}{2}$. 30. Fair and pleasant Weather, with small Gales at *N. E.* the Mercury at $29\frac{1}{2}$; at Noon a fresh Gale, the Mercury falling to $29\frac{1}{2}$; at Night temperate Weather, and little Wind, the Mercury rising to $29\frac{1}{2}$.

Dec. 1. Fine, temperate Weather, with small Gales at *N. E.* the Mercury at $29\frac{1}{2}$ in the Morning; fair Weather all Day, and small Breezes at *N. E.* the Mercury at Noon falling to $29\frac{1}{2}$, and in the Evening to $29\frac{1}{2}$, and at Night rising to $29\frac{1}{2}$, being fine, clear Weather. 2. Fair and temperate
Weather,

Weather, somewhat cloudy, and overcast, with small Gales at *N. E.* the Mercury at $29\frac{1}{2}$, and at Night rising to $29\frac{1}{2}$. 3. A clear and cold Morning, with a fine sharp Gale at *N. b. E.* the Mercury at $29\frac{1}{2}$; a cold Air all Day, the Mercury at Noon falling to $29\frac{1}{2}$, and at Night the Gale freshning made it colder, the Mercury rising to $29\frac{1}{2}$. 4. A sharp Morning, with a fresh Gale at *N. b. E.* the Mercury at $29\frac{1}{2}$; fair and clear all Day, with a small Northerly Gale, the Mercury by Noon falling to $29\frac{1}{2}$; a serene, temperate Night, and almost calm, the Mercury as before. 5. A fine, clear Morning, with a moderate Gale at *S. W.* somewhat cold, the Mercury at $29\frac{1}{2}$; at Noon a small Breeze at *E. b. S.* pleasant Weather, the Mercury at $29\frac{1}{2}$; at Night a small Gale at *S. b. E.* fair and temperate Weather, somewhat hazy, the Mercury at $29\frac{1}{2}$.

6. This Morning somewhat close and cloudy, with a few Drops of Rain, the Weather temperate, with small Southerly Breezes, the Mercury at $29\frac{1}{2}$, the Afternoon calm, and somewhat hazy, the Mercury falling to $29\frac{1}{2}$; at Night overcast and cloudy, with some Rain, blowing fresh at *N.* the Mercury rising to $29\frac{1}{2}$. 7. A gray Morning, clearing up with a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$; in the Afternoon the Horizon a little hazy, the Mercury falling to $29\frac{1}{2}$; at Night clearer, with a fresher Gale, the Mercury rising to $29\frac{1}{2}$; a very cold Night. 8. A sharp, clear Morning, with a fine Gale at *N. E.* the Mercury at 30; at Noon falling to $29\frac{1}{2}$, a fine Sunshining Day; at Night cold and clear, a small Gale at *N. E.* the Mercury rising to 30. 9. This Morning as the last, all Day and Night the same, and the Mercury also.

10. A cold Morning, somewhat foggy, with a fine Gale at *N. E.* the Mercury at 30; all Day fair, clear, and sunshining; at Night cold, the Mercury at $29\frac{1}{2}$. 11. A cold Morning, with a moderate Gale at *N. W.* the Mercury at $29\frac{1}{2}$; all Day fair and clear, the Mercury falling to $29\frac{1}{2}$; at Night a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$. 12. A gray, cold Morning, somewhat cloudy, with a hazy Horizon, a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$; towards Noon falling to $29\frac{1}{2}$, with little Wind and fair Weather; at Night calm, and somewhat cold, the Mercury rising to $29\frac{1}{2}$. 13. A fine pleasant Morning, with a small Breeze at *N. W.* the Mercury at $29\frac{1}{2}$; at Noon a small Gale at *N. E.* and in the Afternoon calm, the Mercury falling to $29\frac{1}{2}$; all Day serene, at Night calm, with a clear Sky, somewhat cold, the Mercury rising to $29\frac{1}{2}$. 14. A fine temperate Morning, with some small Rain like Dew, and a moderate Gale at *S. W.* the Mercury $29\frac{1}{2}$; the Afternoon a little overcast, and the Horizon somewhat hazy, a small Gale at *S. E.* the Mercury falling to $29\frac{1}{2}$; at Night temperate and calm, the Mercury rising to $29\frac{1}{2}$. 15. A fine, temperate, calm Morning, the Mercury at $29\frac{1}{2}$; at Noon fair, pleasant, calm Weather, the Mercury fallen to $29\frac{1}{2}$; all the Afternoon, and at Night, a fresh Gale at *N. E.* fair Weather, the Mercury rising to $29\frac{1}{2}$. 16. A gray, cloudy Morning, somewhat hazy, with a fresh Gale at *N. E.* the Mercury at $29\frac{1}{2}$; at Noon fair and clear, the Gale moderate, and the Mercury falling almost to $29\frac{1}{2}$; the Afternoon somewhat cloudy, with a fine Gale at *N. E.* at Night a little Wind, serene and sharp, the Mercury rising to $29\frac{1}{2}$. 17. A gray Morning,

XXVII. The Weather 1699 at Upminster; by Mr. Will. Derham, n. 262. p. 527.

JANUARY, 1699.

D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
	8	Froft	S. e. b. f. 0		29 77				8		n. w. b. w. 0		30 22	94	
1.	12	Fair	S. S. E. 1		29 73			17.	12	Foggy	N. W. 0		30 24	100	
	9	Snow			29 43				9				30 27	94	
	8	Rain	S. 3		29 20	0 63			8	Fog	W. 0		30 26		
2.	12	Warmer						18.	12						
	9	and Rain	S by E. 3		28 70	0 29			9						
	8		S. 3	S. by W.	28 57	0 37			8	Fog					
3.	12	Same						19.	12						
	9		S. by W. 3		28 47				9				30 34	77	
	8	Cloudy	S. S. W. 3	S. w. b. w.	28 44	110			8	Hard Fr. S.	0		30 27	70	
4.	12	Fairer	S. W. 4		28 50	109		20.	12	Fair	S. by E. 1		30 24		
	9		S. W. 4		28 72	108			9	Foggy			30 21	76	
	8	Froft	S. W. 3		29 22	85			8	Hard Fr.	S. by E. 0		30 18	62	
5.	12	and Fair	S. 1		29 29	94		21.	12	Fog	E. N. by 1	E. N. E.	30 18	82	
	9	Rain							9	Fair			30 18	81	
	8	Rain	S. c		28 67	104 0 75			8	Froft	E. by N. 1		30 16	77	
6.	12	Warm			25 61	105		22.	12	and	E. by N. 2	E. by N.	30 18	86	
	9	Snow	S. 8				3 48		9	Fair			33 19	84	
	8	Small Fr.	S. W. 2		29 00	85			8	Cloudy	N. E. 2		30 15	87	
7.	12	Fair	S. w. b. w. 3	S. by W.	29 08	86		23.	12	Fair					
	9	Rain	S. by W. c	S. W.	29 19	85 0 03			9	Small Fr.			30 13	81	
	8	Froft	S. W. c	W. S. W.	29 34	85			8	Froft	E. by N. c		30 13	73	
8.	12	and	W. by S. 1	S. W.	29 44	88		24.	12	and	E. 2		30 14	88	
	9	Fair			29 70	88			9	Fair			30 12	88	
	8	Hard Fr.			29 72				8	Froft	E. c		30 11	73	
9.	12	and						25.	12	Fair and	E. 1		30 12	86	
	9	Fair			29 73				9	Pleas. D.			30 09	79	
	8		E. by S. 1	E. S. E.	29 82	85			8		E. c		30 05	70	
10.	12	Same	S. e. b. e. 2		29 82	89		26.	12	Same	E. 1			88	
	9				29 60				9				29 06		
	8	Rain	S. W. 2	W. S. W.	29 59	101 0 40			8	Froft and	E. N. E. c	E.	29 76	76	
11.	12	Cloudy	S. w. b. w. 2	W.	29 59	99		27.	12	Cloudy	E. by N. 1		29 72	85	
	9				29 71	102			9	Fair			29 59	76	
	8	Cloudy	S. w. b. f. 0		29 69	103			8	Rain	S. E. 2	S. E. by S.	29 48	89	
12.	12	Mifling	S. W. 2		29 66	109		28.	12	and	E. by S. 2	S.	29 47	92	
	9	Rain		W. by S.	29 59	101			9	Thaw			29 66	93 1 51	
	8	Fair	S. w. b. w. 3	W.	29 48	93 0 16			8	Froft	S. w. b. f. c	W. by N.	29 86	85	
13.	12	Cloudy	W. by S. 3	W. by N.	29 42	107		29.	12	Fair	S. 1		29 87	92	
	9	Rain			29 48	93			9	Rain			29 72	98	
	8	Fairer	N. w. b. w. 4	N. W	29 53	94 0 14			8	Cloudy	S. 2	S.	29 56	107 0 82	
14.	12		N. by W. 4	N. by W.	29 69			30.	12	Warm	S. 3	S. by W.	29 49	115	
	9	Cloudy			29 97	96			9	Day	S. S. W. 3	S. W. b. S.	29 42	109	
	8	Rain	N. 1		30 12	90 0 16			8	Cloudy	S. by W. 2	W. S. W.	29 49	108 0 17	
15.	12	Cloudy	N. by W. 1		30 14	94		31.	12		S. 3		29 37	113	
	9	Day			30 17	82			9	Rain	S. S. E. 2	S. S. E.	29 47	109	
	8	Froft	W. by S. 0	N. by W.	30 10	81							Total		8 91
16.	12														
	9	Cloudy			30 15	90									

F E B R U A R Y, 1699.

D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	7	Fair	S. W. 1		29 43	98		17.	7	Cloudy	E. by N. 0		29 76	93	
	12	Pleasant Day	W by S. 2	S. W.	29 53	108			9	Rain	E. by N. 1	W. b. S.	29 82	109	
	9		W. by S. 3		29 77	83							29 83	94	
2.	7	Small Fr.	W.S.W. 3	W. n. w.	29 88	79			7	Fair and	N.N.W. 1		29 84	91	0 09
	12	Hazy	S. by W. 0		29 91	95		18.	12	Pleasant	N. W. 1		29 93	110	
	9	Rain	S. 1		29 85	100	0 05		9	Rain			29 85	99	
3.	7	Rain	S. S. E. 3	S by E.	29 59	100			7	Fair	W. by S. 3		29 71	87	0 13
	12		S. by W. 3	S. W.	29 51	105		19.	12	Fair	W. by N. 4		29 77	104	
	9	Fair	S. w. b. w. 1		29 64	92	1 05		9				29 94	90	
4.	7	Small Fr.	W.S.W. 1	W. n. w.	29 74	82			7	Frost	W. S. w. 1		30 00	82	
	12	Fair Cloud.	W. 2	N. by W.	29 80	101		20.	12	and					
	9	Rain	S. 1	S. W.	29 73	80			9	Fair			29 98	97	
5.	7	Cloudy	S. w. b. w. 3	W.S.W.	29 48	104	0 37		7	Cloudy	W.S.W. 1	W. n. w.	29 94	92	
	12	Fair	W.S.W. 3	W.	29 51	113		21.	12	Fairer	W. by N. 2		29 92	110	
	9	Rain	W. by S. 3	W.	29 48	91			9				29 91	90	
6.	7	Small Fr.	W. by N. 1		29 70	85			7	Cloudy	W. b. S. 2	W. n. w.	29 81	84	
	12	Fair						22.	12	Sleet	N. W. 3		29 72	100	
	9	Rain			29 52	93			9	Cold			29 75	79	0 09
7.	7	Violent Storms	W. 8	W. by N.	28 99	103	1 52		7	Hoar Fr.	N. W. 2		29 83	75	
	12		W. n. w. 10	N. W.	29 22	101		23.	12	Fair			29 59	86	
	9				29 78	92			9	Sleet					
8.	7	Cloudy	N. W. 0	N. w. b. n.	29 98	88			7	Cloudy	N. N. W. 0		29 00	92	0 40
	12	Fair	S. b. W. 1	N. W.	30 00	101		24.	12	Blister.			29 91	85	
	9	Cloudy			29 88	99			9	Fairer					
9.	7	Milling	W.S.W. 3	W. by N.	29 79	100			7	Fair	N. w. b. w. 1		29 90	83	
	12							25.	12	Cloudy	S. w. b. w. 1	N. W.	29 82	102	
	9	Fair			30 07	87	0 26		9	Rain			29 75	96	
10.	7	Hoar Fr.	S. W. 2	N. N. W.	30 02	82			7	Fair	W. 1	W. n. w.	29 77	86	0 08
	12	Some-what Fair	W. 3	N.	30 03	109		26.	12	and	W. by N. 1		29 83	105	
	9				30 01	95			9	Pleasant			29 77	95	
11.	7	Cloudy	W. by S. 1	N. W.	29 98	81			7	Rain	W. b. S. 2	W. b. N.	29 64	59	
	12		S. W. 2	W. by N.	29 90	100		27.	12	Fair	n. w. b. w. 3		29 67	103	
	9	Fairer			29 98	96			9				29 71	92	0 45
12.	7	Fair	S. W. 2	N. by W.	29 94	84			7	Cloudy	S. W. 3	W.	29 58	93	
	12	Hazy	S. W. 3	N. W.	29 84	102		28.	12						
	9	Cloudy Ra.	W. 5		29 46	101			9						0 10
13.	7		W. 4	W.	29 34	107	0 02								
	12														
	9														
14.	7														
	12														
	9														
15.	7														
	12														
	9														
16.	7	Rain					1 50								
	12	Cloudy	E. by N. 2	N. E.	29 37	102									
	9				29 52	97									
													Total		0 05



APRIL, 1699.

D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	6	Rain	W. b. N. 1	N. W.	29 37	93		17.	6	Rain	W. S. w. 3		29 21	103	
	12	and	N. 4		29 39	102		17.	9	Fair			29 25	99	0 21
	9	Hail			29 52	98	0 27		6	Hoar Fr.	S. W. 1		29 34	85	
2.	6	Same	N. N. w. 3		29 50	92		18.	6	Fair	S. 1		29 34	100	
	12		N. 2		29 53	102		18.	9	Rain	S. 1		29 34	100	
	9		N. b. E. 2	N. E.	29 61	95	0 14		6	Fairer	E. 2		29 28	103	0 02
3.	6	Cloudy	N. 2	N. e. b. n.	29 63	88		19.	6	Cloudy	W. b. N. 1		29 42	125	
	12		N. e. b. n. 3		29 67	108		19.	9	Cloudy			29 65	110	
	9		N. b. E. 3	N. e. b. n.	29 70	93			6	Hoar Fr.	W. 0		29 72	89	
4.	6	Fairer	N. b. E. 3	N. E.	29 85	90		20.	6	Fair			29 84	115	
	12	Day	N. E. 4		29 90	107		20.	9	Fair			29 84	115	
	9		N. b. E. 2		29 91	86			6	Mild	S. S. W. 1	S. W.	29 87	110	
5.	6	Frost and	N. b. E. 2		29 83	82		21.	6	warm &	S. W. 2		29 94	81	
	12	Fair	N. E. 2		29 75	109		21.	9	Fair			29 98	115	
	9	Cloudy			29 69	95			6	Cloudy	W. S. w. 0	W.	29 99	97	
6.	6	Cloudy	E. b. N. 0	N.	29 55	92		22.	6	Fairer	W. b. S. 2		29 00	130	
	12		E. S. E. 1	S.	29 46	112		22.	9	Fairer			29 97	110	
	9				29 43	95			6	Fair	S. w. b. w. 2		29 96	104	
7.	6	Cloudy	S. e. b. e. 1	S. E.	29 37	85		23.	6	and	W. S. W. 3	N. W.	29 97	131	
	12	Cold	E. 2		29 36			23.	9	Pleasant			29 88	113	
	9	Fair			29 28	98			6	Fair	S. S. W. 3	W. S. W.	29 74	109	
8.	6	Cloudy	N. 2		29 17	98		24.	6	Fair			29 60	110	
	12	with some	N. b. W. 1		29 21	103		24.	9	Fair	S. w. b. w. 3	W.	29 64	102	
	9	Drops			29 17	98			6	Fair			29 37	105	
9.	6	Cloudy	S. 0	N. W.	29 13	97		25.	6	Fair	S. w. b. w. 4	W.	29 12	109	0 71
	12	Rain	S. 1	S. W.	29 15	115		25.	9	Rain	W. 4		29 15	123	
	9				29 16	97	0 52		6	Cloudy			29 14	100	
10.	6	Fair	S. b. W. 0	S. W.	29 23	93			6	Fair	S. W. 1		29 23	91	
	12		S. 1		29 31	124		26.	6	Rain	W. b. S. 1		29 31	124	
	9	Cloudy			29 43	104		26.	9	Cloudy			29 41	105	0 01
11.	6	Rain	N. 1		29 46	99			6	Fair	W. b. N. 1	N. b. W.	29 52	89	
	12		N. 3	N. N. E.	29 48			28.	6	Drops of	N. 2		29 64	122	
	9				29 52	101	0 07	28.	9	Rain	E. 1	E. b. N.	29 77	101	
12.	6	Cloudy	N. E. 3		29 59	103	0 35		6	Hoar Fr	N. E. 0		29 81	92	
	12		N. E. 4		29 70	113		29.	6	Fair	E. 1	N. b. E.	29 81	109	
	9				29 83	99		29.	9	Cloudy	E. 0		29 79	104	
13.	6	Cloudy			29 90				6	Cloudy	E. 0	N. b. W.	29 78	96	
	12	Fair	N. E.		29 86	97		30.	6	Fair	S. b. W. 1	n. w. b. w.	29 70	135	
	9	Cloudy			29 82	104		30.	9	Cloudy	N. e. b. n. 0		29 81	117	
14.	6	Cloudy	N. e. b. e. 3		29 83	121							Total		3 44
	12	Fair	E. N. E. 3	E.	29 83	121									
	9	Rain			29 76	108	0 12								
15.	6	Cloudy	N. e. b. n. 3	E.	29 64	105	0 05								
	12	Rain	S. W. 1	S. W.	29 61	118									
	9	Fairer			29 61	101	0 97								
16.	6	Cloudy	S. b. W. 1		29 58	101									
	12	Fair	S. 1		29 50	129									
	9				29 36	103									

M A Y, 1699.

D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	h.	Weather	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	6	Fair	W. by S. 1 N. W. 1	N. W.	29 24	118		17.	6	Cloudy	E. N. E. 3 N.e.b.e. 3		29 76	113	
	9					138			9				29 72	137	
2.	6	Fair							9	Fair	N.e.b.n. 2		29 71	113	
	9	Dry						18.	6	and hot			29 69	115	
	9	Rain	S. by W. 3		29 65	113			9	Day			29 77	124	
3.	6	Cloudy	S.w.b.w. 2 W S.W. 3		29 47	120	0 34		6	Fair	N. 2 N.e.b.e. 3	N. b. E.	29 80	113	
	9	Showers	W. 3		29 38	135	0 19	19.	6	Fair	E. b. S. 0		29 83	140	
4.	6	Fair	S. b. W. 1		29 35	106			9		N. E. 2		29 86	110	
	9	Rain			29 34	105		20.	6	Same	E. by S. 2		29 86	145	
5.	6	Fair	W. by S. 2 S. W. 1		29 17	90			9				29 83	110	
	9	Thunder			29 31	118			6	Cloudy	N. N. E. 1		29 80	112	
	9	Rain			29 40	98	0 20	21.	6	Hot and	E. by N. 2		29 76	148	
6.	6	Hoar Fr.	S. S. W. 1		29 51	92	0 08		9	Fair	N. E. 3		29 75	120	
	9	Fair	S. W. 3		29 58	121			6	Fair	N. E. 2		29 72	112	
	9	Showers			29 69	107	0 01	22.	6	Hot and			29 66	115	
7.	6	Fair	S. by W. 0 S. by E. 2	S.	29 79	98			9	Dry			29 66	115	
	9				29 81	157			6	Cloudy	N.e.b.n. 1	N. b. E.	29 66	109	
8.	6	Fair	S. 1 S. 2		29 90	102			9	Fair	E. 1	N.	29 59	134	
	9				30 87	108			6	Rain	E. 1	W.	29 49	145	
9.	6	Fair			29 90	92			9	Fair	N.N.E. 3	N. b. E.	29 43	117	
	9	and			29 93	115			6	Fair			29 50	106	0 08
	9	Rain	E. 1		29 93	115			6	Fair	N.N.W. 2	N. b. W.	29 53	102	
10.	6	Same	N. E. 1 N. b. E. 1		29 90	92			9	Hail	N.byW. 3		29 55	120	
	9				29 88	147			6	Fair	E. by S. 0		29 57	107	0 61
	9				29 92	118			9	Fairer	S. by S. 1	N. b. W.	29 55	104	
11.	6	Same	N. by E. 3 N. 2		30 00	117			6	Rain	S. W. 2	W. by S.	29 57	132	
	9				30 10	150			9	Fairer	W. 0		29 62	113	0 10
	9				30 21	108			6	Fair	S. W. 1		29 65	109	
12.	6	Fair	N. by W. 2 N. 4		30 17	105			6	Cloudy	S. W. 1	S.	29 67	140	
	9	and			30 14	132			9	Fair	S. 0		29 66	118	
	9	Dry			30 10	108			6	Fair	E. 1	S. E.	29 61	122	
13.	6	Same	N. b. E. 3 N. N.E. 4		30 10	110			6	Sultry	E. 2	S.	29 57	150	
	9				30 08	137			9	Rain	E. 0	E. S. E.	29 58	131	
	9				30 09	109			6		E. 0	N. W.	29 63	124	0 09
14.	6	Cloudy	N. N.E. 2 N. b. E. 2		30 05	110			6						
	9	Fair	E. 1	N. N. E.	30 02	130		30.	6						
	9				30 01	112			9						
15.	6	Same	E. N. E. 1	N. E.	29 99	110			6	Hot and					
	9				29 92	100		31.	6	Dry					
16.	6	Cloudy	N.e.b.e. 2	E. N. E.	29 88	108			9		W. b. S. 2		30 08	114	
	9	Fair	E. N. E. 3		29 87	151							Total		2 6;
	9	Cloudy			29 83	110									

J U N E, 1699.

D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	6	Very dry, hot Day	S. W. 2	W. b. S.	30 08	132		6							
	9				30 00	138		17.	12						
2.	6	Fair	S.w.b.f. 0	S.w.byS.	29 91	132		6							
	9	Rain			29 85	134	0 01	18.	12						
3.	6		W. 2		29 90	123		6							
	9							19.	12						
4.	6							6	Some Cloudy	W.N.W. 1			29 88	148	3 61
	9							6	Some P.	W.N.W. 0	N.w.b.n.		29 92	128	
5.	6							6		W. 0	N.N.W.		29 95	130	
	9						0 01	21.	12	S. 1	N. W.		29 98	163	
6.	6	Fair and Dry	W. by 2		29 72	120		6							
	9		W. by S. 3	W. by N.	29 78	121		22.	12						
7.	6		W. 2		29 82	142		6	Fair						
	9							23.	12	S. E. 1			29 93	165	
8.	6							6	Hot Day				29 93	141	
	9							24.	12	S. E. 1			29 94	140	
9.	6	Great Drought						6	Fair	N. by W. 1	W.		29 94	165	
	9							6	Sultry Rain	E. 1			29 93	140	0 20
10.	6	Cloudy		N. W.				6	Fair	E. 0	W. by N.		29 89	140	
	9	Fair	W. by N. 2	W. by N.	29 67	146	0 53	25.	12	W. by S. 1			29 87	166	
11.	6	Fair	W. 0		29 73	125		6	Hot Day	S.w.b.w. 2			29 82	144	
	9	Hot Cloudy	W. by S. 1		29 79	126		6	Fair	W. 2	W. by N.		29 76	142	
12.	6	Hot and very Dry	E. 1	W. by S.	29 80	138		6	Fair	N. W. 2			29 84	134	
	9		E. by S. 0		29 81	136		6	Same	N. W. 2	N.w.b.n.		29 98	130	
13.	6	Fair	E. 1		29 76	131		6	Same	S. 2	W.		30 01	158	
	9	Rain	E. by S. 1	S.E. by S.	29 71	158		6	Same	W.S.W. 2	W.		29 90	133	
14.	6		S. 1	S. by E.	29 70	138	0 04	6	Same	W.N.W. 2	W.		29 91	161	
	9		S. S. W. 3		29 86	126		6	Same	W. by S. 1			29 92	125	
15.	6		S. by W. 4	S.w. by f.	29 92	154		6	Same	n.w.b.w. 1	N. W.		29 99	135	
	9							6	Same	n.w.b.w. 3	N.		29 97	162	
16.	6							6		E. ;			29 97	130	
	9												Total		4 40

JULY, 1699.

D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
6		Miling	N.e.b.e 1		30 00	134	
1.	12	Hot and	E. S. E. 2		30 00	150	
	9	Fair			29 97	122	
	6	Fair	E. S. E. 1		29 96	125	
2.	12	and	N. E. 2		29 92	150	
	9	Hot			29 87	124	
	6		E. 1		29 83	131	
3.	12	Same	E. 2		29 82	157	
	9				29 78	129	
	6	Fair	E. b. N. 1		29 74	120	
4.	12	Cloudy					
	9	Fair	N.e.b.n. 1		29 80	135	
	6	Fair	N. 2		29 85	123	
5.	12		N. 2	N. N. E.	29 87	150	
	9	Cloudy			29 90	125	
	6		N. b. E.		29 90	120	
6.	12	Cloudy	N. N. E. 2		29 90	143	
	9				29 86	115	
	6		N.e.b.n. 0	E. b. N.	29 84	120	
7.	12	Fair	E. 1		29 81	147	
	9				29 78	125	
	6	Fair	E. by S. 1		29 79	110	
8.	12	and	W.n.w. 1	W. b. N.	29 82	165	
	9	Hot	N.w.b.n. 0		29 90	143	
	6		N. b. W. 1		30 01	152	
9.	12	Same	n.w.b.w. 1	N. W.	30 03	153	
	9				30 04	131	
	6				30 01	119	
10.	12	Same					
	9		W.		29 88	147	
	6	Hot and	W. by S. 2		29 89	140	
11.	12	Dry	W. b. N. 2	N. W.	29 89	162	
	9				29 92	143	
	6	Sultry	E. by N. 0		29 97	140	
12.	12	Hot	E. N. E. 1		29 97	178	
	9	Cloudy			29 97	143	
	6	Very	E. by S. 0		29 96	133	
13.	12	Hot and	E. S. E. 1	S. b. E.	29 97	173	
	9	Dry			29 90	142	
	6	Sultry	E. 1		29 87	136	
14.	12	Rain &	E. by S. 2	E. b. N.	29 88	164	
	9	Thunder			29 91	139	0 64
	6	Cloudy	N.e.b.n. 2		29 93	136	
15.	12	Fair and	N. E. 3		29 90	164	
	9	Dry			29 87	136	
	6	Fair	N. E. 2		29 87	140	
16.	12	Hot and	E. 2	N. E.	29 88	172	
	9	Dry			29 89	134	

D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
	6		E by N. 0		29 91	138	
17.	12	Same	E. by N. 2		29 93	167	
	9				29 90	131	
	6	Cloudy	N. by E. 3		30 03	130	
18.	12	Cool	N. 2		30 06	142	
	9	Day			30 06	127	
	6		N. 2		30 01	126	
19.	12	Same	N. 1		29 98	138	
	9	Rain			29 92	123	
	6	Cloudy	N. N. w. 1		29 86	115	
20.	12	and	N. w. b. n. 2		29 86	139	
	9	Cool			29 86	120	0 66
	6	Cloudy	N. N. w. 1		29 87	120	
21.	12		N. N. w. 1	N. N. E.	29 87	155	
	9	Fair	S. 1		29 83	134	
	6	Fair	W. by S. 1		29 81	122	
22.	12		N. W. 1		29 80	159	
	9	Cloudy	S. E. 0		29 78	135	
	6	Fair	S. E. 1		29 78	131	
23.	12	Some	S. 2		29 74	172	
	9	Drops			29 73	139	
	6	Fair	S. W. 1		29 71	128	
24.	12	Rain	S. W. 2	W.	29 67	160	
	9	Fair			29 58	129	0 01
	6		S. S. E. 1		29 37	129	
25.	12	Rain	S. 1	S.	29 21	129	1 89
	9				29 17	129	1 89
	6	Fairer	S. 1	S. W.	29 21	118	
26.	12	Rain		S. S. W.	29 21	156	
	9	Fair	S. 2		29 25	129	0 23
	6		S. by W. 2	S. W. b. f.	29 11	128	
27.	12	Same	S. 4	S. S. W.		153	
	9				29 18	128	0 21
	6	Fair	S. 1		29 24	125	
28.	12		S. W. 4	S. S. W.	29 27	147	
	9	Rain			29 28	129	0 34
	6	Fair	S. by W. 3		29 30	129	
29.	12	Rain	S. w. b. f. 4	S. W.	29 29	148	
	9	Thunder			29 35	124	2 21
	6		S. w. b. f. 3	S. W.	29 38	122	
30.	12	Fairer	S. W. 4		29 42	149	
	9				29 46	128	
	6	Rain	S. S. E. 1	S. by W.	29 36	126	1 04
31.	12		S. 4		29 34	144	
	9	Fair			29 36	127	
					Total		6 63

AUGUST, 1869.

D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain	D.	h.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
1.	6	Fair	S. by W. 4	S. S. W.	29 32	128		17.	6	Fair	N. N. W. 1		29 98	108	
	12	Rain	S. w. b. f. 4		29 33	14			12						
	9	Cloudy	S. W. 8		29 36	130	0 07		9	Cloudy			30 00	116	
	6	Fair	W. by S. 1		29 62	118					N. by W. 1		30 01	110	
2.	12	Fair	W. S. W. 1	W. by S.	29 70	145		18.	12	Cloudy	N. 2	N. N. E.	30 03	138	
	9	Cloudy			29 63	131			9				30 02	115	
	6	Cloudy	N. N. W. 1	W. S. W.	29 56	123			6		N. 2		29 97	116	
3.	12	Fair			29 72	117		19.	12	Cloudy	N. by E. 2	N. N. E.	29 92	142	
	9	Fair			29 72	117			9				29 87	121	
	6	Cloudy	N. N. W. c	W. by S.	29 75	105			6	Cloudy	E. N. E. 1		29 82	119	
4.	12	Fair	E. by S. 2	W. by N.	29 71	147		20.	12	Fairer	N. e. b. n. 2		29 80	140	
	9	Rain			29 50	12			9	Cloudy			29 76	127	
	6	Rain	E. by S. c	S. w. by l.	29 37	125	3 38		6		N. E. 1	N. e. b. n.	29 70	117	
5.	12	Fairer	S. W. 1	W.	29 31	139		21.	12	Fairer			29 56	129	
	9	Fairer			29 63	127	0 46		9				29 50	125	
	6	Showery	S. c		29 07	123			6	Mist	N. N. E. 0		29 53	150	
6.	12	Showery	S. 2		29 59	139		22.	12	Fair	W. by N. 1		29 59	122	
	9	Fairer			29 50	131	0 08		9	Fair			29 63	118	
	6	Fairer	S. W. 4		29 39			23.	12	Misty	S. by W. 0	S.	29 64	118	
7.	12	Rain			29 32	126			9	Fair	S. 2		29 56	128	
	9	Rain			29 32	126			6	Cloudy	S. 1	S. by W.	29 47	120	0 24
	6	Fair	S. W. 4		29 30	118	0 75						29 43	148	
8.	12	Rain	S. W. 3		29 55	117	0 66	24.	12	Cloudy	S. by W. 3		29 37	127	0 21
	9	Rain			29 55	117	0 66		9	Rain			29 41	119	
	6	Fairer	S. W. 2	W. S. W.	29 63	116			6	Cloudy	S. W. 1	W.	29 53	149	
9.	12	Fairer	S. w. b. w. 3		29 66	145		25.	12	Fair	S. W. 3		29 64	124	
	9	Fairer			29 69	125			9	Fair			29 71	116	
	6	Fair	S. w. b. f. 3		29 70	119			6	Fair	S. W. 1	W. by S.	29 68	137	
10.	12	Cloudy	S. W. 3		29 72	150		26.	12	Rain	S. by E. 2		29 61	136	0 58
	9	Cloudy			29 72	131			9	Rain			29 67	120	
	6	Fair	S. 1	S. S. W.	29 65	116			6	Fair	S. w. b. l. 2		29 65	143	
11.	12	Cloudy	S. 3		29 58	152		27.	12	Cloudy	S. w. b. f. 3	S. S. W.	29 45	128	
	9	Cloudy			29 43	137			9	Cloudy	S. 4		29 48	118	
	6	Rain	N. W. 1	W. by S.	29 49	117			6	Fair	S. W. 5	S. w. b. w.	29 59	140	
12.	12	Fair	W. by N. 3		29 57	140		28.	12	Fair	W. by S. 5	W. N. W.	29 80	117	
	9	Fair			29 65	120	0 44		9	Fair	W. S. W. 1	W.	29 86	112	
	6	Cloudy	S. S. W. 3	N. W.	29 67	120			6	Fair	S. W. 0	W.	29 89	129	0 12
13.	12	Rain			29 65	132		29.	12	Rain	S. W. 1		29 89	121	
	9	Rain			29 65	132			9	Rain			29 80	150	
	6	Cloudy	S. W. 2		29 61	131	0 17		6	Fair	S. S. W. 2	S. W.	29 78	121	
14.	12	Fair	W. by S. 2	N. W.	29 69	153		30.	12	Fair	S. S. W. 2	S.	29 60	115	0 01
	9	Fair			29 73	134			9	Fair			29 73	129	
	6	Fair	W. S. W. 2	W. by S.	29 75	139			6	Fair	E. 1		29 73	129	
15.	12	Rain	W. S. W. 3		29 72	158		31.	12	Rain	W. 2		Total	8 57	
	9	Rain			29 75	122	0 44		9	Rain					
	6	Fair	N. W. 1		29 87	110									
16.	12	Fair	N. w. b. n. 2		29 98	132									
	9	Fair			30 00	111									



OCTOBER, 1699.

D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
	6	Fairer	E. by N. 1	E.	29 97	122		6		Fair	E. 1	S. E.	29 50	117	
1.	12		E. 2		29 93	132		17.	12	Fair	E. 1	S. E. by E.	29 56	130	
	9	Cloudy			29 93	123			9				29 61	111	
	6	Rain	E. by N. 2		29 87	118			6		N. E. 2		29 65	118	
2.	12	Fairer	E. by N. 1		29 80	131		18.	12	Cloudy	E. by N. 1		29 65		
	9	Rain			29 73	111	1 45		9				29 66	110	
	6	Fairer	E. by S. 1	S. S. W.	29 67	115	1 92		6		N. E. 2		29 68	110	
3.	12	Cloudy	S. W. 2		29 67	128		19.	12	Same	E. by N. 3		29 71	83	
	9				29 73	118			9				29 74	114	
	6		S. W. 0		29 79	108			6	Cloudy	E. 3		29 75	111	
4.	12							20.	12	and	E. by N. 3		29 80	111	
	9								9	Cool			29 85	93	
	6	Cloudy							6		E. 1		29 89	79	
5.	12	Fair			29 98	96		21.	12	First Ice	E. 3		29 92	120	
	9								9				29 95	83	
	6	Hoar Fr.	N. N. W. 1		30 12	87			6	Frost	S. 0		29 91	73	
6.	12	and	N. 1		30 17	112		22.	12	and	E. by S. 1		29 91	98	
	9	Fair			30 22	80			9	Fair			29 87	79	
	6		N. W. 0		30 18	99			6		E. 0		29 77	70	
7.	12	Cloudy	W. by N. 1		30 19			23.	12	Same	E. by S. 2	E.	29 77	101	
	9	Rain			30 20	96			9				29 70	82	
	6		N. e. b. n. 1		30 21	103	0 07		6	Cloudy	E. 1	S. W.	29 51	85	
8.	12	Cloudy	E. by N. 1		30 20	119		24.	12		S. E. 3	S. W. b. S.	29 32	111	
	9				30 16	110			9	Rain			29 07	1 95	95
	6		E. 0		30 07	106			6	Fair	S. W. 3		29 18	94	1 04
9.	12	Same	E. by N. 2		30 06	119		25.	12	Cloudy					
	9				30 01	99			9	Rain			29 16	95	
	6	Mist	E. by N. 0		29 92	92			6		W. 1	N. w. b. n.	29 18	92	0 90
10.	12	Fair			29 85	104		26.	12	Fair	N. by W. 3	N. W.	29 32	110	
	9								9		W. N. W. 0		29 51	88	
	6	Mist	E. 1		29 80	99			6	Frost	W. S. W. 0		29 51	82	
11.	12	Cloudy						27.	12		S. 3		29 42	117	
	9	Misting			29 80	120			9	Cloudy	S. W. 1		29 43	111	
	6	Mist	S. e. b. e. 0		29 75	109	0 40		6	Cloudy	S. W. 0		29 51	100	
12.	12	Warm	S. 2		29 77	140		28.	12		S. w. b. f. 1		29 51	114	
	9	Fair			29 79	115			9	Rain	E. S. E. 2		29 28	110	1 24
	6	Cloudy	S. 0	S. by W.	29 77	106			6		S. 3		29 08	117	0 31
13.	12	and	S. w. b. f. 3		29 70	136		29.	12	Rain	S. S. E. 2	S.	29 03	122	
	9	Warm			29 87	119			9		W. N. W. 3		29 10	96	0 43
	6		S. by E. 2		29 78	119			6		S. w. b. w. 2		29 48	89	
14.	12	Same	S. 2		29 81	133		30.	12	Fair			29		
	9				29 65	122			9				29 48	100	
	6	Cloudy	S. 3	S. S. W.	29 57	129			6	Cloudy	S. 4	S. W.	29 36	115	3 12
15.	12	Misting	S. 2		29 57	136		31.	12				29		
	9	Rain			29 54	127			9	Rain			29 14	113	
	6		E. S. E. 2	S. E. by S.	29 52	122							Total		13 49
16.	12	Rain	S. E. 1	S. by E.	29 48	130									
	9				29 50	122	0 64								

DECEMBER, 1699.

D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.	D.	b.	Weather.	Winds.	Clouds.	Barom.	Ther.	Rain.
8		Cloudy	N.N.W. 0		29 71	73		8		Frost and	N. 0		30 25	73	
1.	12	Hard Fr.	N. W. c		29 71	76		17.	12	Fair	S. W. 1		30 20	88	
	9	Fairer			29 58	60		9		Rain			30 33	90	0 29
2.	8	Frost	E. by S. 3		29 30	78		8		Frost	N. W. 1		30 44	82	
	12	Cloudy	E. 4		29 12	82		18.	12	Hazy			30 35	76	
	9	Snow			28 01	81		9		Fair			30 21	81	
3.	8	Rain	E. 3		28 61	91	0 56	19.	12	Cloudy with	W. 1	N. W.	30 20	93	
	12		E. by S. 3		28 52	94		9		Thaw	N. W. 1		30 23	91	
	9				28 41	100		8		Cloudy	N. W. 0	N.	30 26	86	
4.	8	Cloudy	E. S. E. 3	S. S. E.	28 00	98	0 18	20.	12	Fair	N. W. 1		30 27	102	
	12	Fair			28 74	99		9		Fair	W.N.W. 0		30 31	94	
	9	Rain			29 01	99	0 13	8		Mistling	N. by W. 0		30 36	90	
5.	8	Fair	S. by E. c	S. by W.	29 14	110		21.	12	Fairer	N. by E. 1		30 40	99	
	12	Rain	S. 2	S. S. W.	29 28	103		9		Mistling	N. 0	N. E.	30 50	89	
	9				29 26	107	0 74	22.	12	Cloudy	N. 1		30 49	92	
6.	8	Fair	S. 2		29 32	115		9		Fairer			30 46	85	0 67
	12	Rain and Warm	S by E. 3	S. by W.	29 39	108		8		Frost	N. by W. 0		30 40	74	
	9				29 50	106	0 36	23.	12	Fog	N. c		30 38	88	
7.	8	Cloudy and Warm	S. 1		29 48	112		9		Cloudy	S. by E.		30 15	86	
	12				29 48	105		8		Cloudy	S. W. 0		30 21	86	
	9				29 37	109		24.	12	Cloudy	S.w.b.f. 2		30 19	94	
8.	8	Cloudy	S. S. E. 1	S. by E.	29 32	116		9		Fairer	S. S. W. 1		30 15	91	
	12	Mistling Warm	S. S. E. 3		29 36	114		25.	12	Rain	S.w.b.w. 1		30 14	98	
	9				29 19	113		9		Fairer	S. by W. 1		29 98	102	
9.	8	Rain	S. E. 3		29 19	117		26.	12	Cloudy	W. c	n.w.b.w.	29 96	107	0 68
	12		S. S. E. 3		29 29	112	0 38	9		Fair	W. 1	N. W.	30 06	105	
	9				29 41	102		27.	12	Fair	W. by S. 2	N.N.W.	29 95	80	
10.	8	Fair	S. by E. 1		29 46	112		9		Fair	N. W. 2		29 94	98	
	12		S. by E. 2		29 57	98		9		Fairer	W. by N. c	N. by W.	29 94	91	
	9				29 83	92	0 06	8		Fog	W. by N. 0		29 90	94	
11.	8	Fair	S. W. 0		29 95	108		28.	12	Mistling	W. by S. c	n.w.b.w.	29 86	108	
	12	Cloudy Rain			29 84	109	0 36	9		Rain			29 80	106	0 21
	9				29 78	115		8		Fair	W. by N. 2		29 72	90	0 50
12.	8	Cloudy and some Rain	S. by E. 2	S. by W.	29 73	108		29.	12	Fair	N. W. 4		30 03	82	
	12		S. 1	S. W.	29 54	110	0 61	8		Frost	S. W. 2		30 01	89	
	9				29 57	112		30.	12	Cloudy	S. W. 3	W. by S.	29 96	104	
13.	8	Cloudy	S. W. 3		29 63	104		9		Rain			29 94	105	0 24
	12	Fair	S.w.b.w. 3		29 51	102	0 21	8		Fairer	S. W. 3		29 95	110	0 0
	9				29 43	108		31.	12	Cloudy	S. W. 3		29 92	112	
14.	8	Rain	S. W. 1	W. by S.	29 48	98		9		Cloudy			29 95	108	
	12		W. by S. 1		29 64	100							Total		5 77
	9				29 69	103									
15.	8	Fair	W. by N. 2	N.N.W.	29 91	99									
	12	Cloudy	N.N.W. 1		30 07	95									
	9				30 14	101									
16.	8	Mistling	N.N.W. 1		30 27	87									
	12	Fair	N. 1												
	9														

N. 249.
p. 46.

In these Tables, I have never set down the *Flying of the Clouds*, but when they varied from the Winds; which oftentimes happens, especially before the Wind shifteth its Course: Mountains, &c. may cause some Variation, but as little at *Upminster*, as almost any where. This last Column will be necessary, amongst other Uses, to shew the Reason why the *Mercury* varies sometimes: As suppose the Wind was in the Southerly Points, and the Clouds flew from the Northerly; the Rising of the Mercury would be readily accounted for.

N. 262.
p. 527.

My *Thermometet* is graduated by Inches and decimal Parts. The Point of Freezing is about 80, or at most 82 Degrees, and consequently 'tis cold at about 90, and temperate at about 100 Degrees. I need not say, that the Degrees above 100 are warm or hot; and those below 80 are harder Frosts. The Degrees of my *Thermometer* reach to 240, although I could never make the Spirits descend with artificial Freezing, much lower than 50, neither when exposed to the Heat of a pretty strong Sun, did they ascend above 225. It is placed in the open Air, and always defended from the Beams of the Sun. So that it sheweth only the true present Temperature of the Air.

The Winter has been so mild (as appears by the *Thermometer*) that many of the Days of *November* and *December* were not much colder than many of the Mornings and Evenings of the warmer Months. These two last Months have been also much drier than usual, so that had it not been for the Rains of *October*, perhaps a Drought had been a general Calamity.

I have had frequent Confirmations of what I observed last Year, concerning the Mercury rising in foggy Weather. The like it doth also in misting Weather; as may be seen in divers Places of this Table: Particularly *December* 22, the Weather being misting, and Wind Northerly, it ascended to 30, 50 Inches, the highest I ever saw at *Upminster*.

Hurricanes
and Storms,
by Mr. J.
Templer, n.
71. p. 2156.

XXVIII. 1. *October* 30, 1659. Between five and six of the Clock in the Evening, the Wind Westerly, at *Ashley* in *Northamptonshire*, happen'd a formidable *Hurricane*, scarce bearing sixty Yards in its Breadth, and spending itself in about seven Minutes of Time. Its first discerned Assault was upon a *Milk-maid*, taking her Pail and Hat from off her Head, and carrying her Pail many Scores of Yards from her, where it lay undiscovered some Days. Next it storm'd the Yard of one *Sprigg*, dwelling in *Westberp*, where it blew a Waggon-body off the *Axle-trees*, breaking the *Wheels* and *Axle-trees* in pieces, and blowing three of the *Wheels* so shatter'd over a Wall. This *Waggon* stood somewhat cross to the Passage of the *Wind*. Another *Waggon* of Mr. *Salisbury's* marched with great Speed upon its *Wheels* against the Side of his House, to the Astonishment of the Inhabitants. A Branch of an *Ash-tree*, of that Bigness, that two lusty Men could scarce lift it, blew over Mr. *Salisbury's* House without hurting it; and yet this Branch was torn from a Tree an hundred Yards distant from that House. A Slate was forced upon a Window of the House of *Sam. Templer*, Esq; which very much bent an Iron Bar in it; and yet 'tis certain, that the nearest Place the Slate was first forced from, was near

near 200 Yards. At Mr. *Maidwell's* Senior, it forced open a Door, breaking the Latch, and thence marching, through the *Entry*, and forcing open the Dairy-door, it over-turned the Milk-Vessels, and blew out three Panes or Lights in the Window; next it mounted the *Chambers*, and blew out 9 *Lights* more. From thence it proceeded to the *Parsonage*, whose Roof it more than decimated; thence it crosseth the narrow Street, and forcibly drives a Man head-long into the Doors of *Tho. Briggs*. Then it passed with a cursory Salute at *Tho. Marston's*, down to Mr. *Geo. Wignil's*, at least a *Furlong's* Distance from *Marston's*, and two *Furlongs* from *Sprigg's*, where it play'd notorious Exploits, blowing a large Hovel of *Pease* from its Supporters, and setting it cleverly upon the Ground, without any considerable Damage to the Thatch. Here it blew a Gate-post, fix'd two Foot and an half in the Ground, out of the Earth, and carried it into the Fields many Yards from its first Abode.

About half a Mile distant from the Town is a small *Wood* on the Top of an Hill, and partly descending into a Vale encompassed by Northerly and Southerly Hills; so that the Wind may seem confin'd to the Vale as a *Channel*, before it assaulted the Town, and thereby enforc'd to spend itself only in that *Glade*. But I am unapt to think, that some *Flatus* from the descending Wood-ground might contribute to this Accident, because the Wind continued, so far as Men could judge, as high in the Field afterwards; and the Site of the Town did expose (by reason of those Vallies) a far greater Part of the Town to this Damage than was troubled, the Valley being above four or five times the Breadth of that Part of the Town concerned in it.

2. Oct. 13, 1670. At *Braybrook* in *Northamptonshire*, about eleven a Clock, the Wind, in a strange Form, assaulted a *Pease-Rick* in the Field, uncovering the Thatch of it, and leaving another within twenty Yards unconcerned. Thence it proceeded to the *Parsonage*, where it carried not twelve, scarce eight Yards in Breadth, blowing up the End of a *Barley-Rick*, and therewith some Stakes in it of near five Foot long. In the mean while it left a *Wheat-hovel* within six Yards of the *Barley-Rick*, and being without all Shelter, untouched, no Part of the Thatch of the *Hovel* being so much as furled. Nevertheless it beat down a *Jackdaw* from the Rick, with that Violence, as forc'd the Guts out of the Body, and made it bleed plentifully at the Mouth. This I saw, and took up, in some Company, the Daw very warm. Thence it went in a right Line to the *Parsonage House*, took off the Cover of all the House in its Compass. From hence it passed over the Town without any Damage, the rest of the Town being low in Situation, and went on to a Place called *Fortbill*, where it uncloathed so much of the Malt-house as lay within its Line and Breadth, so as to expose the Malt upon the Floor to the open Air.

By Mr. J.
Templer, *ib.*
p. 2157.

Braybrook stands in a Valley environed by Hills on three Sides, at three Quarters of a Mile's Distance from it. But (what I could chiefly observe) there is an Hill call'd by the Name of *Clackbill*, within a Mile of it, and exactly in that Point of the *Compass* in which the Wind then stood; no Hill in its way till the *Wind* had passed over all the Places it endamaged. And which is remarkable, there have been two Earthquakes in this Town within these ten Years,

Years, when the then gentle Air (or Wind shall I call it) only vibrated upon that Point of the Compass.

By Sir Geo.
Mackenzie,
n. 124. p.
307.

3. Dec. 21. 1674. The *Wind* here (at *Tarbut*) was extraordinary: It broke a Standard-Stone, that stood as an *Obelisk* near an old Church; which Stone was about twelve Foot high, five Foot broad, and near two Foot thick. Whole Woods were overturned, and torn up from the Root, though in a low Situation. It blew from the North-west, and of a long time the Wind had continued Westerly.

By Mr.
Scarsburgh,
n. 231. p.
659.

4. Oct. 19. 1693. There happen'd a most violent Storm in *Virginia*, which stopped the Course of the ancient Channels, and made some where never were any: So that betwixt the Bounds of *Virginia* and *Newcastle* in *Pensylvania*, on the Sea-board Side, are many navigable Rivers for Sloops and small Vessels.

By . . . n.
212. p. 192.

5. Aug. 1, 1694. There happen'd here (at *Warrington* in *Northamptonshire*) between One and Two a Clock, a very terrible *Whirlwind* amongst the Shocks of Corn, in that Part of *Acrement Close*, which is in the Possession of Mr. *Holt*, and took up into the Air about 80 or 100 Shocks, carrying a great deal out of Sight; the rest was scattered about the Field, or on the Tops of Houses or Trees thereabouts. I have seen of the Corn which was carried a Mile distant from the Field; and it is reported by Persons of good Credit, that some was carried four or five Miles distant. The *Whirlwind* continued in *Acrement Close* full half an Hour: I myself, and several other Persons, saw at least three or four Waggon Loads of Corn all at once whirled about in the Air.

A Spout at
Topsham,
near Exeter,
by Mr. Z.
Maine, n.
215. p. 18.

XXIX. These Appearances are frequent abroad, but very seldom or never seen before with us, tho' some pretend to have seen of them in the *Downs*. The *French* call them *Trombs*, I suppose from the Figure and the Noise that they make, that Word signifying a Sort of a *Humming Top*. They are certain Elevations of Water during *Storms* and *Tempests*, reaching from the Superficies of the Sea to the Clouds. They happen several Ways; sometimes the Water is seen to boil, and raise itself for a considerable Space round, about a Foot from the Surface, above which appears, as it were, a thick and black Smoak, in the Midst of which is observed a Sort of Stream or Pipe resembling a Tunnel, which riseth as high as the Clouds; at other Times these Pipes or Tunnels are observed to come from the Clouds, and suck up the Water with great Noise and Violence. They move from the Place where they were first gathered, according to the Motion of the *Wind*, and discharge themselves sometimes into the Sea, to the unavoidable Destruction of such Ships as are in their Way, if they be small Vessels, and to their great Damage be they never so big: Sometimes on the Shore beating down all they meet with, and raising the Sand and Stones to a prodigious Height. 'Tis said that Vessels, that have any Force, usually fire their Guns at them, loaden with a Bar of Iron; and if they be so happy as to strike them, the Water is presently seen to run out of them with a mighty Noise, but no further Mischief.

One of these *Spouts* happened here, at *Topsham*, Aug. 7, 1694, between nine and ten of the Clock in the Forenoon: 'Twas then very near, if not quite
Low-

Low-Water, which is look'd on as a special Providence, since had it been High-Water, 'tis concluded its Strength would have been much greater, and its Consequences more sad. The Water that was nearest seemed to fly hither and thither, as though it would fain make its Escape from it: Yet I cannot find, upon Enquiry, that the Channel was at all wholly dry. There was also some Wind, though not so violent as it had been before, or when the *Spout* or *Tromb* began to move; it went with the Wind (which was then at *W. N. W.*) like a dark Smoke.

The Marks *++-* shew the River, *O* the *Spout*, *S* Mr. *Seaward's* House, Fig. 19. which it gently touch'd with little Damage, blowing only off a few Tiles; *G*, Widow *Goldsworby's* House, which it in Part uncovered, and took almost all the Thatch off her Garden Wall. It took off also an Apple-tree, which was no way decay'd, and between fifteen and sixteen Inches about, within two or three Inches from the Ground, almost as exactly as any Saw could have done it, and carried it, as I judge, between twenty and thirty Foot from the Place where it grew, and that not forward in the Path that it took, but almost directly backward; which makes me conclude, that it had a double Motion; the one external from the Wind strait forward, the other internal and circular, like the *Fly* of a *Jack*, which a Man may carry in his Hand, that will strike any Thing either forward or backward as it meets with it. *H*, Mr. *Green's* House, which was for the most Part untiled. There were two Houses more, *W*, *L*, very much damaged in their Coverings; yet Mr. *Moxam's*, *M*. tho' it stood between them, and was much higher than either, had only two or three Quarries of Glass broken. *EEEE*, shews the March of the *Spout*. *X*, Planks that were blown, some upright, some several Yards out of their Place. *D*, a Ship newly launched, of about one hundred Tuns, which was much shaken, but not hurt. *K*, a Mast of near a Tun Weight, thrown out of its Place. *C*, an Anchor that was torn out of the Ground and carried seven or eight Foot with a Boat that was fasten'd to it, and blown up into the Air; that Boat was rent from the *Head* to the *Keel*. *B*, another new Boat blown about six Foot high, and turned upside down. *F*, a Fisher-boat with one Man in it, which was near the Place where the *Spout* was at first perceived, but through Mercy escaped. *P*, a Lane that goes from the River in which some Houses suffered Damage, which shews that the *Spout* was divided in its March. 'Tis no small Mercy that no Man, Woman, or Child received the least Injury in their Persons.

XXX. 1. *John Gill* affirms, that he hath observed on several Occasions, that being in a Calm, that Way which the Sea began to loom or move, the next Day the Wind was sure to blow.

Prognosticks of the Wind; by *J. Gill*, n. 26, p. 481.

2. It hath been the Custom of our *English* and *French* Inhabitants of the *Caribbee Islands*, to send in, about the Month of *June*, to the native *Caribbees* of *Dominico* and *St. Vincent*, to know whether there would be any *Hurricanes* that Year; and about ten or twelve Days before the *Hurricane* came, they did constantly send them Word, and it very rarely or seldom failed. From one of these *Indians* (whom in 1657, I engaged by Civilities to remain with me several Years) I had the following *Prognosticks*.

Prognosticks of Hurricanes; by *Capt. Langford*, n. 246, p. 407.

1. All Hurricanes come either on the Day of the Full, Change, or Quarter of the Moon.

2. If it will come on the Full-Moon, you being in the Change, then observe these Signs.

That Day you will see the Skies very turbulent, the Sun more red than at other Times, a great Calm, and the Hills clear of Clouds, or Fogs over them, which in the *Highlands* are seldom so. Likewise in Hollows, or Concaves of the Earth, or Wells, there will be a great Noise, as if you were in a great Storm, and at Night the Stars looking very big with Bars about them, and the North-west Sky very black and foul, the Sea smelling stronger than at other Times, as usually it doth in great Storms; and sometimes that Day, for an Hour or two, the Wind blows very hard Westerly, out of its usual Course.

On the Full of the Moon you have the same Signs, with a great Bar about the Moon, and many Times about the Sun.

The like Signs must be taken Notice of on the Quarter Days of the Moon, in the Months of *July*, *August*, and *September*; for the Hurricanes come in those Months; the soonest that I ever heard of was the twenty fifth of *July*, and the latest was the eighth of *September*: But the usual Month they come in is *August*.

The Benefit I have had of foretelling these Hurricanes is, that whereas heretofore they were so dreadful, that all Ships were afraid to go to Sea, and did rather chuse to stay in the Roads at Anchor, than to run the Hazard of the merciless Sea, altho' never Ship escaped at Anchor, but was cast ashore, many Times by the Violence of the Storm, some Vessels having been cast so far on the Shore, that when the Storm was over, they have been from twenty or thirty Yards dry from the Wash of the Shore, and the Vessels set whole; and by this Means the Lives of those that were in those Vessels were saved: But I finding that if a Man keeps his Ship failable, with good Store of Ballasts, his Ports well barr'd and calked, his Top-masts down, and his Tops too if he have Time, his Yards a-port laced, or long Ships, keeping secure his Doors and Windows of his Ship, and she will lie as well as in other Storms; and they may, having their Ships in a Readiness, stay in the Road till the Storm begins, which is always first at North, so to the North-west, till it comes round to the South-east, and then its Fury is over. So with the North Wind they may run away to the South, to get themselves Sea-room for drift of the South-west Wind, where it blows very fiercely: By these Means I have, by God's Blessing, preserved myself in two Hurricanes at Sea, and in three at Shore, in the Years 1657, 1658, 1660, 1665 and 1667; in those at Sea I lost not a Sail, Yard, or Mast, they being two great Hurricanes. And in the Year 1667, I being on Shore at *Nevis*, there was a Hurricane on the nineteenth Day of *August*; and fourteen Days before I did take Notice of the foregoing Signs on a full Moon, and I acquainted Sir *John Berry*, who was Commander of his Majesty's Ship *Coronation*, and several other Commanders there, who did make their Ships ready for the Sea; and in the Morning about four of the Clock, the Wind coming hard Northerly, they

they put to Sea; and by God's Blessing came all back in four or five Days Time safe to the Road again. On the Shore, being confident of the Hurricane's coming, I took such Care before-hand to secure my Sugars and Goods in the Store-house, that when the Hurricane had carried away the Roof of the House, all except one Hoghead of Sugar remained safe.

The Reasons and Causes of these violent Storms, according to my Judgment, may be these:

1. It is not unknown to all Men of Experience, that to the Southward of the *Tropick* there is constantly a *Trade-Wind*, or Easterly Wind, which goes from the North to the South-east all the Year about; except where there are Reversions of *Breezes*, and Inlets near the Land: So that when this Hurricane, or rather Whirlwind, comes in Opposition to the constant Trade-wind, then it pours down with that Force and Violence, that it exceeds all Storms of Wind in the World; for it takes Trees away by the Roots, and those that are extraordinarily strong rooted, it twists off in the Middle: In the Hurricane in 1667, at *Nevis*, I saw the high Mountain that was all green with Trees, left in most Places bare, and the Wood lying in such a Condition, with half Trees, or Stumps, or Quarters, that one would think it almost incredible.

2. It is remarkable by all Men that have been in those Parts where the Sun comes to a *Zenith*, that at his Approach towards the *Zenith*, there is always fair Weather; but at his Return to the Southwards, it occasions oft the North Parts of the *Equinoctial* generally much Rains and Storms, as *Tornado's*, and the like, which makes the Winds in the *Tornado's* to come on several Points. But before it comes, it calms the constant Easterly Winds; and when they are past, the Easterly Wind gathers Force again, and then the Weather clears up fair.

3. The Wind being generally betwixt the *Tropicks* Easterly, unless at such Times as before declared, meeting with the Opposition of these *Hurricanes*, which come in a contrary Course to that *Trade-Wind*, doth cause this violent *Whirlwind*, on the Sun's leaving the *Zenith* of *Barbadoes*, and those adjacent Islands; by which the Easterly Wind doth much decay of its Strength; and then the West Wind, which is kept back by the Power of the Sun, doth with the greater Violence and Force pour down on those Parts where it encroaches. And it is usual in our sailing from *Barbadoes*, or those Islands, to the North for a Westerly Wind, when we begin to lose our Easterly Wind, to have it calm, as it is before *Hurricanes*: And then the Wind springing up, causeth it, till it comes well settled, to be various; but after the settled Westerly Wind comes fresh, we have been constantly without those Shufflings from Point to Point.

Here it is to be observed, that all *Hurricanes* begin from the North to the Westward, and on those Points that the Easterly Wind doth most violently blow, doth the *Hurricane* blow most fiercely against it; for from the *N. N. E.* to the *E. S. E.* the Easterly Wind bloweth freshest; so doth the *W. N. W.* to the *S. S. W.* in the *Hurricane* blow most violent; and when it

comes back to the S. E. which is the common Course of the *Trade Wind*, then it ceaseth of its Violence, and so breaks up. So, with Submission to better Judgments, I take the Cause of *Hurricanes* to be the Sun's leaving the *Zenith* of those Parts towards the South. And Secondly, the Reverse or Rebounding back of the Wind, which is occasioned by the calming of the *Trade Wind*.

But it will be objected, Why should not this Storm be all over those Parts of the *West-Indies*, as well as *Barbadoes* and the *Leeward Islands*? To which I answer, That it hath, in about twenty five Years of my Experience, taken its Course from *Bermudas* or *Summer-Islands*, to the *Caribbee Islands*; but seldom or never doth it carry such a Breadth, as from the Latitude of 16 to 32 Degrees, which are the Latitudes of the one and the other Place; but it hath been observed, that when *Hurricanes* have been in *Martinico*, which is within two Degrees of Latitude, and two Degrees of Longitude, according to the Miles of that Circle, yet no *Hurricane* hath been in *Barbadoes*; nor could I ever call any of the former Storms at *Barbadoes*, *Hurricanes*, till that in 1675. Again, it hath been noted, that *Hurricanes* have done the like to the Northwards: For when the *Hurricane* hath been in *Antegoa* and *St. Christopher's*, those Ships that were but in the Latitude of twenty Degrees, had no *Hurricane*, but constant Westerly Winds reasonably fair, and then there were no *Hurricanes* in *Bermudas*; and when the *Hurricanes* were at *Bermudas*, the *Leeward* or *Caribbee-Islands* had no *Hurricane*; nor had those Islands the *Hurricane* when *Barbadoes* had it.

It may well be further objected, Why the *Hurricane* was never known to go farther to the Westward than *Porto Rico*, which lies in or near the Latitude of those Islands of *St. Christopher's*? To this I answer, That from *Porto Rico* downwards, both that Island as well as *Hispaniola*, and other Islands there adjacent, are of vast Greatness, and very high Lands, that of themselves do most commonly give Reversal or Westerly Winds at Night, through the Year: For there, for the Reasons aforesaid, the Easterly Wind towards Night doth calm, and those Lands afford a *Land Wind*, which the other Islands cannot do, by Reason of the Smallness of those *Carribbe-Islands*, but very near the Shore, the *Trade-Wind* having its full Power till this general *Whirl-wind* comes, for the Reasons aforesaid.

I do imagine so likewise to the Southwards of *Barbadoes*; where the *Tornadoes* come frequently, there are no *Hurricanes*; neither was there at *Barbadoes*, when these *Tornadoes* did commonly come there, which made some small Reversal, though it was but for two or three Hours: Yet the Easterly Wind, giving some way by the Sun's declining from that *Zenith*, doth prevent this furious Reverse, where it hath no Vent, till by the Violence of the two *Winds*, it is forced.

An Experi-
ment of the
Evaporation
of Water; by
Mr. Edm.
Halley, n.
:89. p. 366.

XXXI. We took a Pan of *Water* (salted to the same Degree as is common *Sea-Water*, by the Solution of about a fortieth Part of Salt) about four Inches deep, and 7 Inches $\frac{2}{8}$ Diameter, in which we placed a *Thermometer*, and by Means of a Pan of Coals, we brought the *Water* to the same Degree of Heat which is observed to be that of the Air in our hottest Summers; the *Thermo-*
metet.

meter nicely shewing it. This done, we affixed the Pan of *Water*, with the *Thermometer* in it, to one End of the Beam of the Scales, and exactly counterpoised it with Weights in the other Scale; and by the Application or Removal of the Pan of Coals, we found it very easy to maintain the *Water* in the same Degree of Heat precisely. Doing thus, we found the Weight of the *Water* sensibly to decrease; and at the End of two Hours we observed, that there wanted half an Ounce *Troy*, all but 7 Grains, or 233 Grains of *Water*, which in that Time had gone off in Vapour; tho' one could hardly perceive it smoak, and the *Water* were not sensibly warm. This Quantity in so short a Time seemed very considerable, being little less than 6 Ounces in 24 Hours, from so small a Surface as a Circle of 8 Inches Diameter. To reduce this Experiment to an exact *Calculus*, and determine the Thickness of the Skin of *Water* that had so evaporated. I assume the Experiment ailedged by Dr. *Edw. Barnard* to have been made in the *Oxford Society*, viz. that the Cube Foot *Engliso* of *Water* weighs exactly 76 Pounds *Troy*; this divided by 1728, the Number of Inches in a Foot, will give $253\frac{1}{3}$ Grains, or half Ounce $13\frac{2}{3}$ Grains for the Weight of a Cube Inch of *Water*; wherefore the Weight of 233 Grains is $\frac{233}{253\frac{1}{3}}$ or 35 Parts of 38 of a Cube Inch of *Water*. Now the Area of the Circle, whose Diameter is $7\frac{2}{3}$ Inches, is 49 square Inches; by which dividing the Quantity of *Water* evaporated, viz. $\frac{233}{253\frac{1}{3}}$ of an Inch, the Quote $\frac{13\frac{2}{3}}{49}$ or $\frac{1}{3}$, shews that the Thickness of the *Water* evaporated was the 53d Part of an Inch: But we will suppose it only the 60th Part, for the Facility of Calculation. If therefore *Water*, as warm as the Air in Summer, exhales the Thickness of a 60th Part of an Inch in two Hours from its whole Surface; in 12 Hours it will exhale $\frac{1}{10}$ of an Inch; which Quantity will be found abundantly sufficient to serve for all the Rains, Springs, and Dews, and account for the *Caspian Sea's* being always at a Stand, neither wasting nor overflowing; as likewise for the Current said to set always in, at the *Streights of Gibraltar*, though those *Mediterranean Seas* receive so many, and so considerable Rivers.

To estimate the Quantity of *Water* arising in Vapour out of the Sea, I think I ought to consider it only for the Time the Sun is up, for that the Dews return in the Night as much, if not more Vapours than are then emitted; and in Summer the Days being longer than twelve Hours, this Excess is balanced by the weaker Action of the Sun, especially when rising before the *Water* be warmed: So that if I allow $\frac{1}{10}$ of an Inch of the Surface of the Sea to be raised *per diem* in Vapours, it may not be an improbable Conjecture.

Upon this Supposition, every 10 square Inches of the Surface of the *Water* yields in Vapour *per diem*, a Cube Inch of *Water*; and each square Foot half a *Wine* Pint; every Space of 4 Foot Square, a Gallon; a Mile Square, 6914 Tons; a square Degree, suppose of 69 *Engliso* Miles, will evaporate 33 Millions of Tons: And if the *Mediterranean* be estimated at 40 Degrees long and 4 broad, Allowances being made for the Places where it is broader by those where it is narrower (and I am sure I guess at the least) there will be 160 square Degrees of Sea; and consequently the whole *Mediterranean*

must lose in Vapour, in a Summer's Day, at least 5280 Millions of Tuns. And this Quantity of Vapour, though very great, is as little as can be concluded from the Experiment produced: And yet there remains another Cause, which cannot be reduced to the Rule, I mean the *Winds*, whereby the Surface of the *Water* is lick'd up somewhat faster than it exhales by the Heat of the Sun; as is well known to those that have considered those drying *Winds* which blow sometimes.

The *Mediterranean* receives these considerable Rivers; the *Iberus*, the *Rhone*, the *Tiber*, the *Po*, the *Danube*, the *Neister*, the *Borysthenes*, the *Tanais*, and the *Nile*; all the rest being of no great Note, and their Quantity of *Water* inconsiderable. We will suppose each of these nine Rivers to bring down ten Times as much *Water* as the River *Thames*, not that any of them is so great in Reality, but to comprehend with them all the small Rivulets that fall into the Sea, which otherwise I know not how to allow for.

To calculate the *Water* of the *Thames*, I assume that at *Kingston-Bridge*, where the Flood never reaches, and the *Water* always runs down, the Breadth of the Channel is 100 Yards, and its Depth 3, it being reduced to an Equality (in both which Suppositions I am sure I take with the most.) Hence the Profile of the *Water* in this Place is 300 square Yards: This multiplied by 48 Miles (which I allow the *Water* to run in 24 Hours, at 2 Miles in an Hour) or 84480 Yards, gives 25344000 Cubick Yards of *Water* to be evacuated every Day, that is, 2030000 Tons *per diem*; and I doubt not but in the Excess of my Measures of the Channel of the River, I have made more than sufficient Allowance for the Waters of the *Brent*, the *Wandel*, the *Lea*, and *Darwent*, which are all worth Notice, that fall into the *Thames* below *Kingston*.

Now if each of the aforesaid nine Rivers yield ten Times as much *Water* as the *Thames* doth, 'twill follow that each of them yields but 203 Millions of Tons *per diem*, and the whole nine but 1827 Millions of Tons in a Day; which is but little more than $\frac{1}{3}$ of what is proved to be raised in Vapour out of the *Mediterranean* in twelve Hours Time.

The Evaporation of Water in a Close Room at Gresham Coll. 1693. by Mr. Edm. Halley, n. 212. p. 183.

XXXII. In order to explain the Circulation of Vapour experimentally, I caused an Experiment of the Quantity of Vapours arising simply from the Warmth of the *Water*, without being exposed either to Sun or Wind, to be made in *Gresham College*, which was performed with great Care and Accuracy, by Mr. *Hunt*, Operator to the *Royal Society*. Having added up into one Sum, the Evaporations of the whole Year, I find, that from a Surface, as near as could be measured of eight square Inches, there did evaporate during the Year, 16292 Grains of *Water*, which is 64 Cube Inches of *Water*; and that divided by eight Inches, the Area of the *Water's* Surface, shows that the Depth of *Water* evaporated in one Year amounts to eight Inches. But this is much too little to answer to the Experiments of the *French*, who found that it rained nineteen Inches *Water* in a Year at *Paris*; or those of Mr. *Townley*, who by a long continued Series of Observations, has sufficiently proved, that in *Lancashire*,

cashire, at the Foot of the Hills, there falls above forty Inches of Water in the Year's Time. Whence it is very obvious, that the Sun and Wind are much more the Causes of Evaporation, than any internal Heat or Agitation of the Water.

The same Observations do likewise shew an odd Quality in the Vapours of Water, which is that of adhering to the Surface that exhaled them, which they cloath, as it were, with a *Fleece* of vaporous Air, which once investing it, the Vapour rises afterwards in much less Quantity: Which was shewed by the small Quantity of Water that was lost in twenty four Hours Time, when the Air was very still from Wind, in Proportion to what went away when there blew a strong Gale, although the Experiment were made in a Place as close from the Wind as could be well contrived. For which Reason I do not at all doubt, that had the Experiment been made where the Wind had come freely, it would have carried away at least three Times as much as we found, without the Assistance of the Sun, which might perhaps have doubled it.

By the same Experiment it likewise appears, that the Evaporations in *May*, *June*, *July*, and *August* (which are nearly equal) are about three Times as much as what evaporated in the four Months of *November*, *December*, *January* and *February*, which are likewise nearly equal, *March* and *April* answering nearly to *September* and *October*.

This *Fleece* of Vapour in still Weather hanging on the Surface of the Water, is the Occasion of very strange Appearances, by the Refraction of the said Vapours differing from that of the common Air, whereby every Thing appears raised, as Houses like Steeples, Ships as on Land above the Water, and the Land raised, and, as it were, lifted from the Sea, and many Times seeming to overhang. And this may give a tolerable Account of what I have heard of seeing the Cattle at high Water Time, in the Isle of *Dogs* from *Greenwich*, when none are to be seen at low Water (which some have endeavour'd to explain, by supposing the Isle of *Dogs* to have been lifted, by the Tide coming under it.) But the evaporous Effluvia of Water having a greater Degree of Refraction than the common Air, may suffice to bring those Beams down to the Eye, which when the Water is retired, and the Vapours subsided with it, pass above; and consequently the Objects seen at the one Time, may be conceived to disappear at the other.

JANUARY, 1693.				FEBRUARY, 1693.			
D.	Grains.	Ther.	Barometer. Weather.	D.	Grains.	Ther.	Barometer. Weather.
1	31 $\frac{1}{2}$	5	29. 7 Frost.	1	36	29	30. 0
2	21	14	29. 7 Some Rain.	2	27	26	30. 2
3	21	18	29. 7	3	33	25	30. 2
4	23 $\frac{3}{4}$	8	29. 7	4	48	16	29. 9
5	23 $\frac{1}{2}$	8	30. 1	5	39 $\frac{1}{2}$	20	29. 9 Some Rain.
6	26 $\frac{1}{2}$	1	30. 5 Frost.	6	26	16	29. 9 Small Rain.
7	31	—	30. 5 Frost.	7	26	17	29. 8
8	25	—	30. 4 Frost.	8	28	11	29. 9 A Fog
9	23	—	30. 4 Frost.	9	23	16	30. 0
10	18	0	30. 4	10	26	20	30. 0
11	18	0	30. 4	11	39	8	30. 0
12	18	—	30. 4	12	40	5	29. 8
13	22	—	30. 3 Frost.	13	52	—	1 29. 4 High Wind.
14	20 $\frac{1}{2}$	—	30. 3 Frost.	14	35	6	29. 2
15	21 $\frac{1}{2}$	—	30. 3 Frost.	15	35	11	29. 4 Some Rain.
16	24	—	30. 4 Frost.	16	24	20	29. 2 Rain.
17	18	—	30. 3 $\frac{1}{2}$ Frost.	17	39	20	29. 5 Rain.
18	18	—	30. 2 Frost.	18	39	19	29. 8
19	14	—	30. 1 Frost.	19	35 $\frac{1}{2}$	17	29. 7
20	14	—	3 29. 6	20	35 $\frac{1}{2}$	16	29. 3
21	21	0	29. 9	21	35	17	29. 0 Rain.
22	18	2	29. 9	22	29	10	29. 2
23	18 $\frac{1}{2}$	0	30. 0 Frost.	23	35	5	29. 3
24	18 $\frac{1}{2}$	—	30. 0 Frost.	24	37	1	29. 2
25	14 $\frac{1}{2}$	9	29. 9	25	35	—	5 29. 4
26	14 $\frac{1}{2}$	14	29. 7	26	23 $\frac{1}{2}$	—	8 29. 0 Snow.
27	20	17	29. 2	27	21	—	11 29. 4 Snow.
28	36	10	29. 7	28	24	—	14 29. 3 Frost.
29	27 $\frac{1}{2}$	15	29. 5 Some Rain.				
30	27 $\frac{1}{2}$	15	29. 7				
31	27	27	29. 6				
	675 Gr.				690 $\frac{1}{2}$ Gr.		

MARCH,

JANUARY

UNED

MARCH, 1693.				APRIL, 1693.			
D.	Grains.	Tber.	Barometer. Weather.	D.	Grains.	Tber.	Barometer. Weather.
1	25	—12	29. 2 Frost.	1	32	15	29. 4
2	31½	—12	29. 1 Snow.	2	39	15	29. 5
3	28	—13	29. 3 Snow, Frost.	3	37½	14	29. 7
4	28	—12	29. 6 Frost.	4	37	23	29. 6½
5	28	— 8	29. 3 Frost.	5	38	29	29. 2
6	20	— 1	29. 1	6	29	32	29. 2
7	35½	— 5	29. 3 Rain.	7	32	33	29. 3
8	39	9	29. 7	8	32	35	29. 4
9	42½	8	30. 0	9	28½	40	29. 2
10	39	14	30. 0	10	35	33	29. 4
11	33	21	30. 0	11	37	33	29. 4
12	42	21	29. 8	12	34	37	28. 9
13	42	22	29. 6½	13	39	32	29. 4
14	46	23	29. 4	14	39	33	29. 5
15	62½	14	29. 6	15	39	29	29. 7
16	41	19	29. 5	16	35	30	29. 8
17	42½	12	29. 4	17	37	31	29. 6½
18	50	10	28. 9	18	36½	36	29. 4
19	51½	7	29. 2	19	38½	36	29. 3½
20	45	8	29. 2	20	36	32	29. 3
21	41	7	29. 0	21	39	37	29. 2
22	50	8	29. 4	22	46	35	29. 4
23	37	10	29. 5	23	42½	35	29. 5
24	33½	6	29. 4	24	52	35	29. 2
25	27½	7	29. 3	25	50	35	29. 3½
26	30	11	29. 4	26	56	36	29. 7
27	57	9	29. 6	27	38	44	29. 5
28	38	4	29. 6	28	43	46	29. 7½
29	30	17	29. 5	29	40	49	29. 6
30	30	20	29. 4½	30	52	42	29. 9
31	20	24	29. 3				
	1166G.				1203 G.		

M A Y, 1693.

J U N E, 1693.

M A Y, 1693.				J U N E, 1693.			
D.	Grains.	Tber.	Barometer. Weather.	D.	Grains.	Tber.	Barometer. Weather.
1	56	36	30. 1	1	78	65	29. 9
2	61	26	30. 0	2	85	62	30. 0
3	66	21	30. 1	3	95	54	30. 2
4	61	19	30. 1	4	77	52	30. 1 $\frac{1}{2}$
5	52	31	30. 1	5	63	50	29. 9
6	48	45	29. 8	6	49	60	29. 7 $\frac{1}{2}$
7	59 $\frac{1}{2}$	35	29. 8	7	46	67	29. 7
8	51	34	29. 7	8	63	63	29. 7
9	51	31	29. 6	9	63	69	29. 8
10	43	35	29. 5	10	63	63	29. 8
11	49	30	29. 5	11	55	70	29. 8 $\frac{1}{2}$
12	54	32	29. 6	12	58	87	28. 8
13	59	26	29. 7	13	59	75	29. 9
14	59	32	29. 7 $\frac{1}{2}$	14	86	72	29. 7
15	46 $\frac{1}{2}$	35	29. 7	15	63	79	29. 8
16	46 $\frac{1}{2}$	34	29. 8 $\frac{1}{2}$	16	58	78	29. 9
17	56	36	30. 1	17	86	79	30. 0
18	70 $\frac{1}{2}$	35	30. 3	18	81	66	30. 0
19	58 $\frac{1}{2}$	47	30. 1	19	92	57	30. 1
20	76	50	30. 0	20	81	60	30. 0
21	62	52	30. 1	21	80	71	29. 9
22	73	64	30. 1	22	76	67	29. 8
23	78 $\frac{1}{2}$	64	30. 1	23	63	69	29. 7
24	90	62	29. 9 $\frac{1}{2}$	24	63	62	29. 6
25	61	74	29. 9	25	57	65	29. 8
26	67 $\frac{1}{2}$	68	29. 9 $\frac{1}{2}$	26	46	70	30. 0
27	64	75	29. 9 $\frac{1}{2}$	27	49 $\frac{1}{2}$	68	30. 0
28	71	67	30. 1	28	52	74	30. 0
29	80	69	30. 2	29	59	68	30. 2
30	89 $\frac{1}{2}$	70	30. 2	30	62	69	30. 2
31	106	68	29. 9				
	1968 G.				2008 $\frac{1}{2}$ G.		

JULY, 1693.

AUGUST, 1693.

JULY, 1693.				AUGUST, 1693.			
D.	Grains.	Ther.	Barometer. Weather.	D.	Grains.	Ther.	Barometer. Weather.
1	75	67	30. 0	1	80	71	29. 5
2	75	67	30. 0	2	77	73	29. 6
3	63	62	30. 0	3	77	63	29. 8
4	62	61	30. 1	4	78	64	29. 9
5	60	63	30. 1	5	79	73	29. 9
6	74	65	30. 0	6	81	70	29. 9
7	61	65	30. 0	7	94	83	29. 6
8	51	65	30. 0	8	79	86	29. 6
9	46	74	29. 9	9	68	82	29. 7
10	52	77	29. 9	10	70	83	29. 8
11	72	74	29. 8	11	92	85	29. 8 $\frac{1}{2}$
12	74	82	29. 4	12	70	80	30. 0
13	88	75	29. 7	13	81	73	29. 9
14	83	62	29. 9	14	68	75	29. 7
15	84	65	30. 1	15	69	74	29. 9
16	84	68	29. 8	16	77	72	29. 8
17	71	58	30. 1	17	77	77	29. 7
18	77	65	30. 2	18	84	77	29. 7
19	66	78	30. 1 $\frac{1}{2}$	19	86	64	29. 5
20	71	78	30. 1	20	78	68	30. 0
21	72	82	30. 0	21	68	67	29. 7
22	90	74	30. 0	22	71	65	29. 7
23	99	68	30. 0	23	75	55	29. 9
24	85	71	30. 0	24	64	54	29. 5
25	85	81	29. 9	25	63	57	29. 5
26	94	75	29. 9 $\frac{1}{2}$	26	58	59	29. 4
27	97	70	29. 8	27	60	55	29. 5
28	81	78	29. 7	28	53	55	29. 9
29	87	67	29. 9	29	53	58	29. 7
30	78	64	29. 9	30	53	56	29. 7
31	78	79	29. 3 $\frac{1}{2}$	31	63	48	29. 7
2335 G.				2246 G.			

SEPTEMBER, 1693.				OCTOBER, 1693.			
D.	Grains.	Ther.	Barometer. Weather.	D.	Grains.	Ther.	Barometer. Weather.
1	53	53	29. 7	1	40	35	29. 9
2	55	50	29. 6	2	57	41	29. 6
3	61	50	29. 7	3	41	35	29. 7
4	61	48	29. 7	4	27	49	29. 6
5	63	44	29. 8	5	29	48	30. 0
6	74	40	29. 7	6	31	49	30. 2
7	62	39	29. 6	7	29	58	30. 0
8	59	49	29. 5	8	37	60	30. 0
9	40	52	29. 5	9	39	59	30. 2
10	50	48	29. 6 $\frac{1}{2}$	10	37	55	30. 1
11	46	41	29. 7	11	34	55	29. 9
12	48	43	29. 8	12	38	55	29. 8
13	46	53	29. 7	13	39	42	30. 0
14	43	57	29. 5	14	49	38	29. 8
15	46	70	29. 2	15	44	28	29. 7
16	49	54	29. 3	16	44	19	29. 7
17	46	52	29. 1	17	35	23	29. 1
18	52	45	29. 0	18	34	24	29. 2
19	48	45	29. 3	19	34	20	29. 2
20	50	44	29. 6	20	35	21	29. 5
21	43	42	29. 9	21	35	17	29. 9
22	41	51	29. 5	22	24	28	29. 7
23	46	45	29. 9	23	28	25	29. 7
24	44	52	29. 7	24	39	20	30. 0
25	41	47	29. 8	25	41	13	30. 0
26	43	47	29. 6	26	34	16	29. 9
27	46	45	29. 7	27	33	13	30. 0
28	47	40	29. 9	28	32	18	29. 8
29	50	44	29. 8	29	33	10	29. 8
30	40	42	29. 5	30	35	5	29. 7
				31	28	7	29. 4
	1495 G.				1095 G.		

NOVEMBER, 1693.				DECEMBER, 1693.			
D.	Grains.	Ther.	Barometer. Weather.	D.	Grains.	Ther.	Barometer. Weather.
1	18	22	29. 6	1	34 $\frac{1}{2}$	—16	30. 0 Frost.
2	15	30	29. 7	2	16 $\frac{1}{4}$	—10	30. 0 Rain.
3	24	34	29. 6	3	12	— 0	29. 9
4	26	30	29. 7	4	12	7	29. 4 Some Rain.
5	33	21	29. 8	5	17 $\frac{1}{2}$	10	22. 2
6	33	10	29. 8	6	33	15	29. 4 Some Rain.
7	29	9	29. 7	7	19 $\frac{1}{2}$	15	29. 1 $\frac{1}{2}$
8	20	23	29. 5	8	18	20	29. 0 R. & much Wet
9	21	21	29. 9	9	18	27	28. 6 $\frac{1}{2}$ R. & Storm.
10	21	30	29. 7	10	25	16	28. 9 Some Rain.
11	32	27	29. 7	11	28 $\frac{1}{4}$	13	29. 6
12	22 $\frac{1}{2}$	34	29. 5	12	28	9	29. 5
13	31	23	29. 4	13	25	14	29. 2
14	25 $\frac{1}{2}$	15	29. 9	14	15	20	29. 2 Some Rain.
15	27	10	29. 4	15	19	20	29. 5
16	25 $\frac{1}{2}$	3	29. 6	16	22 $\frac{1}{4}$	15	29. 5
17	26	—	7 29. 5	17	17 $\frac{1}{2}$	20	29. 5
18	21	—	1 29. 5 Great Fog.	18	21 $\frac{1}{2}$	10	30. 1
19	21	—	2 29. 5 Great Fog.	19	22	3	30. 0
20	19	2	29. 6	20	16	6	29. 8
21	15	5	29. 8 Fog.	21	14 $\frac{1}{2}$	9	29. 6
22	11 $\frac{1}{2}$	12	29. 7 Some Rain.	22	16 $\frac{1}{2}$	14	29. 3
23	20 $\frac{1}{2}$	14	29. 7	23	22	11	28. 5 Stormy.
24	24 $\frac{1}{2}$	8	29. 8	24	23	4	29. 0
25	24 $\frac{1}{2}$	5	29. 9	25	22	0	29. 5 Frost.
26	33	—12	29. 9 Frost.	26	22	5	29. 2 Rain.
27	33 $\frac{1}{2}$	—12 $\frac{1}{2}$	29. 9 Frost.	27	16	10	29. 3
28	27	—14	29. 8 Frost.	28	20	6	29. 0
29	42	—16	29. 8 Water	29	25 $\frac{1}{2}$	0	29. 2 Frost.
30	42	—17	29. 9 Frozen.	30	29 $\frac{1}{2}$	5	28. 6 Stormy.
				31	24	7	29. 2
	764 Gr.				646 Gr.		

Note, That in the Column of the *Thermometer*, — denotes Degrees of Cold below the freezing Point; and that from the tenth of *Nov.* to the End belong to the foregoing Year, 1692.

The Changes
of Weather
from the
Alterations
of the Gravi-
ty of the At-
mosphere;
by Dr. Gor-
den, n. 171.
P. 991.

XXXIII. 1. The *Air* agrees with all other *Fluids* in this, that it *gravitates*; and it has this peculiar Property (which is not so much observed of other *Fluids*) that its *specific Gravity* is not always the same. Now you know, according to the certain Rules of the *balancing* of *Fluids* amongst themselves, every *Fluid specifically lighter* than another, will ascend and emerge above it; and every *Fluid specifically heavier* than another, will *descend* and *subside* below. Now there is some certain *Proportion* between the *specific Gravities* of the *Fluid* of *Air*, and of that which ascends in *Vapours*, and falls down again into *Rain*; and if this *Proportion* were still the same, 'tis like we should have no *Commixture* of those *Fluids*, but the *Vapours* would either always *float* above, or always *stay* below. But this *Proportion* of their *specific Gravity* is frequently changed: For it's known that *Water*, when warm and tepid, is lighter than when it is cold; and the daily *Observations* of the different Heights of the *Mercury* in the *Baroscope* do make appear, that the *Atmosphere's Gravity* is not always the same. And now from these known Properties may be easily deduced a *statical Account* of the rising of *Vapours*, their being carried in the *Air* in *Clouds*, and their falling down again into *Rain*. For if we may be allowed to suppose that when the *Atmosphere* is heaviest, there is some such *Proportion* between its *specific Gravity*, and that of the *Fluid* of *Vapours*, as there is between *Water* and *Oil*; the *Vapours*, according to the known Laws of *Fluids*, must needs ascend, and so long as this *Proportion* continues they must needs float above in the *Air*; but when the *Atmosphere's Gravity* is chang'd, the *Vapours* must fall down again.

I do not know any determinate Instrument that will indicate the *Ascent* of *Vapours*, as certainly as the *Baroscope* does the Change of the *Air's Weight*, (for our common *Hygrosopes* are not very exact, and besides, I suppose their *Change* by *Moisture* shews rather the falling than the rising of *Vapours*) yet there are two or three *Observations* which seem certain *Indications* of their *Ascent*: as first, if the *Horizon* and the remote *Hills* seems smoaky, and inconspicuous, so that nothing can be seen at any *Distance*, and that, tho' the *Heavens* be not cloudy but clear, and tho' there be no *Fog*, nor yet any *Cap* of *Clouds* upon the *Hills* (which do rather indicate the falling of *Vapours*.) Again, if when you look to any distant Part of the *Country*, round about you, it appear all in an undulating Motion, this seems to be a Sign of the plentiful rising of *Vapours*; for this is only occasioned by looking through an unequal waving *Medium*, which makes frequent *Inflexions* of the *Beams* of *Light*, as you see any *Object* seems to have a tremulating Motion in all its *Parts* when you look upon it through *Smoke*. Another *Indication* of the *Ascent* of *Vapours* seems to be the copious rising of *Steams* above *Waters*, *Marsh Grounds*, and *Fens*; which is frequently seen in *Frosts*, and in cool *Nights* in *Summer*. To these I may add the *Redness* of the *Sun* (so as to be easily look'd upon) and *Moon*, a considerable Time before their setting, or after their rising. Now since I have had Occasion to make *Observations* of the *Baroscope*, I have always taken notice of all these, when the *Mercury* was rising, and consequently in the *Increase* of the *Atmosphere's Gravity*: But on the contrary, when the *Mercury* has been low in the *Baroscope*, and so the *Atmosphere's Gravity* less, I have observed none of these *Effects*, but the remote *Hills* were clear and distinct,

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(unless sometimes a Cloud had fall'n down upon them) and no waving to be observed in the Air, nor Steams from the Waters. I know not whether I may add here a Conjecture about the great Light, and the *Caprae saltantes*, which are some Nights to be seen in the North. I have taken notice of them usually when the *Mercury* has been high in the *Baroscope*; and then they appearing in that Quarter of the Heavens where the Sun is at that Time below the *Horizon*, this has given me Occasion to think, that perhaps the Steams of Vapours may have ascended so far in the *Atmosphere* as to be beyond the Earth's Shadow in that Part of the *Horizon*, and so by refracting the Beams of Light towards us, to occasion that Light, and those *Caprae saltantes*. It may be considered also whether the red Skies in the Evening, which betoken fair Weather, do not proceed from the Height of the Clouds, occasioned at that Time by the Increase of the *specific Gravity* of the *Atmosphere*.

Now as to the falling down of the Vapours again, it is visible by their gathering into thick and dark Clouds, by the falling down of Clouds and Mists on the Tops of Hills, and thick Fogs in the Air, and by their dropping down into Rain, Snow, &c. and that these do usually fall out only when the *Mercury* subsides a little, and consequently when the *Atmosphere's Gravity* is less, is the constant Observation of those who have had Occasion to take notice of the Changes of the *Baroscope*.

Against this it may be objected, that it is observable many times that even when the *Mercury* in the *Baroscope* is rising, there will be Rain, and particularly sometimes in *North-East Winds*. To this I answer, That if the Clouds have been carried for some while towards one Quarter of the Heavens by the *Winds*, and then if the *Winds* do suddenly change into another Quarter, these *Vapours*, which were formerly scatter'd into small Particles, and so did easily float, are suddenly driven together into little Drops, and so must needs fall down into *Rain*; and therefore the falling of *Rain* while the *Mercury* is rising, is observable only upon the sudden Change of contrary *Winds*.

But let us consider, in the next Place, whether those frequent *Commutations* in the *Air*, which we call *Winds*, may not be accounted for upon the same Principles. That known *Definition* of *Archimides* is universally acknowledged, *Quod earum partium minus pressa expellantur a magis pressis*; so that if there be any Portion of a Fluid of a far less Pressure and Resistance than the rest, the whole Fluid runs in a *Current* thither, till all be reduced to an *Equilibrium*. Now it is evident that the Pressure of the Air is not always the same, and 'tis very probable (which *Experience* will determine, by making joint *Observations* of the *Baroscope* in several Places of the *Earth* at the same time) that the *Air's Gravity* is not alike chang'd throughout the whole *Atmosphere* in an Instant. So that when the Air becomes *specifically lighter* in one Place, or its Pressure lessened, the neighbouring Parts of the *Atmosphere*, whose *Weight* is not thus lessened, run thither in a *Current*, till the *Atmosphere* thereabouts be reduc'd to an *Equilibrium* again; and according to the Portion of Air thus changed, and the lessen'd or acquir'd Degrees of the *Weight* and *Spring*, the *Currents* or *Winds* are strong or weak, of a long or short Continuance. Now *Observation* and *Experience* do agree with this, the *Mercury* being found to
subside.

subside for the most Part in the *Baroscope* at the rising of Winds; at least it is observed to be in Motion, and either rising or falling, and consequently there is a Change in the *Atmosphere's* Pressure at that Time.

But the great Difficulty remains still, how to account for the different Changes of the *specifick Gravity* of the *Atmosphere*. Of this there can hardly be expected a satisfactory Account, till we come to know the Cause of Gravity in general, and of the Air's Weight in particular; and therefore I shall only here offer two or three Hints, which perhaps may incite others to consider it more narrowly. And *first*, it is now almost generally acknowledged, that there must needs be a *Fluid* much more subtile than common *Air*, and of a far greater Pressure than *Air*; which is the Cause of the Continuity and Cohesion of all terrestrial Bodies, and in which the *Air* seems as it were to float, and to have the same Relation to it, as the Vapours do in, and have to the *Air*; and therefore if we could reach its Nature and Properties, it might be considered what Influence this may have upon the Change of the Air's Gravity. Or, *secondly*, seeing the Infusion of one Liquor into another, in *Chymical Preparations*, will alter its *specifick Gravity*, so that the Bodies which were formerly born up in it, will fall down and be precipitated; as the Particles of Gold floating thro' *Aqua Regis* will be precipitated by the Infusion of another Chymical Liquor; it may be considered, whether Plenty of nitrous Steams, or some such Mixture, may not alter the Air's *specifick Gravity*. Or, *thirdly*, we may possibly come to a nearer Resolution of this, by considering the Influence which the Heat and Cold have upon the Air's Spring. The Air you know has this peculiar Property, which is not so much observed of other Fluids; that it is endued with *Elasticity* as well as *Gravity*; and therefore we are to consider what Influence the Change of its *Spring* may have upon the Change of its Weight: and it seems evident, that the Increase of its Spring doth diminish its Weight, and the lessening of its Spring will increase it; for upon the Increase of the Air's Spring, the Air is rarified, and so a lesser Portion of it presses upon the subjacent Fluid: But when it is lessened, the Air is condensed, and so a greater Portion of it presses upon the subjacent Body. For Example, let us suppose the springy Particles of Air to be like the springy Hairs of Wool, or the Spring of a Watch; and that many Millions of Rows of them go to make up the Cylinder of Air, which, from the Top of the *Atmosphere*, presses upon the *Mercury* in the *Baroscope*, and keeps it suspended to the Height of thirty *Inches*; let us suppose this Air rarified, so that all its springy Particles expand themselves, and therefore shut off of this Cylinder some thousands of those Rows; this Cylinder, being now made up of a far lesser Number of those Rows of Particles, must needs have a lesser Pressure upon the *Mercury*, so that it will subside, perhaps, to twenty nine. And thus it continues till the Air's Spring be weakned, and so the Particles crowded again into narrower Room. Now if this be found to hold in the *Theory*, Experience seems very well to answer it: For I have hitherto observed, that in cold Weather, and sharp Frosts, the *Mercury* rises highest in the *Baroscope*; and if the Foreign Measures agree with ours, it is usually higher here than in *France* or *Italy*.

I shall here, after all, subjoin two or three Observations, which may serve to confirm what has been said. The first is of the Course of the Weather under or near the *Line*. I have read in the second and fourth Parts of *Purchas* his *Pilgrims*, (and I doubt not but later Travellers attest the same Truth) That, in *Brasil*, and *Guiana* in *America*; in *Guinea*, *Congo*, and *Ethiopia* in *Africa*; in the *East-Indies*, and the *Maldrve* Islands; they have almost continual Floods of Rain from about the Beginning of *May* to the End of *August*, which they call their Winter, and the rest of the Months of the Year fair and clear Weather, which they call their Summer: So that when the Sun is nearest to them, they have constant Rains, and when remotest, fair Weather; and this I impute, amongst other Causes, to the extraordinary Rarefaction of the Air, and lessening of its *specific Gravity* there at that Time; so that the Vapours in the neighbouring Parts of the Air, do all flow thither, and descend, as it were in Floods of Rain. And as this is reckoned to be the Cause of the Inundation of the *Nile*, and some other Rivers, so perhaps this may be the Reason also, why those Countries which are neighbouring to them, and somewhat remoter from the *Line*, such as *Egypt*, and the like, have seldom or never any Rain.

My second Observation is of the *Baroscope*, viz. That when the Wind is North, North-east, or North-west, the Mercury ever Rises, and so the Air is heavier; but when the Wind comes from the South, South-east, or South-west, it falls, and so the Air's Gravity is less: by which we may see what Influence the Cold and Heat have upon the Air's Weight; and you know a cold Wind is said to drive the Sails of a Ship much more forcibly than a warm.

My third Observation is of an Experiment of the honourable Mr. *Boyle*. n. 6. p. 2048. I made, *saith he*, by Distillation a Blood-red Liquor, which chiefly consisted of such saline spirituous Particles, as may be obtained from the Mats of Blood in human Bodies. This Liquor is of such a Nature, that if a Glass Viol, about half filled with it, be kept well stoppt, the red Liquor will rest as quietly as any ordinary one, without sending up any Smoak; but if the Viol be unstoppt, so that the external Air be permitted to come in, within a quarter of a Minute or less, there will be elevated a copious white Smoak, which will not only fill the upper Part of the Glass, but plentifully pass out into the open Air, till the Viol be again stoppt. *And a little after he adds*, If the unstoppt Viol were placed in our *Vacuum*, it would not emit any visible Steams n. 171. p. 1000 at all, nor so much as appear in the upper Part of the Glass that held the Liquor; whereas when the Air was by Degrees restor'd at the Stop-cock, the returning Air would presently raise the Fumes, first into the vacant Part of the Viol, whence they would ascend into the Capacity of the Receiver; and likewise when the Air that was requisite to support them, was pumped out, they also accompanied it, as their unpleasant Smell evinced, and the red Spirit, tho' it remained unstoppt, emitted no more Fumes till the new Air was let in again. *So far he*. Such you see was the Proportion between the Gravity of the Vapours of this red Liquor and the Air, that the Air being in its ordinary Degree of Gravity, these Vapours did ascend: but the Air's Gravity being much lessened in the Receiver, by the pumping out a great deal of it, and so expanding the Spring of the rest, it was not able to elevate those Vapours.

By Dr. Wallis, ib. p. 1602.

2. That there is in our Air a Body more subtile than are the Fumes and Vapours mingled with it in our lower Region, and which, with it, do make up that heterogeneous Mixture, which we commonly call Air, I think to be very certain. But whether that subtile Body be (as Dr. *Gorden* seems to suppose) much heavier than our common Air, I much doubt; and do rather think it not, not having hitherto observed any cogent Experiment, either to prove it heavy or elastick: But it may, for ought I know, be void as well of Weight as Spring; and, what we find of either, in our common Air, may be attributed to the other Mixtures with it. For the Air being of a different Gravity, in different Times and Places (arising, I suppose, from the different Kinds and Quantities of the Fumes and Vapours, and other Particles, which are Ingredients in it, and the different Force of the Sun's Heat acting thereupon, increasing or allaying the Spring thereof, and otherwise) we are therefore to consider of the Air as a Fluid, whose Parts are in some Places heavier, and others lighter; and therefore much of a like Nature, as if they were different Fluids, of different *specifick* or intensive Gravity, one from the other

Now when several Fluids, or several Parts of a Fluid, are thus of different Weights, they will (from the general Nature of heavy Fluids,) when undisturbed, change Places with one another, till the heavier becomes lowest, and the lighter highest.

And this not only as to the minuter Parts; it is observed in Chymical Precipitations, or the sinking of Sand in Water, or its smaller earthly Particles, which subside in a muddy Sediment, and the like of other Liquors when at rest, and the Atoms (as they were wont to be called) flying in the Air when disturbed, but subsiding in the Form of Dust when at rest, all which, according as they be smaller, do (*cæteris paribus*) subside more slowly: But much more as to larger Parcels; as when Oyl, Wine, Water, Beer, or other the like Liquors, are put together in the same Vessel, as will be observable to the Eye, especially when their Colours are considerably different.

And the same will happen, if some Parts of the same Liquor, do accidentally acquire, by Expansion, or otherwise, a greater Degree of Lightness than the other Parts; those lightned Parts ascending, the heavier subside; as when Water, Beer, or other thin Fluids, be gradually heated by a Fire underneath, the lower Parts being first warmed, ascend to the Top, while the colder and heavier subside; whence we find, in such Cases, that Bubbles do arise, and that at the Top is warmer than that at the Bottom: But in case what is warmed be of a thicker Consistence, so as that the Parts cannot readily shift Places, that at the Bottom will be hotter; and in case it be heated by Fire over it, there will (I suppose) be no such Bubbling, (or not so much of it,) that at the Top being first heated.

From such Considerations as this, Dr. *Gorden* doth well observe, that some Parts of the Air being thus, by Rarefaction, or increasing the Spring thereof, or otherwise, become lighter than others; these heavier Parts, rushing into the Places of those lighter, may cause a Wind as from such Parts; (in like manner as, on a like Occasion, a Tide or Current would arise in Water;) and other Accidents of a like Nature. And contrariwise, on a contrary Occasion.

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And this I take to be true; though such Accidents happening very variously and uncertainly, will cause such Confusion of Motions, and Disturbance of each other, that it will be hard to reduce them to a regular Adjustment.

But I add thereunto, that the Earth's diurnal Motion compounded with its annual, (if we admit that *Hypothesis*, as most do now-a-days) the one in some Parts accelerating, in others retarding the other; and its Difference in different Times of the Year, (by Reason of the Obliquity of the *Zodiack* to the *Æquinoctial*) and in different Times of the Month (because of the Moon's different Position, which is an Appendance to the Earth's Motion, and doth thereby differently affect it) and, according to the different Place of the Earth and Moon, as to the *Aphelion* or *Perihelion* of the one, and the *Apogæum* or *Perigæum* of the other, seem to me to be of much greater Consideration, not only as to the *Ebbing* and *Flowing* of the Sea, but as to the Winds also; especially the *Breezes* and *Trade-Winds*, which at certain Times of the Day, of the Year, of the Month, are observed to blow constantly, or most frequently, from such or such a Coast.

And I am not sure, that the Body of Earth and Water (or terraqueous Globe) is exactly spherical, allowing only for the small Inequalities of Hills and Dales, which, in a Body of that Greatness are inconsiderable, but may have somewhat of an *Oblong Spheroid*, having a longer Axis from *Pole* to *Pole*, than at the *Æquator*. And tho' this cannot be much, because of the Earth's Shadow in the Moon's Eclipse appearing circular; and the Descent of heavy Bodies being always (as to Sense) in a Perpendicular to the *Horizon*; yet if it be but little, this with the Compound Motions before mentioned, will give the Air a considerable Disturbance.

To which I may add also, that we are not sure that the Seas and Continents, which are of very different comparative Weights, Earth being heavier than Water, are so adequately adjusted the one to the other, as that its Center of Gravity, by which a Plain passing divides it into Parts *Æquiponderant*, is the same with its Centre of Magnitude, by which it is divided into Parts equally great; which, if it happen to be otherwise, will with the rest make the Confusions of the Air's Motions yet greater.

From the comparative Weight or Lightness of the Air at different Times, he deduced also the rising or falling of Vapours in it. As if when such Fumes or Vapours, or other the like Matters are lighter than the Air, they ought, according to the exact Rules of *Hydrostaticks*, to ascend therein; but when heavier than so, to fall down. And this certainly (*cæteris paribus*) is to be admitted also. Only I add thereto, that these *statick Principles* do chiefly take place, when Things are otherwise at Rest and Quiet: But when they are in Commotion, it is many times much otherwise. And in such Cases, we must, besides the respective Gravity, take into Consideration the Force, Impulse, or Impetus, that is superadded to the respective Gravity of the Parts of Matter. Thus, if a Bottle be shaken, the Sediment at the Bottom, tho' heavier, and for which Cause it did before subside, will be mingled with the supernatant (finer and lighter) Liquor. And if a Room be swept, it will, as we use to speak, make a Dust, that is, the small earthy

Particles of Dust will rise and mingle with the Air, not because they be lighter than it, for we see that at Leisure they will subside again; but because by a Force upon them they be put into Motion. And this I take to be the Cause of Fumes, Vapours, and other like Matters, (most of them) which ascend in the Air, not because lighter than it, but because impell'd upward out of the Bowels of the Earth, or from the superficial Parts of it, either by some subterranean Heats, or other Ferments, that put them into Motion, and force them upward, where they remain suspended in the Air, so long as that Force continues, or the Force of others sent after them on the like Errand, which rather impels them farther, than gives them leave to fall, till either such Force abate, or the great Weight of so many Things suspended doth over-power, not only the Air's Weight, but the Strength of that that impelled them. And that there are such Fumes, and other like Matter projected upwards from the Bowels of the Earth, and some of them with great violence, is undeniable, not only from Earthquakes and other Eruptions, with great Noises, as well of Vapours as of burning Mountains, but even poisonous Steams, and others, in Mines and bubbling Springs, where Bubbles of Air are seen to make their Passage through the Water, and other Perspirations of Air or Vapour, through Crannies, or small Passages of the Earth, discoverable by Steams, whereof some will take Fire at the Light of a Candle, or by the moving of Leaves, and other light Things laid on the Mouths of such private Passages, and by many other Means. And to such Causes I do principally attribute the *Origin of Winds*, and the Ascend of most other Things, which, from this lower World, mount into the Air: and without this, the comparative Gravity of the Air and them, would give us but a lame Account of them.

There is yet another Notion suggested, which is also very considerable as to this Affair, which is the weakning or strengthening the Spring of the Air. That Water hath, of it self, nothing of Spring or Elasticity, otherwise than by reason of some airy Parts, or other elastick Bodies, which may be included within it, is generally held; at least none considerable, such as by any Experiments hitherto made, can be clearly evinced so to be. But that the Air, (such Air, at least, as is the common Air which we are conversant with) is elastick, is, I think, out of doubt: the Experiments which prove its Spring being so many and evident, beyond Exception. And that this Spring of the Air is sometimes stronger, and sometimes weaker, I think, is undoubted also; and that the Spring of the Air is strengthened both by Compression and by Heat, but in a different Manner. If the same Quantity of Air be compressed into a lesser Room, the Spring is certainly stronger, as is undoubtedly seen in the Wind Gun, and other compressive Engines. And the same Quantity of included Air in a close Vessel, so as not to communicate with the external Air, will by Application of Heat to it, have its Spring strengthened, and drive its Counterpoise farther off, or if need be, compress it, as is to be seen in *Thermoscopes* of all sorts.

If the Spring be strengthened by Compression, it is manifest that the intensive Gravity must be thereby increased, because the same Quantity of Air, and consequently of Weight, extensively taken, is now contracted into a lesser Room,

Room, which therefore must be intensively heavier (as being the same Weight in a lesser Bulk.) Now this may possibly, as a great Pressure, or stronger Spring, force up the Vapours under it with a greater *Impetus* (according to the Notion I mentioned before) and so make them fly higher: unless we should suppose it may be relieved, by shortning the Height of the *Atmosphere*:) but not so as to make them lighter; but rather the contrary, as pressing them closer: Much less to make them (as the Phrase is) *Specifically Lighter* than is the Air it self (though thus compressed) and it leaves less Room to receive them between the Particles of the compressed Air, as being now thrust closer together.

If the Spring be strengthened the other way; so as by Heat it useth to be: This doth rather diminish its intensive Gravity, by thrusting its Parts further asunder, and so possessing a larger Room. Now in case this Air be, by a close Vessel, confined so as not to expand upward; it will certainly press the harder on the stagnant Quick-silver under, and make that in the Tube rise higher: But in case it be unconfined, as in the open Air, it may as well relieve it self upward, by making the *Atmosphere* in this Part so much the higher.

Nor is there any Necessity, as to the subjacent Parts, that the *Atmosphere* shall be every where of the same Height: But the Laws of *Statics*, as to the subjacent Parts, be equally preserved without it; the greater Altitude compensating for the Levity of the Parts, as when a Portion of the Sea is covered with a Fleet of Ships, the under Parts are equally pressed, partly by Water, and partly by Ships, though the Tops of the Ships over some Parts be higher than the Surface of the Water over others. Only, in such Case, the upper Part of the *Atmosphere*, being fluid, may flow collaterally over the other Parts on either side, if lower. And so, at leisure, (if thus remaining otherwise undisturbed) reduce it self to an equal Height in all Parts; like as the Sea would do, in a perfect Calm, though otherwise its Waves and Billows are far from being in all Places perfectly plain and even.

But, however, though the Spring, fortified by Heat, may thus relieve it self upwards, (yet because it presseth every way,) it must endeavour the like downward also, and thereby press harder what is under it; and because it will require Time to work upward gradually before the Effect reach the Top of the *Atmosphere*; and because by such Dilatation of its Parts, more Room is left in the Intervals to receive what is forced: 'Tis reasonable to believe, that in such Cases, the pressed Vapour (*ceteris paribus*) may rise more copiously, than when the Spring of the Air (for want of Heat) is less strong. The rather, because the same Heat which thus fortifies the Spring of the Air, doth also rarify the Vapours and make them lighter; and may also fortify the subterranean Heat (or whatever else it is,) that drives them up. Notwithstanding all which, we have more Rains in Winter; which should argue, that more Vapours do then arise to supply them.

But I suspect, that in this whole Business (of strengthening the Spring) there may be a Fallacy put upon us: And what we think to be done upon the

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open Air, is indeed done upon the Quick-silver; or rather upon the Air latent therein. My Meaning is this; We find that in very hot Weather, and also in Frosty Weather, the Quick-silver in the Tube commonly stands very high; from whence we are apt to conclude, that therefore the outward Air presses very hard on the stagnant Quick-silver, without the Tube: Wherein I am not satisfy'd; for we are to consider, that, in filling the Tube with Quick-silver, before it be inverted, if great Care be not used to cleanse it from Air, many Airy Particles will remain mixed with it; which, while their Spring is weak, are easily pressed by the Weight of the Quick-silver so close, as hardly to be discerned otherwise than by the Effect: But when, by the external Heat, their Spring is strengthened, they expand themselves, and cause the Quick-silver, wherein they are, to swell in Bulk, without increasing its Weight; and consequently to stand higher, though not to press heavier.

And the same Account, perhaps, may serve for its standing so high in frosty Weather. Water, we know, though it contract with Cold, yet when it comes to freeze, doth expand it self; (which makes Ice lighter than Water, and to swim on the Top of it.) Now whether this be purely of it self, or (in part at least) from the Particles of Air lodged in it, may not perhaps be so easy to determine. However, if there be the like Effects on Air, as on Water, (namely, that it expands with Freezing,) or if in the Quick-silver there be lodged Particles of Water as well as of Air; we have, either way, an Account of this *Phenomenon*. For then the small Particles, whether of Air, or of Water, lodged in the Quick-silver, being thus expanded by Freezing, will make the Quick-silver swell, and so stand higher, without increasing its Weight; and consequently, without arguing a greater Weight of external Air pressing on the stagnant Quick-silver.

The Circulation of Watry Vapours,
by Mr. Edm. Halley, n.
192. p. 468.

XXXIV. I have formerly attempted to explain the Manner of the rising of Vapours by Warmth, by shewing, that if an Atom of Water were expanded into a Shell or Bubble, so as to be ten times as big in Diameter as when it was Water, such an Atom would become *Specifically Lighter* than Air, and rise so long as that *Flatus*, or warm Spirit, that first separated it from the Mass of Water, shall continue to distend it to the same Degree; and that Warmth declining, and the Air growing cooler, and with all *Specifically Lighter*, the Vapours consequently shall stop at a certain Region of the Air, or else descend; which may happen upon several Accounts, as I shall by and by endeavour to make out. Yet I undertake not, that this is the only Principle of the Rise of Vapours, and that there may not be a certain sort of Matter whose *Conatus* may be contrary to that of Gravity; as is evident in Vegetation; wherein the Tendency of the Sprouts is directly upwards, or against the Perpendicular. But whatever is the true Cause, it is in Fact certain, that Warmth doth separate the Particles of Water, and emit them with a greater and greater Velocity, as the Heat is more and more intense; as is evident in the Steam of a boiling Cauldron, wherein likewise the Velocity of the Ascent of the Vapours does visibly decrease till they disappear, being dispersed into and assimilated with the ambient Air.

Vapours being thus raised by Warmth, let us, for a first Supposition, put, that the whole Surface of this Globe were all Water, very deep, or rather that the whole Body of the Earth were Water, and that the Sun had his Diurnal Course about it: I take it, that it would follow that the Air of it self would imbibe a certain Quantity of Aqueous Vapours, and retain them, like Salts dissolved in Water; that the Sun warming the Air, and raising a more plentiful Vapour from the Water in the Day-time, the Air would sustain a greater Proportion of Vapour, as warm Water will hold more dissolved Salts, which upon the Absence of the Sun in the Nights, would be all again discharged in Dews, analogous to the Precipitation of Salts on the cooling of the Liquors; nor is it to be believed, that in such Case there would be any Diversity of Weather, other than periodically, every Year alike, the Mixture of all Terrestrial, Saline, Heterogeneous Vapours being taken away; which, as they are variously compounded, and brought by the Winds, seem to be the Causes of those various Seasons which we now find. In this Case the Airy Regions, every where at the same Height, would be equally replenished with the Proportion of Water it could contain, regard being only to be had to the different Degree of Warmth, from the Nearness or Distance of the Sun; and an Eternal East-wind would blow all round the Globe, inclining only to the same side of the East, as the Latitude does from the *Æquator*; as is observed in the *Ocean* between the *Tropicks*.

Next let us suppose this Ocean interspersed with wide and spacious Tracts of Land, with high Ridges of Mountains; such as the *Pyrenean*, the *Alps*, the *Apennine*, the *Carpathian* in *Europe*; *Taurus*, *Caucasus*, *Imaus*, and several others in *Asia*; *Atlas*, and the *Montes Luna*, with other unknown Ridges in *Africa*, whence come the *Nile*, the *Nigre*, and the *Zaire*, and in *America* the *Andes*, and the *Apalatean* Mountains: Each of which far surpass the usual Height to which the Aqueous Vapours of themselves ascend, and on the Tops of which the Air is so cold, and rarified, as to retain but a small Part of those Vapours that shall be brought thither by the Winds. Those Vapours therefore that are raised copiously in the Sea, and by the Winds are carried over the low Land to those Ridges of the Mountains, are there compelled by the Stream of the Air to mount up with it to the Tops of the Mountains, where the Water presently precipitates, gleeing down by the Crannies of the Stone; and part of the Vapours entering into the Caverns of the Hills, the Water thereof gathers, as in an *Alembick*, into the Basons of Stone it finds, which being once filled, all the Overplus of Water that comes thither, runs over by the lowest Place, and breaking out by the Sides of the Hills, forms single Springs; many of these running down by the Valleys, or Guts between the Ridges of the Hills, and coming to unite, form little *Rivulets* or *Brooks*; many of these again meeting in one common Valley, and gaining the plain Ground, being grown less rapid, become a *River*; and many of these being united into one common Channel, make such *Streams* as the *Rhine*, the *Rbone*, the *Danube*; which latter, one would hardly think the Collection of Water condensed out of Vapour, unless we consider how vast a Tract of Ground that

River

River drains, and that it is the Sum of all those *Springs* which break out on the South-side of the *Carpathian* Mountains, and on the North-side of the immense Ridge of the *Alps*, which is one continued Chain of Mountains from *Switzerland* to the *Black-Sea*. And it may almost pass for a Rule, that the *Magnitude* of a *River*, or the Quantity of Water it evacuates, is proportionable to the Length and Height of the Ridges from whence its *Fountains* arise. Now this *Theory* of Springs is not a bare *Hypothesis*, but founded on Experience, which it was my Luck to gain in my Abode at *St. Helena*; where in the Night-time, on the Tops of the Hills, about 800 Yards above the Sea, there was so strange a Condensation, or rather Precipitation of the Vapours, that it was a great Impediment to my Celestial Observation; for in the clear Sky the Dew would fall so fast as to cover, each half quarter of an Hour, my Glasses with little Drops, so that I was necessitated to wipe them off so often, and my Paper, on which I wrote my Observations, would immediately be so wet with the Dew, that it would not bear Ink: By which it may be supposed how fast the Water gathers in those mighty high Ridges I but now named.

Thus is one Part of the Vapours blown upon the Land returned by the Rivers into the Sea, from whence they came. Another Part by the Cool of the Night falls in Dews, or else in Rains, again into the Sea before it reaches the Land; which is by much the greatest Part of the whole Vapour, because of the great Extent of the Ocean, which the Motion of the Winds does not traverse in a very long Space of Time: And this is the Reason why the Rivers do not return so much into the *Mediterranean* as is extracted in Vapour. A third Part falls on the lower Lands, and is the *Pabulum* of *Plants*, where yet it does not rest, but is again exhaled in Vapour by the Action of the Sun, and is either carried by the Winds to the Sea, to fall in Rain or Dew there; or else to the Mountains to be there turned into Springs: And though this does not immediately come to pass, yet after several Vicissitudes of rising in Vapour, and falling in Rain or Dews, each Particle of the Water is at length returned to the Sea, from whence it came. Add to this, that the Rain-water, after the Earth is fully sated with Moisture, does by the Valleys or lower Parts of the Earth, find its Way into the Rivers, and so is compendiously sent back to the Sea. After this Manner is the *Circulation* performed: and I doubt not but this *Hypothesis* is more reasonable, than that of those who derive all Springs from the Rain-waters, which yet are perpetual, and without Diminution, even when no Rain falls for a long Space of Time: Or than that that derives them from a Filtration, or *Percolation* of the Sea-waters through certain imaginary Tubes or Passages within the Earth, wherein they lose their Saltness; this, besides many others, labouring under this principal Absurdity, that the greatest Rivers have their most copious Fountains farthest from the Sea, and whether so great Quantities of fresh Water cannot reasonably be derived any other Way than in Vapour. This, if we may allow *Final Causes*, seems to be the Design of the Hills, that their Ridges being placed through the Midst of the *Continents*, might serve, as it were, for *Alem-bicks*, to distil Fresh Water for the Use of Man and Beast, and their
Heights

Heights to give a Descent of those Streams to run gently, like so many Veins of the *Macrocosm*, to be the more beneficial to the Creation. If the Difference between Rain and Dew, and the Cause why sometimes 'tis cloudy, at other times serene, be enquired; I can offer nothing like a proper Solution thereof, only with Submission to propose Conjectures, which are the best I can find, *viz.* That the Air being heap'd up with the meeting of two contrary Winds, when the Mercury is high, the Vapours are the better sustained and kept from coagulating or condensing into Drops; whereby Clouds are not so easily generated: And in the Night the Vapours fall down single as they arose in *imperceptible* Atoms of Water. Whereas when the Mercury is low, and the Air rarified by the Exhaustion thereof, by two contrary Winds blowing from the Place, the Atoms of Air keep the Vapours not so well separated, and they coalesce into visible Drops in the Clouds; and from thence are easily drawn into greater Drops of Rain. To which 'tis possible, and not improbable, that some sort of saline or angular Particles of terrestrial Vapour being immixt with the Aqueous, which I take to be Bubbles, may cut or break their Skins or Coats, and so contribute to their more speedy Condensation into *Rain*.

XXXV. The *Trade* or *Tropick Winds* seem in great Part to arise from the daily and constant Breath of the *Sargossa*, or *Lenticula Marina*, which grows in vast Quantities from 36 to 18 Degrees Northern Latitude, and elsewhere upon the deepest Seas; because the Matter of that Wind, coming (as we suppose) from the Breath of only one Plant, it must needs make it constant and uniform; whereas the great Variety of Plants and Trees at Land, must needs furnish a confused Matter of Winds. Again, the *Levant Breezes* are briskest about Noon, the Sun quickning the Plant most then, causing it to breathe faster and more vigorously; and that Plants mostly languish in the Night, is evident from many of them, which contract themselves, and close at that time; also from the Effects of our Winters upon them, which cause them to cast both Fruit and Leaves too; whereas they are said (the same Plants for kind) universally to flourish all the Year alike within the *Tropicks*.

As for the Direction of this *Breeze* from East to West, it may be owing to the general *Current* of the Sea; for a gentle Air will still be led with the Stream of our Rivers, for Example. Again, every Plant is in some measure an *Heliotrope*, and bends itself, and moves after the Sun, and consequently emits its Vapours thitherward; and so its Direction is in that Respect also owing in some measure to the Course of the Sun.

XXXVI. 1. It is generally known that there are continual Eastern Winds under the *Line*, which they call *Breezes*; and therefore the Accounts of *Spanish* Voyages bear, that in their going to the *West-Indies*, they sail southwards from *Spain*, along the Coast of *Africk*, till they be beyond the *Tropick* of *Cancer*, within 20 *Deg.* of the *Line*, where they presently find an Easterly Wind, and so they sail on Westwards with full Wind, so as they have scarce any Need to touch their Sails in the whole Voyage: And this they give as the Reason why the Voyage from *Spain* to the *West-Indies* is shorter, more easy, and more assured, than the Return to *Spain*. In the

The Cause of Trade-Winds; by Dr. M. Lister, n. 156. p. 494.

The Cause of Winds; and of the Change of Weather; by Dr. Geo. Gordon, n. 17. p. 1143.

South Sea also going from *New Spain* or *Peru* to the *Philippines* or *China*, their Voyage is easy, sailing always from East to West near the *Line*, where the Easterly Winds blow in their Poop. *Acosta* reports, that in the Year 1584, there went a Ship from *Calloa* in *Lima* to the *Philippines*, which sailed 2700 Leagues without sight of Land, and this in two Months, their Course being almost under the *Line*.

Now these continual Easterly Winds between the *Tropicks*, I suppose to proceed both from the Motion of the Earth, and the vertical Influences of the Sun; after this manner. As you know the vast Fluid and *Æther*, in which the Earth floats in its annual Motion, moves forward with the Earth in that Motion, or rather carries the Globe of the Earth along with it; even so the *Atmosphere*, and a large Vortex of *Æther* beyond the Moon, goes round with the Earth in its Diurnal Motion; which tho', according as it is removed from the Earth, it may be proportionably slower in its Motion, yet that Portion of the *Atmosphere*, which is nearest the Earth, and surrounds it, may be supposed to keep equal Pace with the Earth in its Motion; and if there were no Changes in the *Atmosphere's* Gravity, I suppose it would always go along with the Globe of the Earth from West to East in an uniform Motion, which would be wholly insensible to us. But that Portion of the *Atmosphere* under the *Line*, being extremely rarified, its Spring expanded, and so its Gravity and Pressure much less than the neighbouring Parts of the *Atmosphere*, and consequently incapable of the uniform Motion to the East, it must needs be prest West-wards, and make that continual *Breeze* from East to West between the *Tropicks*.

2. The same Accounts bear, that on this Side the *Tropick*, about 28 or 30 *deg.* there are to be found constant Westerly Winds; and therefore the *Spanish* Fleets from the *West-Indies* do not return the Way they went, but those both from *Peru*, and *New Spain*, sail along the Coast Northward till they touch at *Havanna* in *Cuba*, and being join'd together there, they seek their Height without the *Tropicks*, where presently they find Westerly Winds, which serve them till they come in view of the *Azores*, and from thence to *Seville*. In like manner in the *South-Sea*, those which return from the *Philippines*, or *China*, to *Mexico*, to the End they may recover the Western Winds, mount a great Height till they come right against the Island of *Japan*; and discovering *California*, they return by the Coast of *New Spain* to the Port of *Acapulco*, from whence they parted. So that though they sail easily from East to West, in both Seas, within the *Tropicks*, for that the Eastern Winds reign there; yet returning from West to East they must seek the Western Winds without the *Tropicks* in the Height of 27 *Degrees*.

Now the Reason of this seems to me clearly deducible from the former; for the Pressure of Air between the *Tropicks* being continually less than the neighbouring Parts of the *Atmosphere*, and so consequently by them pressed West-ward, way being thereby given to the neighbouring Air for some *Deg.* without the *Tropicks*; its Motion from West to East is proportionably increas'd beyond that uniform Motion it would have, if the whole

Atmosphere

Atmosphere were of an equal Pressure; and consequently there will blow a constant Wind from West to East for some *Degrees* beyond the *Tropicks*.

3. Those Easterly Winds between the *Tropicks*, by what I can collect from the Accounts of Eastern Voyages, do not blow constantly from the same Point, nor directly from the East; but for the one half of the Year, *viz.* from *April* to *November*, or thereabouts, they come from the South-East; and for the other half of the Year, *viz.* from *November* to *April*, they blow from the North-East. And these I suppose they call their *Monsoons*, and *Trade-Winds*. Hence it is, that they who sail from *China*, *Japan*, &c. to *Bantam*, must wait the Northerly *Monsoon*, which falls between *November* and *April*; and they who return from *Bantam*, must go back again when the Southerly *Monsoon* comes, which is between *April* and *November*; and the *Currents* of the Sea are said to observe the same Motion and Changes with the Winds. I know not whether these *Monsoons* do blow exactly from the same Points in all Parts; for it's like, where there are Bays, Highlands, and Islands, &c. the *Monsoons* may blow from different Points: but this is chiefly to be understood of open Seas.

Now these *Monsoons*, I think, may be easily accounted for from what has already been said, anent the Cause of the continual Easterly Winds between the *Tropicks*; for seeing the lessening of the Air's Pressure under the *Line*, and the Pressure of the Neighbouring Parts of the *Atmosphere* thereupon, occasion these continual *Breezes*, if the Sun were constantly in the *Equinoctial Line*, it is like the Wind would blow still directly from the East; but in that he is the one half of the Year on the one Side of the *Line*, and the other half on the other, there must of Necessity follow a Change of these *Breezes* into stated *Monsoons*. For, imagine the *Atmosphere* to be divided into two equal Hemispheres by the *Equinoctial Plane*; if the Sun were always in the Plane, there would be still an equal Pressure from both these Hemispheres upon the Air under the *Line*, and the *Breeze* should be directly from the East. But now when the Sun comes on the North-side of the *Line*, as far as the *Tropick* of *Cancer*, and back again, there is not an equal Balance, but the Pressure of the Southern Hemisphere of the Air must needs be greatest, and consequently the *Breeze* must blow all that Season from the South-East; and when the Sun returns again to the Southward of the *Line*, as far as *Capricorn*, and back again, the Pressure of the Northern Hemisphere must needs preponderate, and make the Wind blow all that half Year from the North-East. And this seems to accord very well with Experience: for their Northern *Monsoons* are in our Winter Season, when the Sun is in the Southern Signs; and their Southern ones in our Summer, when he is in the Northern Signs.

4. The Rivers of *Indus* and *Ganges*, where they enter the Ocean, do contain between them a large *Chersonesus*, which is divided in the Middle by a Ridge of high Hills, which they call the *Gate*, which run along from East to West, and quite thorough to Cape *Comori*. On the one Side is *Malabar*, and on the other *Coromandel*. On the *Malabar* side, between that Ridge of Mountains and the Sea, it is, after their Appellation, Summer from *September* till *April*; in which time it is always a clear Sky, without once,

or very little, Raining. On the other Side the Hills, on the Coast of *Coromandel*, it is at the same time their Winter, every Day and Night yielding abundance of Rain. And from *April* to *September* it is, on the *Malabar* Side, their Winter, and on the other Side their Summer: So that in little more than 20 Leagues Journey in some Places, as where they cross the Hills to *St. Thomas*; on the one Side of the Hill you ascend with a fair Summer, on the other you descend with a stormy Winter. The like is said to be at *Cape Razalgate* in *Arabia*. And *Dr. Trapham* relates the same of *Jamaica*, intimating that there is a Ridge of Hills which runs from East to West thro' the Midst of the Island, and that the Plantations on the South-side of these Hills have, from *November* to *April*, a continual Summer, whilst those on the North-side have as constant a Winter; and *è contra* from *April* to *November*.

From these and such like Accounts it seems evident, that a bare lessening of the *Atmosphere's* Gravity will not occasion Rain, but that there is also needful either a sudden Change of Winds, or a Ridge of Hills to meet the Current of the Air and Vapours, whereby the Particles of the Vapours are driven together, and so fall down into Drops of Rain. And hence it is, that whilst the Wind blows from the North-east, *viz.* from *November* to *April*, there are continual Rains in the northerly Plantations of *Jamaica*, and on the Side of *Coromandel* in the *East-Indies*, because the Winds beat against that Side of the Hills; and so there is fair Weather on the other Side of these Hills, in *Malabar* and the southern Plantations of *Jamaica*, there being no Winds to drive the Vapours together. But in the southerly *Monsoon*, *viz.* from *April* to *November*, *Malabar* and the southerly Plantations of *Jamaica*, have Floods of Rains, the Wind beating against that Side of the Hills; whilst in *Coromandel* and the other Side of *Jamaica*, there is Fair and Clear Weather. The Maps make those Mountains of *Gate* run South and North; and, if so, the *Monsoons* must blow from other Points, by reason of the neighbouring Countries and Islands; or else this is not the true Cause of these *Seasons*.

5. This serves also to clear the *Singularity* of *Seasons* in *Peru*, beyond any other Parts of the Earth, and seems to be assigned by *Acosta*, as the Cause of it. *Peru* runs along from the *Line* Southwards about 1000 Leagues. It is said to be divided into three Parts, long and narrow, which they call *Lanos*, *Sierras* and *Andes*; the *Lanos*, or Plains, run along the *South-Sea* Coast; the *Sierras* are all Hills, with some Vallies; and the *Andes* steep and craggy Mountains. The *Lanos* have some ten Leagues in Breadth, in some Parts less, and in some more; the *Sierras* contain some 20 Leagues in Breadth, the *Andes* as much, sometimes more, sometimes less; they run in Length from North to South, and in Breadth from East to West. This Part of the World is said to have these remarkable Things. 1. All along the Coast, in the *Lanos*, it blows continually with one only Wind, which is South and South-west, contrary to that which usually blows under the *Torrid Zone*. 2. It never Rains, Thunders, Snows, or Hails, in all this Coast, or *Lanos*, though there falls sometimes a small Dew. 3. Upon the *Andes* it rains almost continually, though it be sometimes more clear

clear than other. 4. In the *Sierras*, which lie betwixt both the *Extreams*, it rains from *September* to *April*, but in the other Seasons it is more clear, which is when the Sun is farthest off, and the contrary when it is nearest. Now the Reason of all seems to be this. The *Eastern Breezes* which blow constantly under the *Line*, being stopt in their Course by the *Sierras* and *Andes*, and yet the same *Breezes* being to be found in the *South-Sea* beyond *Peru*, as appears by the easy Voyages from *Peru* to the *Philippines*, a Current of Wind blows from the South on the Plains of *Peru*, to supply the *Eastern Breeze* in the *South Seas*; and there being but one constant Gale in these Plains, and no contrary Winds, nor Hills for it to beat upon, this seems to be the Reason why the Vapours are never, or very seldom, driven into Rain. And the *Andes* being as high perhaps in many Places as the Vapours ascend in the highest Degree of the *Atmosphere's* Gravity, this may probably be the Reason why the *Eastern Breeze*, beating constantly against these Hills, occasions Rains upon them at all Seasons of the Year. And the *Sierras* being, it seems lower than the *Andes*; therefore from *September* to *April*, when the Sun is nearest, and so the *Atmosphere's* Gravity less, and the Vapours lower, they are driven against *Sierras* into Rain.

6. The Causes of those particular, various, uncertain, and unconstant Winds, which do blow in the Countries without the *Tropicks*, and that most frequently in mountainous Places, and more seldom in great Plains, such as *Poland*, I cannot so easily conjecture: but those general Winds which usually fall out every where about both *Equinoctials*, seem to proceed from some general Cause: and this I take to be the Change of the *Monsoons*, and *Trade-Winds*, about these Times, between the *Tropicks*. For there must needs be about these Seasons a Change of the Balance of the *Atmosphere*, according to what I have discoursed on the third Head; and this, I think, cannot but occasion strong Winds over all the Earth.

2. Dr. *Gordon* endeavours to explain and give an Account of the *Trade-winds* within the *Tropicks*, from the different Gravity of the *Atmosphere* at divers times of the Year. And yet it is asserted by Dr. *Lister*, that the *Mercury* is not affected with the Weather, or very rarely, let it be cloudy, rainy, windy or serene, in *St. Helena* or the *Barbadoes*, and therefore probably not within the *Tropicks*, unless in a violent Storm or Hurricane. Now if the *Mercury* move little or nothing in the *Baroscope*, 'tis likely there is little or no Change in the Gravity of the *Atmosphere*, within the *Tropicks*.

By Mr. W. Molyneux, n. 177. P. 1237.

Vid. Sect. X. 1.

3. The universal *Ocean* may most properly be divided into three Parts; viz. 1. The *Atlantick* and *Æthiopic* Sea. 2. The *Indian Ocean*. 3. The great *South-Sea*, or the *Pacifick Ocean*.

By Mr. Halley, n. 183. P. 253.

1. In the *Atlantick* and *Æthiopic* Seas, between the *Tropicks*, there is a general Easterly Wind all the Year long, without any considerable Variation; excepting that it is subject to be deflected therefrom, some few Points of the Compass, towards the North or South, according to the Position of the Place.

1. Near the Coast of *Africa*, as soon as you have passed the *Canary Isles*, you are sure to meet a fresh Gale of *N. E.* Wind, about the Latitude of 28°, North, which seldom comes to the Eastwards of the *E. N. E.* or passes the *N. N. E.* This Wind accompanies those bound to the Southward, to the Latitude

titude of 10° North, and about 100 Leagues from the *Guinea Coast*, where till the 4° of North Latitude, they fall into *Calms* and *Tornadoes*.

2. Those bound to the *Caribbee Isles*, find, as they approach the *American Side*, that the aforesaid N. E. Wind becomes still more and more Easterly, so as sometimes to be E. sometimes E. by S. but yet most commonly to the Northward of the East, a Point or two, seldom more. 'Tis likewise observed, that the Strength of these Winds does gradually decrease, as you sail to the Westward.

3. That the *Limits* of the *Trade* and *Variable* Winds in this *Ocean*, are farther extended on the *American Side* than the *African*; for whereas you meet not with this certain Wind till after you have past the Latitude of 28° on this Side; on the *American Side* it commonly holds to 30 , 31 , or 32 of Latitude; and this is verified likewise to the Southward of the *Equinoctial*, for near the *Cape of Good Hope*, the *Limits* of the *Trade Winds* are 3 or 4 nearer the Line than on the Coast of *Brasil*.

4. That from the Latitude of 4° North to the aforesaid *Limits* on the South-side of the *Æquator*, the Winds are generally and perpetually between the South and East, and most commonly between the South-East and East; observing always this Rule, that on the *African Side* they are more southerly, on the *Brasilian* more easterly, so as to become almost due East, the little Deflexion they have being still to the Southwards. In this Part of the *Ocean* it has been my Fortune to pass a full Year, in an Employment that obliged me to regard more than ordinarily the Weather, and I found the Winds constantly about the South-east, the most usual Point *S. E. by E.* when it was Easterly it generally blew hard, and was gloomy, dark, and sometimes rainy Weather; if it came to the Southwards, it was generally serene, and a small Gale next to a Calm; but this is not very common. But I never saw it to the Westwards of the South, or Northwards of the East.

5. That the Season of the Year has some small Effect on these *Trade-winds*, for that when the Sun is considerably to the Northwards of the *Æquator*, the South-east Winds, especially the Streight of this *Ocean*, (if I may so call it) between *Brasil* and the Coast of *Guinea*, do vary a Point or two to the Southwards, and the North-east become more Easterly; and, on the contrary, when the Sun is towards the *Tropick of Capricorn*, the South-easterly Winds become more Easterly, and the North-easterly Winds on this Side the Line were more to the Northward.

6. There is in this *Ocean* a Tract of Sea, wherein the Southerly and South-west Winds are perpetual, viz. all along the Coast of *Guinea*, for above 500 Leagues together, from *Sierra Leona* to the Isle of *St. Thomas*; for the South-east *Trade-Wind* having passed the *Line*, and approaching the Coast of *Guinea*, within 80 or 100 Leagues, inclines towards the Shore, and becomes *S. S. E.* and by Degrees, as you come nearer, it veers about to South, *S. S. W.* and in with the Land *South-West*, and sometimes *W. S. W.* which Variation is better expressed in the Map than it can well be in Words. These are the Winds which are observed on this Coast when it blows true, but there are frequent Calms, violent sudden Gusts, called *Tornadoes*, from all Points of the
Compass,

Compass, and sometimes unwholesome, foggy, easterly Winds, called *Hermi-tae*, by the Natives, which too often infest the Navigation of these Parts.

7. That to the Northwards of the Line, between 4 and 10 *deg.* of *Latitude*, and between the Meridians of *Cape Verde*, and of the Eastermost Islands that bear that Name, there is a Tract of Sea, wherein it were improper to say there is any *Trade Wind*, or yet a *Variable*, for it seems condemned to perpetual Calms, attended with terrible Thunder and Lightning, and Rains so frequent, that our Navigators from thence call this part of the Sea the *Rains*: the little Winds that are, be only some sudden uncertain Gusts, of very little Continuance and less Extent; so that sometimes each Hour you shall have a different Gale, which dies away into a Calm before another succeed; and in a Fleet of Ships in Sight of one another, each shall have the Wind from a several Point of the Compass; with these weak *Breezes*, Ships are obliged to make the best of their way to the Southward, thro' the afore-said six *Degrees*, wherein 'tis reported some have been detained whole Months for want of Wind.

From the three last Observables is shewn the Reason of two notable Occurrences in the *East-India* and *Guinea* Navigations. The one is, why notwithstanding the narrowest Part of the Sea, between *Guinea* and *Brazil*, be about 500 Leagues over; yet Ships bound to the Southward, sometimes, especially in the Months of *July* and *August*, find a great Difficulty to pass it. This happens, because of the South-east Winds, at that time of the Year, commonly extending some *deg.* beyond the ordinary Limit of 4 *deg.* North *Lat.* and withal they come so much southerly, as to be sometimes South, sometimes a Point or two to the West; there remains then only to ply to Windward, and if, on the one side they stand away *W. S. W.* they gain the Wind still more and more easterly, but there is Danger of not weathering the *Brazilian* Shore, or at least the Shoals upon that Coast. But if upon the other Tack they go away *E. S. E.* they fall into the Neighbourhood of the Coast of *Guinea*, from which there is no departing without running Easterly, as far as the Isle of *St. Thomas*, which is the constant Practice of all the *Guinea* Ships, and which may seem very strange, without the Consideration of the 6th Remark, which shews the Reason of it. For being in with the Coast, the Wind blows generally at *S. W.* and *W. S. W.* with which Winds they cannot go to the Northward for the Land, and on the other Tack, they can lie no nearer the Wind than *S. S. E.* or *S.* and with these Courses they run off the Shore, but in so doing they always find the Winds more and more contrary; so that when near the Shore, they could lie South, at a greater Distance they can make their way no better than *S. E.* and afterwards *E. S. E.* with which Courses they fetch commonly the Isle of *St. Thomas* and *Cape Lopez*, where, finding the Winds to the Eastward of the South, they keep them favourable, by running away to the Westward in the South *Lat.* 3 or 4 *Deg.* where the *S. E.* Winds are perpetual.

For the sake of these general Winds, all those that use the *West-Indian* Trade, even those bound to *Virginia*, count it their best Course to get as soon as they can to the Southwards that so they may be certain of a fair and fresh

fresh Gale, to run before it to the West-wards; and for the same Reason those homewards bound from *America*, endeavour to gain the Latitude of 30 deg. as soon as possible, where they first find the Winds begin to be variable; tho' the most ordinary Winds in the northern Part of the *Atlantick Ocean* come from between the South and West.

As to those furious Storms called *Hurricanes*, which are, as it were, peculiar to the *Caribbee Isles*; and which so dreadful afflict them in the Month of *August*, or not much before or after, they do not so properly belong to this Place, both by Reason of their small Continuance and Extent, as likewise because they are not Anniversary; some Years having more than one, and sometimes for several Years together there being none at all. But their Violence is so inconceivable, and their other *Phænomena* so surprising, that they merit well to be considered apart.

What is here said, is to be understood of the Sea-Winds, at some Distance from the Land; for, upon and near the Shores, the Land and Sea Breezes are almost every where sensible; and the great Variety which happens in their Periods, Force and Direction, from the Situation of the Mountains, Vallies and Woods, and from the various Texture of the Soil, more or less capable of retaining and reflecting Heat, and of exhaling or condensing Vapours, is such, that it were an endless Task to endeavour to account for them.

2. In the *Indian Ocean*, the Winds are partly general, as in the *Ethiopic Ocean*, partly periodical, that is, half the Year they blow one way, and the other half near upon the opposite Points; and these Points and Times of Shifting are different in different Parts of this Ocean.

1. Between the Latitudes of 10 deg. and 30 deg. South between *Madagascar* and *Hollandia Nova*, the *General Trade-Winds* about the *S. E. by E.* is found to blow all the Year long, to all Intents and Purposes after the same Manner as in the same Latitudes in the *Æthiopic Ocean*, as it is described in the 4th Remark foregoing.

2. That the aforesaid *S. E.* Winds do extend to within 2 deg. of the *Æquator*, during the Months of *June, July, August, &c. to November*, at which time, between the South Latitudes of 3 and 10 Deg. being near the Meridian of the North End of *Madagascar*; and between 2 and 12 South Latitude, being near *Sumatra* and *Java*; the contrary Winds from the *N. W.* or between the North and West, set in and blow for half a Year, viz. from the Beginning of *December* till *May*: and this *Monsoon* is observed as far as the *Molucca Isles*; of which more anon.

3. That to the Northward of 3 Deg. South Latitude, over the whole *Arabian* or *Indian Sea* and *Gulf of Bengal*, from *Sumatra* to the Coast of *Africa*, there is another *Monsoon*, blowing from *October* to *April*, upon the *N. E.* Points; but in the other half Year, from *April* to *October*, upon the opposite Points of *S. W.* and *W. S. W.* and that with rather more Force than the other, accompanied with dark rainy Weather, whereas the *N. E.* blows clear. 'Tis likewise to be noted, that the Winds are not so constant, either in Strength or Point, in the *Gulf of Bengal*, as they are in the *Indian Sea*,
where

where a certain steady Gale scarce ever fails. 'Tis also remarkable, that the *S. W.* Winds in these Seas are generally more Southerly on the *African* Side, more Westerly on the *Indian*.

4. There is a Tract of *Sea* to the Southwards of the *Æquator*, subject to the same Changes of the Winds, *viz.* near the *African* Coast, between it and the Island *Madagascar* or *St. Lawrence*, and from thence Northwards as far as the *Line*; wherein from *April* to *October* there is found a constant Fresh *S. S. W.* Wind, which, as you go more Northerly, becomes still more and more Westerly, so as to fall in with the *W. S. W.* Winds, mention'd before in those Months of the Year to be certain to the Northward of the *Æquator*: What Winds blow in those Seas for the other half Year, I have not yet been able to obtain to my full Satisfaction: The Account which has been given me is only this, that the Winds are much Easterly hereabouts, and as often to the North of the true East as to the Southwards thereof.

5. That to the Eastward of *Sumatra* and *Malacca*, to the Northwards of the *Line*, and along the Coast of *Camboia* and *China*, the *Monsoons* blow North and South; that is to say, the *N. E.* Winds are much Northerly, and the *S. W.* much Southerly. This Constitution reaches to the Eastwards of the *Philippine* Isles, and as far Northerly as *Japan*. The Northern *Monsoon* setting in, in these Seas, in *October* or *November*, and the Southern in *May*, blowing all the Summer Months. Here it is to be noted, that the Points of the Compass, from whence the Winds come in these Parts of the World, are not so fixt as in those lately describ'd; for the Southerly will frequently pass a Point or two to the Eastwards of the South, and the Northerly as much to the Westwards of the North; which seems occasioned by the great Quantity of Land which is interspersed in these Seas.

6. That in the same *Meridians*, but to the Southward of the *Æquator*, being that Tract lying between *Sumatra* and *Java* to the West, and *New-Guinea* to the East, the same Northerly and Southerly *Monsoons* are observed; but with this Difference, that the Inclination of the Northerly is towards the *N. W.* and of the Southerly towards the *S. E.* but the *Plage Venti* are not more constant here than in the former, *viz.* Variable 5 or 6 Points: Besides, the Times of the Change of these Winds are not the same as in the *Chinese* Seas, but about a Month or 6 Weeks later.

7. That these contrary Winds do not shift all at once, but in some Places the Time of the Change is attended with *Calms*, in others with *Variable* Winds; and it is particularly remarkable, that the End of the Westerly *Monsoon* on the Coast of *Coromandel*, and the two last Months of the Southerly *Monsoon* in the Seas of *China*, are very subject to be *Tempestuous*: The Violence of these Storms is such, that they seem to be of the Nature of the *West-India Hurricanes*, and render the Navigation of these Parts very unsafe about that time of the Year. These *Tempests* are by our Seamen usually term'd, the *Breaking up of the Monsoons*.

By reason of the shifting of these Winds, all those that sail in these Seas, are oblig'd to observe the Seasons proper for their Voyages, and so doing, they fail not of a fair Wind and speedy Passage; but if so be they chance to out-stay their Time, till the contrary *Monsoon* sets in, as it frequently happens,

they are forced to give over the Hopes of accomplishing their intended Voyages, and either return to the Port from whence they came, or else put into some other Harbour, there to spend the Time till the Winds shall come favourable.

8. That Navigation that there is on the *Mare Pacificum*, is by the *Spaniards*, who go yearly from the Coast of *New-Spain* to the *Manilba's*: But that is but by one beaten Tract; so that I cannot be so particular here as in the other two. What the *Spanish* Authors say of the Winds they find in their Courses, and what is confirm'd by the old Accounts of *Drake* and *Candish*, and since by *Schooten*, who sailed the whole Breadth of this Sea in the Southern *Latitude* of 15 or 16 *deg.* is, that there is a great Conformity betwixt the Winds of this Sea, and those of the *Atlantick* and *Æthiopic*; that is to say, that to the Northwards of the *Æquator*, the predominant Wind is between the *E.* and *N. E.* and to the Southwards thereof, there is a constant steady Gale between the *E.* and *S. E.* and that on both Sides the *Line*, with so much Constancy that they scarce ever need to attend the Sails, and so much Strength, that it is rare to fail of Crossing this vast *Ocean* in ten Weeks time, which is about 130 Miles *per diem*: Besides, 'tis said that Storms and Tempests are never known in these Parts; wherefore some have thought it might be as short a Voyage to *Japan* and *China*, to go by the *Streights* of *Magellan*, as by the *Cape of Good Hope*.

The Limits of these *General* Winds are also much the same as in the *Atlantick* Sea, *viz.* about the 30th Degree of *Latitude* on both Sides; for the *Spaniards*, Homewards bound from the *Manilba's*, always take the Advantage of the Southerly *Monsoon*, blowing there in the Summer Months, and run up to the Northwards of that *Latitude*, as high as *Japan*, before they meet with *Variable* Winds, to shape their Course to the Eastwards. And *Schooten* and others that have gone about by the *Magellan Streights*, have found the Limits of *S. E.* Winds, much about the same *Latitude* to the Southwards; besides, a farther Analogy between the Winds of this *Ocean* and the *Æthiopic* appears in that, that upon the Coast of *Peru* they are always much Southerly, like as they are found near the Shores of *Angola*.

Fig. 20.

To help the Conception of the Reader in a matter of so much Difficulty, I believ'd it necessary to adjoin a *Scheme*, shewing, at one View, all the various *Tracts* and *Courses* of these Winds. The *Limits* of these several *Tracts* are designed every where by prickt Lines, as well in the *Atlantick* and *Æthiopic*, where they are the Boundaries of the *Trade* and *Variable* Winds, as in the *Indian Ocean*, where they also shew the Extent of the several *Monsoons*. The Course of the Winds is express'd by Rows of Stroaks in the same Line that a Ship would move, going always before it; the sharp End of each little Stroak pointing out that Part of the *Horizon*, from whence the Wind continually comes; and where there are *Monsoons*, the Rows of the Stroaks run alternately backwards and forwards, by which means they are thicker there than elsewhere. As to the great *South-Sea*, considering its vast Extent, and the little Variety there is in its Winds, and the great Analogy between them, and those of the *Atlantick* and *Æthiopic Oceans*; besides, that, the greatest Part thereof is wholly unknown to us; I thought it unnecessary to lengthen the *Map* therewith. In

In the foregoing History are contained several Problems, that merit well the Consideration of our acutest Naturalists, both by reason of the Constancy of the Effect, and of the immense Extent thereof; near half the Surface of the Globe being concerned; wherein if I am not able to account for all Particulars, yet 'tis hoped the Thoughts I have spent thereon, will not be judged wholly lost by the Curious in natural Inquiries.

1. *Wind* is most properly designed to be the Stream or Current of the Air; and where such Current is perpetual, and fixt in its Course, 'tis necessary that it proceed from a permanent unintermitting Cause, capable of producing a like constant Effect, and agreeable to the known Properties of the Elements of *Air* and *Water*, and the Laws of the Motion of fluid Bodies. Such an one is, I conceive, the Action of the Sun's Beams upon the *Air* and *Water*, as he passes every Day over the *Oceans*, considered together with the Nature of the Soil and Situation of the adjoining *Continents*. I say, therefore, *First*, That, according to the Laws of *Statics*, the Air, which is less rarified or expanded by Heat, and consequently more ponderous, must have a Motion towards those Parts thereof which are more rarified, and less ponderous, to bring it to an *Æquilibrium*; and, *Secondly*, That the Presence of the Sun continually shifting to the Westwards; that Part towards which the Air tends, by reason of the Rarefaction made by his greatest Meridian Heat, is with him carried Westward, and consequently the Tendency of the whole Body of the lower Air is that way. Thus a *General Easterly Wind* is formed, which being impressed upon all the Air of a vast Ocean, the Parts impel one the other, and so keep moving till the next Return of the Sun; whereby so much of the Motion as was lost, is again restor'd, and thus the Easterly Wind is made *Perpetual*.

2. From the same Principle it follows, that this Easterly Wind should, on the North-side of the *Æquator*, be to the Northwards of the East, and in South *Latitudes* to the South thereof; for, near the *Line*, the Air is much more rarified, than at a greater Distance from it; because of the Sun's being twice in a Year vertical, and at no time distant above 23 *deg.* and a half, at which Distance the Heat, being as the Sine of the Angle of Incidence, is but little short of that of the perpendicular Ray. Whereas under the *Tropicks*, though the Sun stay long vertical, yet he is as long 47 *deg.* off; which is a kind of Winter, wherein the Air so cools, as that the Summer Heat cannot warm it to the same Degree with that under the *Æquator*: wherefore the Air to the Northwards and Southwards, being less rarified than that in the Middle, it follows, that from both Sides it ought to tend towards the *Æquator*. This Motion compounded with the former Easterly Wind, answers all the *Phænomena* of the *General Trade-Winds*; which, if the whole Surface of the Globe were Sea, would undoubtedly blow all round the World, as they are found to do in the *Atlantick* and *Æthiopic* *Oceans*.

3. But seeing that so great *Continents* do interpose and break the Continuity of the *Ocean*, regard must be had to the Nature of the Soil and the Position of the high Mountains; which I suppose the two principal Causes

of the several *Variations* of the *Winds* from the former General Rule: For if a Country lying near the Sun prove to be flat, sandy, low Land, such as the *Deserts* of *Lybia* are usually reported to be, the Heat occasioned by the Reflection of the Sun's Beams, and the Retention thereof in the Sand, is incredible to those who have not felt it; whereby the Air being exceedingly rarified, it is necessary that the cooler and more dense Air should run thitherwards to restore the *Æquilibrium*. This I take to be the Cause, why near the Coast of *Guinea* the Wind always sets in upon the Land, blowing Westerly instead of Easterly; there being sufficient Reason to believe, that the Inland Parts of *Africa* are prodigiously hot, since the Northern Borders thereof were so intemperate, as to give the Antients Cause to conclude, that all beyond the *Tropick* was made *Uninhabitable* by Excess of Heat. From the same Cause it happens, that there are so constant *Calms* in that Part of the Ocean, called the *Rains* (described in the 7th Remark on the *Atlantick Sea*;) For this Tract being placed in the Middle, between the Westerly Winds blowing on the Coast of *Guinea*, and the Easterly *Trade-Winds* blowing to the Westwards thereof, the Tendency of the Air here is indifferent to either, and so stands in *Æquilibrium* between both; and the Weight of the incumbent *Atmosphere* being diminished by the continual contrary Winds blowing from hence, is the Reason that the Air here holds not the copious Vapour it receives, but lets it fall into so frequent *Rains*.

4. But as the cool and dense Air, by reason of its greater Gravity, presses upon the hot and rarified, 'tis demonstrative that this latter must ascend in a continual Stream as fast as it rarifies, and that being ascended, it must disperse it self to preserve the *Æquilibrium*, that is, by a *contrary Current*, the upper Air must move from those Parts where the greatest Heat is: So by a kind of Circulation, the *N. E. Trade-Wind* below will be attended with a *S. W.* above, and the *S. E.* with a *N. W.* Wind above. And that this is more than a bare Conjecture, the almost instantaneous Change of the Wind to the opposite Point, which is frequently found in passing the Limits of the *Trade-Winds*, seems to assure us: But that which above all confirms this *Hypothesis*, is the *Phænomenon* of the *Monsoons*, by this Means most easily solved, and without it hardly explicable. Supposing therefore such a Circulation as above; 'tis to be considered, that to the Northward of the *Indian Ocean* there is every where Land within the usual Limits of the *Latitude* of 30, *viz.* *Arabia, Persia, India, &c.* which, for the same Reason as the Mediterranean Parts of *Africa*, are subject to unsufferable Heats when the Sun is to the North, passing nearly Vertical, but yet are temperate enough when the Sun is removed towards the other *Tropick*, because of a Ridge of Mountains at some Distance within the Land, said to be frequently in Winter covered with Snow, over which, the Air, as it passes, must needs be much chilled. Hence it comes to pass, that the Air coming, according to the general Rule, out of the *N. E.* in the *Indian Seas*, is sometimes hotter, sometimes colder, than that which by this Circulation is returned out of the *S. W.* and by Consequence, sometimes the under Current or Wind is from the *N. E.* sometimes from no other Cause,

Cause, is clear from the Times wherein these Winds set in, viz. in *April*, when the Sun begins to warm those Countries to the North, the *S. W. Monsoon* begins, and blows during the Heats till *October*, when the Sun being retired, and all Things growing cooler Northward, and the Heat increasing to the South, the *N. E. Winds* enter and blow all the Winter till *April* again.

5. And it is undoubtedly from the same Principle that to the Southwards of the *Æquator*, in part of the *Indian Ocean*, the *N. W. Wind* succeeds the *S. E.* when the Sun draws near the *Tropick of Capricorn*. But I must confess, that in this latter occurs a Difficulty not well to be accounted for, which is, why this Change of the *Monsoons* should be any more in this *Ocean*, than in the same *Latitudes* in the *Æthiopic*, where there is nothing more certain than a *S. E. Wind* all the Year.

6. 'Tis likewise very hard to conceive, why the Limits of the *Trade-winds* should be fixt about the 30th *Deg. of Latitude* all round the Globe; and that they should so seldom transgress or fall short of those Bounds: as also that in the *Indian Sea*, only the Northern Part should be subject to the changeable *Monsoons*, and in the Southern there be a constant *S. E.*

These are Particulars that merit to be considered more at large, and furnish a sufficient Subject for a just Volume.

XXXVII. Mr. *Henshaw* has observ'd, That *Dew* newly gathered, and filtred through a clean Linen Cloth, tho' it be not very clear, is of a yellowish Colour, somewhat approaching to that of *Urine*.

Observations upon May-Dew; by Mr. Tho. Henshaw, n. 3. P. 33.

That having endeavour'd to putrify it, by putting several Proportions into glass Bodies with blind Heads, and setting them in several Heats, as of *Dung*, and gentle Baths, he quite failed of his Intention: for Heat, tho' never so gentle, did rather clarify and preserve it sweet, though continued for two Months together, than cause any Putrefaction or Separation of Parts.

That exposing of it to the Sun for a whole Summer in Glasses, that hold about 2 Gallons, with narrow Mouths that might be stopp'd with Cork, the only considerable Alteration he observ'd to be produced in it was, that Store of green Stuff (such as is seen in Summer in Ditches and standing Waters) floated on the Top, and in some Places grew to the Sides of the Glass.

That putting 4 or 5 Gallons of it into a half Tub, as they call it, of Wood, and straining a Canvas over it to keep out Dust and Insects, and letting it stand in some shady Room for 3 Weeks or a Month, it did of it self putrify and stink exceedingly, and let fall to the Bottom a black Sediment like Mud.

That coming often to see what Alterations appeared in the Putrefaction, he observ'd, that at the Beginning, within 24 Hours, a slimy Film floated on the Top of the Water; which after a while falling to the Bottom, there came another such Film in its Place.

That if *Dew* were put into long narrow Vessels of Glass, such as formerly were used for *Receivers* in distilling of *Aqua Fortis*, the Slime would rise to that Height, that he could take it off with a Spoon; and when he had put a pret-

ty

ty Quantity of it into a Drinking-glass, and it had stood all Night and the Water drained from it, if he had turned it out on his Hand, it would stand upright in Figure of the Glass, in Substance like boiled white Starch, tho' somewhat more transparent; if his Memory, *saith he*, fail him not.

That having once gotten a pretty Quantity of this Gelly, and put it into a Glass-body and Blind-head, he set it into a gentle Bath, with an Intention to have putrified it; but after a few Days, he found the Head had not been well luted on, and that some Moisture exhaling, the Gelly was grown almost dry, and a large *Mushroom* was grown out of it within the Glass; it was of a loose waterish Contexture, such an one as he had seen growing out of rotten Wood.

That having several Tubs with good Quantity of *Dew* in them, set to putrify in the Manner abovesaid, and coming to pour out of one of them to make use of it, he found in the Water a great Bunch bigger than his Fist, of those Insects commonly called *Hog-lice*, or *Millepedes*, tangled together by their long Tails, one of which came out of every one of their Bodies about the Bigness of a Horse Hair. The Insects did all live and move after they were taken out.

That emptying another Tub, whereon the Sun, it seems, had used sometimes to shine, and finding, upon the straining it thro' a clean Linen Cloth, two or three Spoonfuls of green Stuff, though not so thick nor so green as that above mentioned, found in the Glasses purposely exposed to the Sun; he put this green Stuff in a Glass, and tied a Paper over it, and coming some Days after to view it, he found the Glass almost filled with an innumerable Company of small Flies, almost all Wings, such as are usually seen in great Swarms in the Air in Summer Evenings.

That setting about a Gallon of this *Dew* (which, he saith, if he misremember not, had been first putrified and stained) in an open Jarr-Glass with a wide Mouth, and leaving it for many Weeks standing in a South-window on which the Sun lay very much, but the Casements were kept close shut; after some time, coming to take Account of his *Dew*, he found it very full of little *Insects*, with great Heads and small tapering Bodies, somewhat resembling *Tadpoles*, but very much less. These, on his Approach to the Glass, would sink down to the Bottom, as it were, to hide themselves, and upon his Retreat, wriggle themselves up to the Top of the Water again. Leaving it thus for some time longer, he afterwards found the Room very full of *Gnats*, tho' the Door and Windows were kept shut. He adds, that he did not at first suspect that those *Gnats*, had any Relation to the *Dew*; but, after finding the *Gnats* to be multiplied, and the little watry Animals to be much lessened in Quantity, and finding great Numbers of their empty Skins floating on the Face of his *Dew*, he thought he had just Reason to persuade himself that the *Gnats* were by a second Birth produced of those little Animals.

That vapouring away great Quantities of his putrified *Dew* in Glass Basons and other earthen glazed Vessels, he did at last obtain, as he remembers, above 2 Pound of greyish Earth; which, when he had washed with more of the same *Dew* out of all his Basons into one, and vapoured to Siccity, lay in
Leaves

Leaves one above another, not unlike to some Kind of brown Paper, but very friable.

That taking this Earth out, and after he had well ground it on a Marble, and given it a smart Fire in a coated Retort of Glass, it soon melted and became a Cake in the Bottom when it was cold, and looked as if it had been Salt and Brimstone in a certain Proportion melted together; but, as he remembers, was not at all *inflammable*. This ground again on a Marble, he saith, did turn spring Water of a reddish, purple Colour.

That by often calcining and filtering this Earth, he did at last extract 2 Ounces of a fine small white *Salt*, which looked on through a good *Microscope*, seem'd to have Sides and Angles in the same Number and Figure, as *Rock Petre*.

XXXVIII. 1. We had of late in the County of *Limerick* and *Tipperary*, Showers of a Sort of Matter like Butter or Grease; if one rub it upon one's Hand it will melt, but lay it by the Fire and it dries and grows hard, having a very stinking Smell. Some of it fell here at *Kilkenny*, Nov. 14, 1695. which I did see myself the next Morning.

A kind of Dew like Butter, in Ireland; by Mr. R. Vans, n. 220. p. 223.

2. Having very diligently enquired concerning a very odd Phænomenon, which was observed in many Parts of *Munster* and *Leinster*, the best Account I can collect thereof, is as follows: For a good Part of the Winter 1695, and Spring following, there fell in several Places a Kind of thick Dew, which the Country People call'd *Butter*, from the Consistency and Colour of it, being soft, clammy, and of a dark Yellow; it fell always in the Night, and chiefly in moorish low Grounds, on the Top of the Grass; and often on the Thatch of Cabbins; 'twas seldom observ'd in the same Places twice, it commonly lay on the Earth for near a Fortnight without changing its Colour, but then dried and turned black; Cattle fed in the Fields where it lay indifferently as in other Fields: It fell in Lumps often as big as the End of one's Finger, very thin and scatteringly; it had a strong ill Scent, somewhat like the Smell of Church-Yards or Graves; and indeed, we had during most of that Season very stinking Fogs, some Sediment of which might possibly occasion this stinking Dew, tho' I will by no means pretend to offer that as a Reason of it. I cannot find that it was kept long, or that it bred any *Worms* or *Insects*; yet the superstitious Country People, who had scall'd or sore Heads, rubb'd them with this Substance, and said it healed them.

By the Bishop of Cloyne, ib.

XXXIX. Dec. 6, 1631. Being in the Gulf of *Volo*, riding at Anchor, about 10 of the Clock that Night, it began to rain Sand or Ashes, and continued till two of the Clock the next Morning. It was about two Inches thick on the Deck, so that we cast it over-board with Shovels, as we did Snow the Day before. There was no Wind stirring when these *Ashes* fell; it did not fall only in the Places where we were, but likewise in other Parts, as Ships were coming from *St. John d'Acree* to our Port; they being at that Time 100 Leagues from us. We compared the Ashes together, and found them both one.

A Shower of Ashes in the Archipelago; by Capt. Will Badily, n. 21. p. 377.

N. B. This Shower of Ashes was upon an *Eruption* of Mount *Vesuvius*.

*A Shower of
Ivy Berries,
mistaken for
Wheat; by
Mr. W. Cole
n. 188. p.
281.*

XL. This City of *Bristol* and the Country round, is filled with Reports of raining Wheat about *Warminster* in *Wiltshire*, and other Places within 6 or 8 Miles of it; and many believe it. I have procured several Parcels of it, and find it to be the Seed of *Ivy-Berries*, which from Towers and Churches, Chimneys, Walls, and high Buildings, were lately by very fierce Tempests of Wind and Hail driven away from the Holes, Chinks, and other Parts, where Birds had brought them, especially *Sterlings* and *Cboughs*. It was (among many other prodigious Stories) confidently affirmed, that those Grains were found in the Hail, as Seeds in Comfits. I have by all ways I can imagine, examined and compared them with the Seeds of *Ivy-Berries*, by the Taste, Smell, Size, and Figure, with the Assistance of *Magnifying Glasses*, viewing them in both the superficial and inward Parts.

*A Shower of
Fishes in
Kent, by Dr.
Rob. Cony,
n. 243. p.
289.*

XLI. On *Wednesday* before *Easter*, *An. 1696.* a Pasture Field at *Cranstead*, near *Wrotham* in *Kent*, about two Acres, which is far from any part of the Sea, or Branch of it, and a Place where are no Fish-ponds, but a Scarcity of Water, was all over-spread with little Fishes, conceived to be rained down, there having been at that Time a great Tempest of Thunder and Rain. The Fishes were about the length of a Man's little Finger, and judged by all that saw them to be young Whittings; many of them were taken up and shewed to several Persons. The Field belonged to one *Ware*, a Yeoman, who shew'd some of them, among others, to Mr. *Lake*, a *Bencher* of the *Middle-Temple*, who had one of them, and brought it to *London*. The Truth of it was averr'd by many that saw the Fishes lie scattered all over that Field, and none in the other Fields thereto adjoining. The Quantity of them was estimated to be about a Bushel, being all together.

I had this Account from a worthy Gentleman of this Country, who had a Box full of the Fishes.

*Hailstones of
an extraor-
dinary Big-
ness, by Dr.
Nath. Fair-
fax, n. 26.
p. 481.*

XLII. *July 17, 1666.* About ten in the Forenoon, there fell a violent Storm of *Hail* upon the Coast-Towns of *Suffolk*, tracing along *Seckford Hall*, *Woodbridge*, *Snape-Bridge*, *Aldborough*, &c. more to the Northwards. The *Hail* was small near *Yarmouth*; but at *Seckford-Hall* one *Hail-stone* was found by Measure to be 9 Inches about. One of this Town (*viz. Woodbridge*) found one at *Melton* 8 Inches about. At *Snape-bridge* a Man affirmed, that he lighted on one about 12 Inches about. A Lady of *Friston-Hall* putting one of them into a Balance, found it weigh 12 s. 6 d. Several Persons of good Credit in *Aldborough* affirmed some *Hail-stones* to have been full as big as *Turkey's Eggs* (an ordinary *Hen's Egg* weighs but about 9 s.) *J. Baker* of *Rumbrough* had his Head broken by the Knocks of them through a stiff Country Felt; in some Places his Head bled, in others Bunneys arose: The Horses were so pelted, that they hurried away his Cart beyond all Command. They seemed all white, smooth without, shining within. 'Tis somewhat strange, methinks, that their Pillar of Air should keep them aloft, if they were

were not clap'd together in the falling, especially at such a Time of the Year when the Air is less thickned, and its Springs weaker.

XLIII. In *May* 1686. there fell, at *Lisse* in *Flanders*, Hail of so great a Bigness, that the least exceeded Pigeons Eggs. Several of them were a Quarter of a Pound Weight and more. One among the rest was observed to contain a dark brown Matter in the Middle thereof; and being thrown into the Fire, it gave a very great Report. Others were transparent, which melted before the Fire immediately. This Storm passed over the Citadel and Town, and left not a whole Glass in the Windows on the windward Side. The Trees were broken, and some beat down; and the *Partridges* and *Hares* kill'd in Abundance.

*Large Hail
stones in
Flanders;
by - - n. 203.
p. 858.*

XLIV. I. A very extraordinary Hail fell in these Parts, *April* 29, 1697. The Vapours that disposed the aqueous Parts thus to congeal, came with a South-west Wind out of *Caernarvanshire*, passing near *Snowdon* with a horrid black Cloud, attended with frequent *Lightnings* and *Thunder*. As yet I hear no further of it Westward than out of *Denbighshire*, where it left *St. Asaph* to the Right, and did much Damage between it and the Sea, breaking all the Windows on the Weather-side, and killing Poultry and Lambs, and at *Sir John Conway's*, at *Desert*, a stout Dog; and in the North Part of *Flintshire* several People had their Heads broke, and were grievously bruised on their Bodies. From *Flintshire* it crossed over the Arm of the Sea that comes up to *Chester*, and was only felt in *Cheshire*, at the very *N. W.* Corner of the *Peninsula*, called *Wiral*, between the *Æstuarium* of *Chester* and *Liverpoole*, at a Town called *W. Kirby*, where it hailed but for three Minutes, it being on the extreme Point thereof, on the Right-hand, but it thundred dreadfully, and was here at *Chester* about three in the Afternoon; but the main Body of it fell upon *Lancashire*, in a right Line from *Ormskirk* to *Blackborn*, which is on the Borders of *Yorkshire*; but whether it crossed the Ridge of Hills into *Yorkshire*, we know not. The Breadth of the Cloud was about two Miles; within which Compass it did incredible Damage, killing all Sorts of Fowl and small Creatures, and scarce leaving any whole Panes in any of the Windows where it passed; but which is worse, it plowed up the Earth, and cut off the Blade of the green Corn so as utterly to destroy it, the *Hail-stones* burying themselves in the Ground; and the *Bowling-Greens*, where the Earth was any Thing soft, were quite defaced, so as to be rendered unserviceable for a Time. This I had from an Eye-Witness. The *Hail-stones*, some of which weighed five *Ounces*, were of differing Forms, some round, some half-round, some smooth, others embossed and crenulated, like the Foot of a drinking Glass, the Ice very transparent and hard, but a *snowy Kernel* was in the midst of most of them, if not all. The Force of their Fall argued them to fall from a great Height. What I take to be most extraordinary in this *Phænomenon* is, that such a Sort of Vapours should continue undispersed so long a Tract, as above sixty Miles together, and in all the Way of its Passage occasion so extraordinary a *Coagulation* and *Congelation* of the watry Clouds,

*Extraordi-
nary Hail in
Wales, Che-
shire, &c.
by Mr. Edm.
Halley, n.
229. p. 570.*

as to encrease the *Hail-stones* to so vast a Bulk, in so short a Space as that of their Fall.

By . . . ib.
p. 572.

2. We had only the extreme Skirt of the Shower here, and there fell not above 10 *Hail-stones* in our Court; but they were much larger and harder than the oldest of us had seen. A Gentlewoman found one of them by Measure to be about 5 Inches about. A little while after the Shower was over, I found the *Stones* had fallen at good Distances one from another, and that they were melting very fast, the Weather being very hot; scarce any of them was so little as a Musket Bullet, but most of them far bigger, and of that Figure.

A Servant who was then at *Bottle-Mill*, tells me, That the Sea seemed to be risen to an unwonted Height, and to bear the Appearance of a Wood; that he found *Hail-stones* as big as *Poot Eggs*; and that many Sea-Fowl and Land-Fowl were killed: And as an Instance of it, he took up a *Sea-Swallow* on *Bottle-Marsh*, whose Wing was broken with an icy Pellet, and brought her home. Upon this Story, I rid toward the Grounds which had shared most in the Storm. When I came to *Bottle*, I saw *Jane Mutcke's* Windows ill battered. I found the Storm had been as violent at *Linaker*; I saw what Breaches it had made upon *Will. Halsfall's* Barns, what Boughs it had broke off from his Apple-trees, and what Wounds the *Hail-stones* had made in the green Brow by his House. I measured several of the Holes, and found them generally an Inch deep, and some an Inch and a half. *Will. Halsfall* told me, that the great *Stones* fell so violently into the Marl-pit besides his House, that Spouts of Water rose a Yard and a half high. This unriddled my Man's Story, that the Sea appeared like a Wood. Dr. *Tarleton* took up *Hail-stones* as big as *Duck Eggs* upon *Aughton Common*; and Mr. *Shepherd* professes, that the Church-yard at *Sephton* seem'd as strew'd with *Duck Eggs*; and that one of them was weigh'd, which amounted to full Half a Pound: Two *Hail-stones* were weigh'd at *Ormskirk*, which came to $\frac{1}{4}$ of a Pound a-piece. At *Ince* the *Stones* were part as big as *Duck*, and part as *Goose Eggs*.

I sent some People the next Morning early to the Sea-side, and they brought in seven Sorts of Fowls, as *Curlicu*, *Sea-Pye*, *Sea-Swallow*, *Gorre*, and other we want Names for: And we hear that at the little Towns next the Sea, they were pick'd up by Bushels.

No *Hail* fell at *Everton*, *Lowbill*, or *Leverpoole*, the Storm ending near *Walton*; but there was so thick a Darkness before the Storm, that in *Leverpoole*, many People ran out of their Houses into the Street to look at the Face of the Sky; and it was marvellous dark here. The Neighbours tell doleful Stories of the Effects of this *Hail*: As a young Woman at *Bottle* was running for Shelter, her Hat fell off, and a *Hail-stone* that hit her behind the Ear made her tumble; a Man was knock'd off his Horse by the *Hail*, but presently got up again: Another having pull'd down his Hat to save his Face, a *Stone* fell which tore the Brim from the Crown, so far that he could put his Hand through the Hole: At *Ormskirk* 4 Pounds Damage was done to one Inn, and the Glass broke by the Storm in the whole Town, could not be repaired for 60^l. The *Stones* there rebounded, many of them 2 Yards high;

high ; at *Ince* two Horses were knock'd down in the Plough, and a Man fell at the same Time ; at *Crosby* some Beasts were knock'd down ; one *Jo. Holland* was found dead in *Skirmsdale* after the Shower, but whether by the Hail or Lightning (for it came with Thunder and Lightning) I have not yet heard : Two Women were so beaten by it, in a little while before they got Cover, that they could hardly turn them in their Beds next Morning ; they could hardly pass the Lanes for Baskets, Panniers, Sacks, and People, which the Horses had thrown down in their Return from *Ormskirk* Market.

XLV. On *Tuesday, May, 4, 1697.* (at *Hitchin* in *Hertfordshire*) about nine a-Clock in the Morning, it began to lighten and thunder extremely, some great Showers intervening ; it continued till about two of the Clock in the Afternoon, when on a sudden, a black Cloud arose *S.W.* of us, the Wind being East, and blew hard ; then fell a sharp Shower, with some Hail-stones. I measured some of them 7 and 8 Inches about : But the Extremity of the Storm fell about *Offley*, where a young Fellow was kill'd, one of his Eyes struck out of his Head, his Body was all over black with the Bruises ; another Person nearer to *Offley* escaped with his Life, but much bruised. There was in the House of *Sir Jo. Spencer*, 7000 Quarries of Glass broke, and there was great Damage done to all the neighbouring Houses thereabouts. The Hail fell in such vast Quantities, and so great, that it tore up the Ground, split great Oaks and other Trees in great Numbers ; it cut down great Fields of *Rye*, as with a Scythe, and has destroy'd several hundred Acres of Wheat, Barley, &c. insomuch that they plough it up and sow it with Oats. The Tempest was such when it fell that in 4 Poles of Land, from the Hills near us, it carried away all the Staple of the Land, leaving nothing but Chalk. The Hail broke vast Numbers of Pigeons Wings, Crows, Rooks, and other Birds : The Flood came down, spreading 4 or 5 Acres of Land, rowling like the Bay of *Biscay* ; and which is very strange, all this fell in the Compass of one *English* Mile. I was walking in my Garden, which is very small, perhaps about 30 Yards Square, and before I could get out, it took me to my Knees, and was through my House before I could get in, which I can modestly speak was in the Space of a Minute, and went through all like a Sea, carrying all Wooden Things like Boats on the Water, the greatest Part of the Town being under this Misfortune ; the Surprise was so great, that we had scarce Time enough to save our Children and Wives. There fell some hundred thousand Cart-loads : I saw them 4 Days after ; and if the Beds of Hail had not been broke by Peoples coming, and trampling of Horses, it might have lain till *Michaelmas*. They have been measured from one to thirteen and fourteen Inches certain : Some People talk largely of it, seventeen and eighteen Inches ; but the other is certain Truth. The Figures of them are various, some oval, others round, others pricked, some flat. We were not so curious to weigh them. The Damage about us, and in our Town, is near 4000 *l.*

XLVI. 1. In the Parish of *Westbide*, not far from *Hereford*, there fell, on the 6th *June, 1697.* so great a Quantity of Hail, that it destroy'd all the Poultry, Garden-stuff, Corn, Grass, and most of the Fruit-trees in the Parish,

A Storm of Hail in Hertfordshire, May 4, 1697 by Mr. Rob. Taylor, ib. p. 577.

A Storm of Hail in Hertfordshire, May 4, 1697 by Mr. Rob. Taylor, ib. p. 577.

A Storm of Hail in Hertfordshire, June 6, 1697. by - - ib. p. 579.

but killed no Men nor Cattle ; but hurt several, and broke most of the Windows. Many of the Stones were measured above nine Inches in Compass.

By Mr. Edw. Lhwyd, *ib.*

2. We had at *Ponty-Pool* in *Monmouthshire*, *June 1697.* an extraordinary Shower of *Hail*, which extended about a Mile, and lasted near half an Hour. It broke the Stalks of all the Beans and Wheat within that Circumference, and ruined as much Glass at Major *Hanbury's* House, as cost four Pounds repairing ; some of the *Hail* were eight Inches about, their Figure very irregular and unconstant, several of the *Hail-stones* being compounded.

An unusual Sort of Snow ; By Mr. Joh. Chr. Beckman, n. 39. p. 773.

XLVII. The first of *March*, 166 $\frac{7}{8}$. there fell an unusual Sort of Snow at *Frankfort* in the *Oder* : It had none of the ordinary Figures, but was made up of little Pillars, whereof some were *Tetragonal*, some *Hexagonal*, with a neat *Basis*. On the Top they were somewhat larger, as the *Heads of Columns* are. Considering the whole Shape, we thought fit to give it the Name of *Nix Columnaris*.

Red Snow near Genoa ; communicated by Sig. Sarotti, n. 139. p. 976.

XLVIII. On *St. Joseph's* Day, upon the Mountains called *Le Langbe*, there fell upon the white Snow that was there already, a great Quantity of red, or if you please, of *Bloody Snow* ; from which (being squeez'd) there came a Water of the same Colour.

Observations on Snow ; by Dr. J. Beale, n. 56. p. 1138.

XLIX. I have seen the Water of dissolved Snow perform a quick Cure, in taking out the Fire, when the Flesh was burnt by a Warming-pan of Brass, which Metal commonly makes the Burning more difficult to be cured : Which did put me in Mind to examine the Figures of the Snow which now fell in this extreme Frost. I expected that we might see through the small Particles at least as through Lice, Fleas, Cheese-mites, &c. by some kind of Transparency : But I was deceived ; my Assistants could make nothing of it, either by an ordinary or extraordinary Microscope.

The Nature of Snow ; by Dr. Nehem. Grew, n. 92. p. 5193.

L. He that will enquire of the Nature of Snow, will do it best, not by the Pursuit of his Fancy in a Chair, but with his Eyes abroad ; where if we use them well fixed, and with good Caution, and this in a thin, calm and still Snow, we may by Degrees observe,

1. With M. *Des Cartes* and Mr. *Hook*, that many Parts hereof are of a regular Figure, for the most Part, as it were, so many little Rowels, or Stars, of six Points, being perfect and transparent *Ice*, as any we see upon a Pool or Vessel of Water. Upon each of these six Points are set other collateral Points, and those always at the same Angles as are the main Points themselves.

2. Amongst these regular Figures, many others alike regular, but far less, may likewise be discovered.

3. Looking still more warily we shall perceive, that there are divers others indeed irregular, yet chiefly but the broken Points, Parcels and Fragments of the regular ones.

Lastly, That besides the broken Parts, there are some others which seem to

to have lost their Regularity, not so much in being broken, as by various Winds first gently thaw'd, and then froze into little irregular Clumpers again.

From whence the true Notion, and external Nature of *Snow*, seemeth to appear, viz. That not only some few Parts of *Snow*, but originally the whole Body of it, or of a *snowy* Cloud, is an infinite Mass of *Isicles* regularly figur'd; not one Particle thereof, I say, originally, not one of so many Millions, being indeterminate or irregular; that is to say, a Cloud of Vapours being gathered into Drops, the said Drops forthwith descend; upon which Descent, meeting with a soft freezing Wind, or at least passing through a colder Region of the Air, each Drop is immediately froze into an *Isicle*, shooting it self forth into several Points or *Striae* on each Hand from-ward its Center: But still continuing their Descent, and meeting with some sprinkling and intermixed Gales of warmer Air, or in their continual Motion, and Wastage to and fro, touching upon each other, some are a little thaw'd, blunted, frosted, clumper'd, others broken, but the most hanked and clung in several Parcels together; which we call *Flakes of Snow*.

Hence we understand *why Snow*, though it seems to be soft, yet is truly hard, because true *Ice*, the inseparable Property whereof is to be hard; seeming only to be soft, because upon the first Touch of the Finger upon any of its sharp Edges or Points they instantly thaw, or otherwise they would pierce our Fingers as so many Lancets.

Why again, though it be true *Ice*, and so hard and dense a Body, yet 'tis very light; because of the extream Thinness of each *Isicle* in Comparison of its Breadth: For so Gold, which, though of all Bodies the most ponderous, yet being beaten into Leaves, rides upon the least Breath of Air.

Also how it is White; because consistant of Parts all of them singly transparent; but being mixed together appear white, as the Parts of Froth, Glass, Ice, and other transparent Bodies, whether soft or hard.

The *essential Nature of Snow*, I think may be best understood, by comparing its general Figure with such regular Figures as we see in divers other Bodies; in that where we see the like Configurations, we may believe there is the like *Subjeēt* wherein, or the like *Efficient* whereby, both those and these are made.

As for the *Figure of Snow*, 'tis generally one, viz. That which is above described; rarely of different ones, which may be reduced chiefly to two Generals, Circulars and Hexagonals either simple or compounded together: More rarely, either to be seen of more than six Points, but if so, then not of eight or ten, but twelve: Or in single Shoots, as so many short slender Cylinders like those of *Nitre*: Or by one of these Shoots, as the Axle-tree, and touching upon the Center of a Pair of pointed *Isicles*, joined together as the two Wheels: Or the same Hexagonal Figure, and of the same usual Breadth, but continued in Thickness or Profundity, like the Stone, which, as I remember, *Boetius* calls *Astroites*. All these I say are rare, the first described being the general *Figure*.

As for the *Configurations* of other Bodies, we shall find, that there are divers, which have some a less, others a more near Resemblance hereunto.

Nitre

Nitre is formed, as is commonly known, into long Cylindrical Shoots, as also all *Lixivial Salts*, for the most Part; resembling, though not perfectly, the several Points of each starry *Isicle* of *Snow*. *Salt of Harts Horn*, *Sal Armoniac*, and some other *Volatile Salts*, besides their main and longer Shoots, have others shorter branched out from them; resembling, as those the main, so these the collateral Points of *Snow*. But the *Isicles* of *Urine* are still more near: For, in *Salt of Harts Horn*, although the collateral Shoots stand at acute Angles with the main, yet not by Pairs at equal height; and in *Sal Armoniac*, although they stand diametrically opposite, or at equal Height, yet withal at Right, not Acute Angles; whereas in the *Isicles* of *Urine* they stand at equal Height, and at Acute Angles both: In both, like those of *Snow*. And it is observable, that the *Configuration* of *Feathers* is likewise the same; the reason whereof is, because Fowls having no Organs for the Evacuation of *Urine*, the *urinous* Parts of their Blood are evacuated by the Habit or Skin, where they produce and nourish *Feathers*.

From hence it should seem, That every Drop of Rain aforesaid, containing in it self some *spirituous* Particles (as from the Height to which they are advanced, the prolifick Virtue of *Rain*, and its ealy Tendency to Putrefaction above other Water, is argued they do) and meeting with others in their Descent of a *Saline*, and that partly *Nitrous*, but chiefly *Urinous*, or of an *Acidosalinous* Nature, the said *spirituous* Parts are apprehended by them, and with those the Watry, and so the whole Drop is fixed; yet not into any indifferent and irregular Shape, depriving the *spirituous* Parts of their Motion in an instant; but according to the *Energy* of the *Spirituous*, as the Pencil, and the specifick Nature, or determinate Possibility of the *Saline* Parts, as the Ruler, 'tis thus figured into a little Star.

A Freezing
Rain in So-
merfetshire;
by Dr. J.
Beale, n. 90.
p. 5138.

LI. 1. The *Freezing Rain*, which fell here the 9th, 10th, or 11th, of *December*, 1672. (for I cannot confine the Time exactly) hath made such a Destruction of Trees, in all the Villages and Highways from *Bristol* towards *Wells*, and towards *Shepton-Mallet*, and towards *Bath* and *Bruton*, and in other Places of the *West*, that both for the Manner and Matter it may seem incredible, and is more strange than I have found in any *English* Chronicle. You have the Proof and Manner, and best Measure of it in the following Transcript: “The late prodigious *Frost* (saith a very worthy Person of unquestionable Credit) hath much disabled many old Orchards, exposed to the North-east; had it concluded with some Gusts of Wind it might have been of sad Importance; I weighed the Sprigg of an Ash-Tree of just three Quarters of a Pound, which was brought to my Table; the *Ice* on it weighed 16 Pounds, besides what was melted off by the Hands of them that brought it. A very small Bent at the same Time was produced, which had an *Isicle*, encompassing it, of 5 Inches round by measure. Yet all this while, when Trees and Hedges were loaden with *Ice*, there was no *Ice* to be seen on our Rivers, nor so much as on our standing Pools.” The like, or worse, and more strange Complaints,

plaints, I received from several other Places, and from Eye-Witnesses of Credit. Some Travellers were almost lost by the Coldness of the *Freezing Air*, and *Freezing Rain*. All the Trees, young and old, on the Highway from *Bristol* to *Shepton*, were so torn and thrown down on both sides the Ways, that they were unpassable. By the like Obstructions the Carriers of *Bruton* were forc'd to return back. Some were affrighted by the Noise in the Air, till they discern'd that it was the clatter of *Icy Boughs*, dashed one against another by the Wind. Some told me that riding on the Snowy Downs, they saw this *Freezing Rain* fall upon the Snow; and immediately freeze to *Ice*, without sinking at all into the Snow; so that the Snow was covered with *Ice* all along, and had been dangerous, if the *Ice* had been strong enough to bear them. Others were on their Journey when the *Ice* was able to bear them in some Places, and they were in great Distress.

Dec. 8. Much Snow fell here; the 9th much *Rain* fell here; and all the Snow passed away, not leaving an *Isicle* amongst us. The 10th Day, we had sudden Fits of Cold and relaxing Warmness. On *Wednesday* (Dec. 11.) I saw a young Man, who returning home from a Journey of 5 Miles, and coming into a warm Room, cry'd out of extreme Torments in all Parts of his Body. He affirm'd, that the Air, and the Winds (which were then somewhat high) were so unsufferably cold, that he was in utter Despair of coming home alive; yet all that Day nothing but moist Dew fell under our Feet. If we say, the Earth did send forth warm Steams to keep this *Freezing Rain* dissolved on her Surface; whence shall we say, the Air, and Rain, and Winds, got these *Freezing Isicles* which oppressed Men and Plants? When the Canded *Frosts* do cover our Fruit-Trees perfectly white (as I have oft-times seen it hold for some Weeks together) it is so far from doing hurt to the Trees, that we have it in a Proverb, for a good Sign of abundance of Fruit, in the ensuing Year. But this *Freezing Rain*, as soon as it touched any Bough, settled into *Ice*, and by multiplying and enlarging the *Isicles* (especially where it could lay hold on Moss, or other Asperities of the Tree) it broke all down with the Weight.

This shews that a *Frost* may be very fierce and dangerous in the Air, and n. 116. on the Tops of some Hills and Plains, whilst in many other Places it keeps p. 357. at two, three, or four Foot distance above the Ground, Rivers and Lakes; and many wander, at some Difference of Time, in some Places very furious; in other Places intermediate and not far asunder, very remiss and abated; where it was fierce, always at the Height of Trees at least, never on the Ground vehement, that I could hear of, but on *Salisbury Plains*, which are very high Grounds.

As soon as these *Frosts* were over, we had *glowing Heats*, which caused a n. 90. general Complaint amongst us of excessive Sweating, by Night and Day. p. 5140. The Bushes, and many Flowers in the Garden, appeared in such forwardness, as if it were in *April* or *May*. I saw young Coleworts growing; and not far from my Abode, an Apple-tree blossomed before *Christmas*. This I do not mention for extraordinary; but I think 'tis more than ordinary, that before

New-

New-Years-Tide this Apple-tree bore Apples perfectly knitted, and as big as one's Finger's End.

At Oxford ;
by Dr. Wal-
lis, n. 92. P.
5195.n.231.
P. 654.

2. The like strange Frost was with us at *Oxford*. It was rather a *Raining* of *Ice*, or at least *Rain Freezing* as it fell ; which made strange *Isicles* hanging on Trees, and a strange Noise by the rattling of them upon the Boughs Motion by the Wind ; but not so much as at the Places you mention in *Somersetshire* : Yet more in the Country about us (as from several Relaters I have heard) than with us here. And the great *Warmth* soon after was also with us ; insomuch that not only Blossoms, but (as was then certainly affirmed, though I was not so curious as to get a Sight of any) green Apples were observed on divers Trees, particularly in the Parish of *Holywell*.

Effects of
Cold in the
Northern
Countries ; by
Mr. J. Schefferus, n. 19.
P. 350.

LII. 1. Mr. *John Schefferus*, a Professor in the *Swedish University* at *Upsal*, writes, That he had seen and had *Hares*, which about the Beginning of *Winter* and *Spring* were half *white* and half of their native Colour : That in the midit of *Winter* he never saw any but all *white*. That *Foxes* also were *white* in *Winter*, and *Squirrels* greyish, mix'd of a *dark* and *white* Colour.

That Fishes are killed by reason of the *Ice* not being broken : But first, in Ponds only, or narrow Lakes ; next, in such Lakes only where the *Ice* is pretty thick ; for, where 'tis thin, they die not so easily. Lastly, That those Fishes that lie in slimy or clay Ground die not so soon as others.

That in great Lakes, when 'tis a very bitter *Frost*, *Ice* is wont to be broken either by the Force of the Waves, or of the imprisoned Vapours, raised by the Agitation of the Water, and then bursting out with an Impetuosity ; witness the Noise made by the Rupture of the *Ice* through the whole Length of such Lakes, which he affirms to be not less terrible than if many Guns went off together ; whereby it falls out, that *Fishes* are seldom found dead in great Lakes.

That neither Oil nor a strong Brine of Bay-Salt, is truly congealed into *Ice* in those Parts : That the *Frost* pierces into the Earth two Cubits or *Swedish Ells*, and what Moisture is found in it, is white, like *Ice*. That Waters, if standing, freeze to a greater Depth, even to three such *Ells* or more ; but those that have a Current, less : That rapid Waters freeze not at all, nor ever bubbling Springs ; and that these latter seem even to be warmer in *Winter* than in *Summer*.

By M. Febre
ib. 531.

2. M. *Febre*, Chief Secretary to Prince *Radziwil*, assures us, that in the War against the *Muscovites* and *Cossacks* in *Jan. 1655*. at the Siege of *Bichow* in *White Russia*, all their Provisions of *Spanish Wines* or *Petersmen*, and Beer, were in one Night frozen upon the Sledge, notwithstanding they were covered with Straw ; insomuch that they were constrained to carry them into a Stove to thaw them, which they could not do in two whole Days, and were obliged to break the Vessels, and put Pieces of the *Ice-Wine* into Kettles, to thaw them over the Fire for Drink. But he observed that the *Hungarian Wine* resisted the Cold better than the *Petersmen* ; for it was not so much frozen, unless it be that the Butler transported it sooner into the Stove. That the Scrue of a Flagon of *Aqua Vitæ* being put to his Mouth, stuck close to his Lips that he could not draw it off without drawing Blood.

That

That the Pool of the Village (where they quartered) was so thoroughly frozen, that there was but very little Water left between the Ice and the Bottom.

That Jan. 2, 1665 the Frost was so bitter in Poland, that three Soldiers dy'd of it in passing a long Ditch; and that divers Persons lost some of their Limbs. Ib. p. 352.

LIII. 1. The past Winter 168 $\frac{1}{2}$ has been so severe in my Territories, that where it could, it expugned the more defensible, and such as were inclosed, and it has ravag'd all that lay open, and were abroad, without any Mercy. *The Effects of the Frost, 1683-4; by Mr. J. Evelyn, n. 158. p. 559.*

As to *Timber-Trees*, I have not many here of any considerable Age or Stature, except a few *Elms*, which (having been decayed many Years) one cannot well find to have received any fresh Wounds, distinguishable from old Cracks and Hollownesses; and indeed I am told by divers, that *Elms* have not suffered as the great *Oaks* have done; nor do I find, amongst innumerable of that Species (*Elms*) which I have planted, and that are now about twenty-five and thirty Years standing, any of them touched: The same I observe of *Limes*, *Walnuts*, *Ash*, *Beach*, *Horn-beams*, *Birch*, *Chestnut*, and other Forresters. But, as I said, mine are young comparatively; and yet one would think, that should less protect them, because more tender: So as it seems the Risting so much complain'd of, has happen'd chiefly among the overgrown Trees, especially *Oaks*. My Lord *Weymouth* made his Lamentation to me, and so has the Earl of *Chesterfield*, Lord *Ferrers*, Sir *William Fermor*, and others concerned in the same Calamity; which I mention, because of their distant Habitations. But if rightly I remember, one of these noble Persons lately told me, that since the *Thaw*, the Trees, which were exceedingly split, were come together and closed again; and I easily believ'd it: but that they are really as solid as before, I doubt will not appear, when they shall come to be examined by the Ax, and converted to Use. Nor has this Accident happen'd only to standing Timber, but to that which has been fell'd and season'd, as Mr. *Shish*, the Master-builder in his Majesty's Ship-Yard here inform'd me.

As for *Exoticks*; I fear my *Cork-Trees* will hardly recover. The *Constantinopolitan* or *Horse-Chestnut* is turgid with Buds, and ready to explain its Leaf. My *Cedars*, I think, are lost: The *Ilex* and *Scarlet-Oak* not so: The *Arbutus*, doubtful, and so are *Bays*; but some will escape, and most of them repullulate and spring afresh, if cut down near the Earth, at the latter End of the Month. The *Scotch-Fir*, *Spruce*, and white *Spanish* (which last uses to suffer in its tender Buds by the *Spring-Frosts*) have received no Damage this *Winter*; I cannot say the same of the *Pine*, which bears the greater Cone, but other *Norways* and *Pinasters* are fresh. *Laurel* is only discoloured, and some of the woody Branches mortified, which being cut to the Quick, will soon put forth again, it being a succulent Plant. Amongst our *Strubs*, *Rosemary* is intirely lost; and so universal (I fear) is the Destruction of this excellent Plant (not only over *England*, but our neighbour Countries more Southward) that we must raise our next Hopes from the Seed. *Halimus*, or *Sea-Purslain* (of which I had a pretty Hedge) is also perished, and so another of *French-Furfses*: The *Cypresses* are all of them scorched, and some

some to Death, especially such as were kept shorn in Pyramids; but amongst great Numbers, there will divers escape, after they are well *chastiz'd*, that is, with a tough Hazel or other Wand, to beat off their dead and dusty Leaves, which, growing much closer than other Shrubs, hinder the Air and Dews from refreshing the interior Parts. This Discipline I use to all my *Tonsile Shrubs* with good Success, as oft as a Winter parches them. The Berry-bearing *Savine* (which, if well understood and cultivated, were the only best *Succedaneum* to *Cypress*) has not suffered in the least; it perfectly resembles the *Cypress*, and grows very tall and thick. I think the *Arbor Thuya* is alive, and so is the *American Acacia*, *Acanthus*, *Paliurus*, *Pomgranate*, my *Laurustinus* looks suspiciously: Some large and old *Aaturnus's* are kill'd, especially such as were more exposed to the Sun, whereas those that grow in the Shade escape; the Reason of which I conjecture to be, from the Reciprocations of being somewhat relaxed every Day, and then made rigid and stiff again all Night, which bending and unbending so often, opening and closing the Parts, does exceedingly mortify them, and all other tender Plants; whilst those which grow in shady Places, undergo but one Thaw and Change. Most of these will yet revive again at the Root, being cut close to the Ground. The *Phillyrea's*, *Augusti*, and *Serratifolio's* (both of them incomparably the best for ornamental Hedges of any of the *Perennial Greens* I know) have hardly been sensible of the least Impression, more than tarnishing of their Leaves: no more have the *Spanish Jasmines*, and *Persian*; and I enumerate these Particulars the more minutely, that Gentlemen who are curious, may take notice what Plants they may trust to abroad, in all Events; for I speak only of such as are exposed.

I need say nothing of *Holly*, *Yew*, *Box*, *Juniper*, &c. (hardy and spontaneous to our Country) and yet to my Grief I find a *Holly* Standard of near an hundred Years old, drooping, and of doubtful Aspect; and a very beautiful Hedge (tho' indeed much younger) being clipp'd about *Michaelmas*, is mortified near a Foot beneath the Top, and, in some Places to the very Ground; so as there's nothing seems Proof against such a *Winter*, which is late cut and expos'd. This Hedge does also grow against the South, and is very russet, whilst the contrary Side is as fresh and green as ever; and in all other Places of my Plantations that are shaded, the unshorn *Hollies* maintain their Verdure, and are, I judge, impregnable against all Assaults of *Weather*.

Among the *Fruit-Trees*, and *Murals*, none seem to have suffer'd save *Figs*; but they being cut down, will spring again at the Root. The *Vines* have escaped, and of the *Esculent Plants* and *Salads* most, except *Artichokes*, which are universally lost; and what I prefer before any *Salad* whatever eaten raw, when young, my *Sampire* is all rotted to the very Root: How to repair my Loss, I know not, for I could never make any of the Seed, which came from the *Rock Sampire* (tho' mine were of the very kind) to grow.

The *Arborescent* and other *Sedums*, *Aloes*, &c. (tho' hous'd) perished with me; but the *Yucca* and *Opuntia* escaped. *Tulips* many are lost, and so the *Constantinope Narcissus*, and such *Tuberosæ* as were not kept in the Chimney-Corner, where was continual Fire. Some *Anemonies* appear, tho', I believe, many are rotted: But I have made no great Search in the flowery Parterre;
only

only I find that most Capillaries spring, and other humble and repent Plants, notwithstanding all this rigorous Season.

My *Tortoise* (which, by his constant burying himself in the Earth at Approach of Winter, I look upon as a kind of Plant-Animal) happening to be obstructed by a Vine-Root, from mining to the Depth he was usually wont to inter, is found stark dead, after having many Years escaped the severest Winters. Of *Fish* I have lost very few; and the *Nightingales* (which, for being a short-winged Bird, and so exceeding fat, at the Time of the Year, we commonly suppose to change the Climate; whereas indeed they are then hardly able to fly an hundred Yards) are as brisk and frolick as ever, nor do I think they alter their Summer Stations, whatever becomes of them all Winter.

In this rigid Season nothing seemed more surprizing to us, nor more generally known to be true, than the cleaving or *splitting* of Trees; as of the *Elms* by Mr. *Langley's* House, the Minister of *Tamworth*, and *Asbes* of considerable Bulk and Value, designed for, and capable of divers Uses, as *Wind-Mill-Posts*, *Dresser-Boards*, and other necessary Occasions. Also *Walnut-Trees* in divers Places have suffered by this Calamity, and proved extremely *cleft*; though indeed it hath been most frequent among *Oaks*, many of which have been divided to great Detriment in *England*, some being so rent, that a Man may see through them, and that many times the Cracks came with so great Noise, that as it is related from *Needwood-Forest*, they made such a Noise, that the Keepers there thought that the Deer were shot by the People of the Country; and that in several Parts they were heard as loud as Guns, some having been cruelly affrighted, especially in the Evenings or Nights, as they have passed within the Hearing of this so unexpected and surprizing a Noise. Which *Rifts* or *Clefts* were not at all to the same Point of the Compass, but sometimes on one side only, sometimes two, and sometimes three, and sometimes four several Places, dividing or quartering the Tree, and sometimes quite through: and these *Clefts* were not only in the Bodies, but continued into the larger Boughs and Limbs of the Tree, and sometimes descended into the superficial Roots, but not to those very deep in the Earth; the *Frost*, though extreme, not reaching considerably deep, comparatively to the *Roots* of *Trees*, and the hard binding of the Earth being so *frozen*, would not easily admit of Compression: But several shallow *Roots*, so knotted and knurled, as not to be wrought upon with Beetle and Wedges, are known to be *cleft* by the *Frost*. But it is much to be doubted and suspected, whether any such *cloven* Trees were so perfectly sound and faithful Timber, if proved by the Saw and Ax, as they ought to be; for, if so, all might equally suffer, the Air having impartial Access to one as well as the other; but some being taken with this Disease, and others left untouch'd, there certainly was some Cause or Defect in those liable to it, rather than the rest. A great Part of the Cause of it is supposed to be Imperfection in such a Tree, and that generally from the too large *Sap-Vessels* and unnatural Cavities therein, which some call *Wind-shaken*, and some *lagg'd* Trees; the Cause whereof remains yet to be examined, whether the *shaking* of the Wind may not, with its great Weight and Force, taking

By Mr. Jacob Bobart.
n. 165.
p. 766.

the whole Tree with its Boughs, Limbs and Body, having one End firmly fixed in the Earth, at some Age or other, as well work wrack, and make Splintering and stretched Pores, Passages, Cavities, and such like, in a live and growing Tree, at some times of Continuance of its Force with its oft repeated beating, twisting, and pressing Blasts; as well as the best chosen Mast of a Ship may suffer Damage by the same Cause, even to total Fraction. By some this is supposed to proceed from Earthquakes, but whether or not, is yet to be examined. But the Opinion of some seems not to be extravagant, who think it to be an original Dilemper in the Tree, and to proceed from the *Soil*, or rather an innate Disease from some, though undiscernible Imperfection in the *Seed* it self, and yet not so much but that they live many Years, and grow to great Bulk and Stature, being observed to bear lesser Leaves and smaller Acorns; but whether the *Soil* be concerned, it may be urged, that the Trees about *Oxford* Westward, are generally affected with this Disease, and those from the East-side prove excellent sound Timber, tho' the *Soils* seem to resemble one another.

But by what Means soever this may come, it is certain that some Trees are much more sound than other, and that some prove full of inbred Diseases and Cavities, before they are cut down, which Cavities and stretch'd Vessels being fill'd with too great a Quantity of aqueous and undigested *Sap*, as it were *hydropical*, (for it is thought that the genuine and natural *Sap* of these our native Trees, though undergoing Condensation, will remain secure and safe; as may be supposed from those that are well and firmly standing) are thereby rendered capable of not only Condensation but *Glaciation* also by the Continuance and Severity of the Air's *frigefactive* Power; which being sufficiently known to employ more Room being *Ice*, than formerly Liquid, might probably cause these *Breaches*; and if we consider the expansive Motion and Spring of the Air included in the Cavities of the *Air Vessel*, suffering more Pressure than they are patient of, from the *coagulated* and contiguous aqueous Parts then *congealed*, we may be induced to suppose these *strepitous* Eruptions to proceed from thence. But whether Mr. *Hobbs's* Hypothesis will certainly hold, that the Swelling is caused by the Intrusion of the Air, is somewhat to be doubted.

It need not prove troublesome to any to think the *Ice* to be able to *tear* the *Oaks* or other Trees, who shall consider the great Force and elastick Power thereof; whereof that most excellent and curious Philosopher of our Age, Esquire *Boyle* hath, in his *History of Cold*, set forth several Experiments and Examples; as Vessels of several Kinds of Metals being made strong on purpose, and fill'd with Water, close stopp'd, and exposed to the *Cold*, which being not capable of withstanding the expansive Force of the inclosed *Ice*, have been found *cleft* and broken; as for Instance, the strong Barrel of a Gun close stopped, with Water in it, and *frozen*, hath proved rent longways, and never across the Vessel, nor Bodies of the Trees we here mention. Another time a Brass Vessel of a Cylindrical Form being made not more than five Inches deep, and not two Diameter, filled with Water, and afterwards *frozen*, in one Night lifted off the Cover prepar'd and closely fitted,

fitted, with a Weight of fifty-six Pounds that was laid upon it. *Olearius*, Secretary to the Duke of *Holstein's* Embassy into *Russia*, tells us, that in the City of *Moscow* he observed, (the *Cold* being very intense) the Earth to be cleft many Yards in length, and a Foot broad, which according to Conjecture, was occasioned by the Heaving and Swelling thereof to enlarge its Room, as here we see Ice crackt and cleft considerably long and broad, according to its Thickness along the Ridge or turgid Part thereof. And that the Earth doth so rise when frozen, is easily made manifest, by little Sticks or Plants set into the Ground against the approaching Winter, which being risen two or three Inches, or more, according to the Depth and Strength of the Frost, and, upon the Thaw, the Earth sinking to its former Station, leaves the unfixed Plants, with their Roots naked, above Ground, as it were, spewed out. And not such moist Bodies only, but Metals, as Brasses, Iron, &c. have been swelled in the Time of being frozen, as hath been proved by Clocks, Locks, and other Instruments, and become laxed and pliant again upon the Thaw. Many more Examples might be easily produced to induce us to the Thoughts, that the Sap is not right and genuine in such ill-disposed Trees, and that Ice might, upon due Examination, be found in any such bursten Bodies, as we are informed have been found and observed by some; and if Ice, then Pressure; and if Pressure, then Breaking and Explosion.

It may be doubted too, whether some of these Trees thus liable to the Fury of the Frost, have not been *Coltie*; a Term commonly used among *Timber-Merchants*, and by them avoided; which is, towards the Middle of the Tree, among the *Annual Circles*, some one is much larger than the rest, and the *Sap Vessels* there seem much extended beyond their Fellows; and upon cleaving or sawing such a Tree, that inclosed or inward Heart, Part thereof where that Circle is, will slip and drop from the other Part oft-times without any Force to divide it, as an Instrument out of a Case or Mould made fit for it.

Some suppose that these *wind-shaken* or *lagg'd* Trees may be known, or nearly guessed at by the Out-side, when growing, by the great Ribs, two, three, or four in a Tree from the Bottom to the Branches, and that they have been affected somewhat considerably with this Disease before, and perhaps cleft, (tho' not in so great a Measure as now) and the Fissures closed up again; as we see these do quickly after the Frost, insomuch that it is scarce discernible already, and the Bark not having been divided from the Body, upon coming together again, each turn and twist of the Grain fitting its Place, prove fresh, and vigorously growing: But that ever such Trees will prove whole and sound, doth scarcely consist with Reason or our present Thoughts. And this Calamity hath not been found in Trees only that were fresh and standing, but also in Trees cut down, as is affirmed by Mr. *Shish* and others; but notwithstanding it is thought to be only among such diseased Trees as are before-mentioned.

But it is yet to be questioned whether *Vines* have proved cleft and crackt along the Bodies by the same Way and Reason as *Timber-Trees*, which Decay is especially to be seen on Walls exposed to the Southern Aspect; so that the Sun, our accustomed Friend, now proved our great Enemy, by thawing and
relaxing

relaxing the Sap every Day, and then being frozen and made stiff again every Night; which often Repetition of bending and unbending, softening and hardning, the vivid spirituous Juice being destroyed, and Day and Night the Drought vigorously acting (the Sap being this Year disordered and surprized, not gradually seasoned even before *Michaelmas-Day*, and the fresh Sap to supply its Defects being wholly detained from arising, there then being none, or very little Exhalations or Evaporations arising out of the frozen and bound Earth) these poor slender Bodies fill'd only with thin and not viscous Sap, have proved as great Sufferers as if by Amputation they had been deprived of their natural Sustenance; for if they could have none from the Earth, and their own true Juice mortified; and it be certain that *omne Siccum appetit humidum*, it will follow that such Branches will by the Constancy and Continuance of such Sevrity (the Day being as bad as the Night) prove as dry as Sticks cut off long before: whereas those of this kind and other sorts also growing in more shadowy Parts, and undergoing but one Change, have remained in good Condition, especially among red Grapes, which seem much more hardy than white ones.

We see other *Wall-Fruits* on the same Position, as *Apricocks, Peaches, Plumbs, Cherries, &c.* are not at all injured or prejudiced by the Weather, which are of a more clammy viscous Juice: These we see run sometimes and give Gum, but the Leakage of *Vines* is as thin as Water; which different Juices and Saps in other Trees, and the Degrees thereof, as well those with deciduous Leaves, as *Ever-greens*, may prove some Cause of the Weakness and Decay of some, whilst that of another sort standing by, remains fresh and vigorous, only stagnated, sedate and quiet, waiting for the benign Sun's Beams to actuate, lenify, and put its Spirits in Motion, and its comfortable Refreshment to arise in due Season: And perhaps according to the Degree of this Qualification in Trees and Plants (some being much more sluggish than other) may be the Cause of their earlier or later *Germination*.

It is easily observed, that in dry, mountainous, rocky and barren Plantations, where Trees, Greens, and other Plants having been sparingly fed, and not pamper'd with such Luxuriance and freeness of Sap, as in the Vallies and richer Soils, have escaped tolerably well: and this, which in other Years proves their Poverty and Disease, now makes them insult over those growing in the fatter Vallies, proportional to the Height of the Hills they grow on.

We may observe Trees all the Winter, while the Sap remains condensed, to be safe and well, but if a flattering too early Glance happens in the Spring to set their Parts in Action, and the Juices to become fluid, and a sudden Mutation of that Warmth to a fresh return of Winter (which too frequently happens in *England*) that then we have not only our Hopes of that Year's Fruit blasted, but even the Passages in the Branches and Boughs stopped, and the crude Sap settling, commonly called *Bliting* (though there be many Causes of the Effects which go under that Notion) becomes a Disease in Trees equal to that of *Chil-blanes* in juvenile Blood, which sometimes takes whole Trees, and sometimes Branches only. Hence is supposed the Decay of the *Glastenbury Thorn*, whose Arising-time being between *Michaelmas* and

Christmas,

Christmas, being happily prepared by the Beginning of the hard *Frost*, which hath almost affrighted it out of its Life.

Some Trees and Shrubs seem to have their Vessels and Passages so streightned, and as it were shrunk with *Cold*, that they appear equal to a human Body *Sinew-shrunk* or *Paralytick*, that is, not without much Trouble able to move or bear his decaying Limbs: Thus we see *Trees* with their Bark shrivel'd, with their Passages half-stopp'd, whose *Sap* now only squeezing, and difficultly passing, hath much ado to force its Way through the dry'd and narrow Pores and Passages of the Body and Branches: And sometimes this Distemper is so prevalent, that whole Branches of a Tree are killed, when the other Part is indifferent well.

Some Liquids, such as *Essential Oils*, do rather shrink than increase being frozen; and *Empyreumatical Oils*, will hardly freeze but waste; which Considerations may induce the Thoughts of what some *Trees* are made of, or do abound in, as *Firs*, *Pines*, &c. which are capable of enduring the *Cold* of *Norway*, and other Countries.

What *Timber-Trees* have suffered, are above specified; but divers others of our native *Trees* and *Shrubs* have scarcely proved able to withstand the Force of so rude an Enemy. *Yew* and *Holly* (Things whose Tenderness was never suspected) were in some places quite kill'd, and in many Places so discourag'd, losing their Leaves, and blemishing the Bark, that it is to be feared they will never take on their pristine Splendor and Verdure; the *Furze* in many Places quite kill'd, and in most Places cut down and spring again, but often the Resurrection in vain expected. Common *Broom* proves a Degree hardier. In some Places the sunny Side of a *Juniper Bush* proves scorchi'd between Sun and Cold, but that proves one of the most hardy of our native *Greens*; so that it is hard to say what is Winter-proof even among our Natives, except *Box* and *Ivy*, which stand in Defiance of all.

In the Gardens (which are generally Nurseries of *Exoticks*, and from warm Countries) this Calamity hath principally bent its Force against *Winter Greens*, such as *Alaternus* (commonly known by the Name of *Phillyrea*) and the true *Phillyrea* also, which are generally kill'd; though some upon cutting down spring again. Also common *Bays* seem in most Places to be kill'd down, and *Laurel* seldom proving impatient, is in some Places kill'd, in some Places half dead; *Rosemary*, *Laurustine*, *Halimus*, *Arbutus*, white *Jessamine*, and other which seldom fail, are generally kill'd through the whole Country. But in all these, and other such like, in mountainous and dry Places (as was before observed) there is brisk Life and Verdure yet remaining, tho' rarely to be met with; but however, enough to retain the several *Species* among us. But if for the future in such Times of Extremity, the Superficies of the Ground, and Bodies of such Things here recited, and *Fig-trees*, were well covered with strawy Matter to keep off the Frost, it might so preserve them as to spring out plentifully the Spring following, tho' their whole Tops being too large and high, and thereby incapable of such Covering, might lose their present Leaves and Beauty; which might from such Respringing be easily repaired, and prove much more satisfactory than to begin the World anew, as we are generally

generally forc'd to do for *Cypresses*, which were used to be excellent Ornaments both in Summer and Winter, now it proving a very rare Thing to see one well alive; in some Places there appears some lingering Life, though scarcely sufficient to recover the whole; but in most Places they are quite dead, that have faced forty, fifty, or sixty Winters before.

Also among those with *Deciduous Leaves*, divers have been Sufferers, as *Arbor Juda*, young *Plane Trees*; though those of a considerable Stature have pretty well escaped; *Paliurus*, the *Aleppo Ash*; in some Places the *Locust Tree*; and in most Hedges the great common Bramble, and some other, which upon cutting do some or most of them spring again.

But such *Greens* also as we receive from abroad, and are the Glory of warmer Countries, and very rare, curious and pleasant with us, such as *Oranges*, *Lemons*, *Myrtles*, *Pomegranates*, and the perfuming *Jasmines*, and divers other Rarities, which are usually kept in Pots and Cates, for the Convenience of removing them into *Green Houses* and *Conservatories*, not being able to endure our milder Winters, have in many Places extremely suffered, especially in Houses of weaker Defence: But where the Skill, Care, and due Management of their Keepers, have met with the Convenience of good warm Houses, with keeping constant Fires (which is a Matter to be regulated with great Discretion) according to the Proportion of which combining Qualifications the Plants have escaped; as in some Places most of them are well, and in some Places half, and in some Places all dead.

Among *Plants*, *Herbs*, and *Flowers*, there hath been great Destruction also, and many of common Use, as most of the *Artichokes* in *England*, and *Winter Coleflowers*, *Sage*, *Thyme*, *Mastick*, *Lavender*, *Lavender-Cotton*, and divers other were generally kill'd; except such as happened to be new planted that Year, and so low, that they had the Enjoyment of the kind covering of a little *Snow*, which proves the most natural Feeding and warm Covering of any Thing to be mention'd; but what peeped its Head above it, seemed in great Danger of being kill'd; and as we may see in the *Corn-fields*, that those Sides of the Lands of *Corn* facing the South, where the *Snow* was melted, and the *Corn* deprived of its Covering, the Want proved deadly, and in many Places Husbandmen were forced to begin again in the Spring to plough and sow other Grain; which may easily teach us rather to heap *Snow* upon our *Herbs* and *Flowers*, than fancy it a cold, unkind Enemy.

But after all this Repetition of Sorrows we are to comfort our selves that such Destruction and Calamity happens but very rarely, the like having not been known in the Memory of Man, if ever before, and that with due Care and Observance the growing Cold might be kept off from such Things as are proved to be impatient of it; which are not all *Greens* in our Gardens; some being able to endure all the Cold that ever came, as *Firs*, *Pines* of divers sorts, *Cedars* of *Libanus* and *Virginia* (tho' that of *Bermudas* proves tender) *Arbor Vitæ*, all the *Savins*, whereof the upright or *Berry-bearing* is the best *Succedaneum* to *Cypress*, capable of finer cutting into *Pyramids*, or other Figures, or Hedges 6 or 8 Foot high, and is one of the best of the *Tonsile Shrubs*; also the *Pyracantha* proves exceeding hardy, and makes good Hedges.

LIV. The *Snow* and *Ice-houses* at *Livorne*, are commonly built on the side of a steep Hill, being only a deep Hole in the Ground, by which Means they easily make a Passage out from the Bottom of it, to carry away all the Water; which if it should remain stagnating therein, would melt the *Ice* and *Snow*. But they thatch it with Straw, in the Shape of a Sauce-pan Cover, that the Rain may not come at it. The Sides (supposing it dry) they line not with any Thing, as is done in *St. James's Park*, by Reason of the Moistness of the Ground. This Pit they fill full of *Snow* or *Ice* (taking Care that the *Ice* be made of the purest Water, because they put it into their Wine) overspreading first the Bottom very well with *Chaff*, but without any Part of the Straw; I think they use *Barley-chaff*. This done, they further, as they put in the *Ice* or the *Snow* (which latter they ram down) line it thick by the Sides with such *Chaff*, and afterwards cover it well with the same; and in half a Year lying so, 'tis found not to want above an eighth Part of what it weighed when first put in. Whenever they take it out into the Air, they wrap it up in this *Chaff*, and it keeps it to Admiration.

To preserve
Ice and
Snow; by
Mr. W. Ball,
n. 8. p. 139.

LV. Among several Ways by which I have made *infrigidating* Mixtures with *Sal Armoniac*, the most simple and facile is this: Take one Pound of powder'd *Sal Armoniac*, and about three Pints (or Pounds) of Water, put the *Salt* into the Liquor, either all together, if your Design be to produce an intense, though but a short, *Coldness*; or at two, three, or four several Times, if you desire that the produced *Coldness* should rather last somewhat longer than be so great: Stir the Powder in the Liquor with a Stick or a Whalebone (or some other Thing that will not be injured by the fretting Brine that will be made) to hasten the Dissolution of the *Salt*; upon the Quickness of which depends very much the Intensity of the *Cold* that will ensue upon this Experiment.

Cold produced
with *Sal Ar-*
moniac, by
Mr. R. Boyle
n. 15. p. 255.

That a considerable Degree of *Cold* is really produced by this Operation, is very evident: *First*, to the Touch. *Secondly*, By this, that if you make the Experiment (as for this Reason I sometimes choose to do) in a Glass Body, or a Tankard, you may observe, that whilst the Solution of the *Salt* is making, the Outside of the metalline Vessel will, as high as the Mixture reaches within, be bedewed (if I may so speak) with a Multitude of little Drops of Water; as it happens when Mixtures of *Snow* and *Salt*, being put into Glasses or other Vessels, the aqueous Vapours that swim to and fro in the Air, and chance to glide along the sides of the Vessels, are by the Coldness thereof condensed into Water. But, *Thirdly*, The best and surest Way of finding out the *Coldness* of our Mixture, is by plunging into it a good seal'd *Weather-glass* furnish'd with tinged Spirit of Wine. For, the Ball of this being put into our *frigorifick* Mixture, the crimson Liquor will nimbly enough descend much lower, than when it was kept either in the open Air, or in common Water, of the same Temper with that wherein the *Sal Armoniac* was put to dissolve. And if you remove the Glass out of our Mixture into common Water, the tinged Spirit will re-ascend; and this has also succeeded

with me when I removed it into Water newly impregnated with *Salt Petre*.

This *Cold* in Summer and hot Weather will soon decay and expire: But if the Quantity of the *Salt* and *Water* be great, the Effect will be as well more lasting as more considerable. I have Reason too to suspect, that there may be a considerable disparity, as to their Fitness to produce *Cold*, betwixt several Parcels of *Salt* that are without Scruple look'd upon as *Sal Armoniac*. I have also often found, that when the tinged Liquor subsided but slowly, or was at a Stand, by putting in from Time to Time two or three Spoonfuls of fresh *Salt*, and stirring the Water to quicken the Dissolution, the *Spirit of Wine* would begin again to descend, if it were at a Stand or Rising, or subside much more swiftly than it did before. And if you would lengthen the Experiment, it may not be amiss that Part of the *Sal Armoniac* be but grossly beaten, that it may be the longer in dissolving, and consequently in cooling the Water. After this Manner a sensible, adventitious *Cold* has been made in the Spring, by a Pound of *Sal Armoniac*, at the utmost, to last about two or three Hours.

Experiments in March, 27. The tinged Spirit in the sealed *Weather-Glass*, when first put into the Water, rested $8 \frac{1}{8}$ Inches. Being suffered to stay there a good while, and now and then stirr'd to and fro in the Water, it descended at length a little beneath $7 \frac{1}{8}$ Inches. Then the *Sal Armoniac* being put in, within about a Quarter of an Hour, or a little more, it descended to $2 \frac{1}{8}$ Inches; but before that Time in half a Quarter of an Hour, it began manifestly to freeze the Vapours and Drops of Water on the Outside of the Glass. And when the *frigorifick* Power was arrived at the Height, I several Times found that Water thinly placed on the Out-side, whilst the Mixture within was nimbly stirr'd up and down, would freeze in a Quarter of a Minute, by a Minute Watch. At about $\frac{1}{4}$ of an Hour after the *infrigidating* Body was put in the *Thermoscope*, that had been taken out a while before, and yet was risen but to the lowest freezing Mark, being again put in, the Liquor fell an Inch beneath the Mark. And about $2 \frac{1}{2}$ Hours from the first Solution of the *Salt*, I found the tinged Liquor to be in the midst between the freezing Marks, whereof the one was at $5 \frac{1}{2}$ Inches (at which Height, when the Tincture rested, it would usually be some, though but a small, *Frost* abroad) and the other at $4 \frac{1}{4}$ Inches; which was the Height to which strong and durable *Frost* had reduced the Liquor in the Winter. At three Hours after the Beginning of the Observation, I found not the crimson Liquor higher than the upper freezing Mark newly mentioned; after which it continued to rise very slowly for about an Hour longer; beyond which Time I had not Occasion to observe it.

2. This *frigorifick* Mixture having been made in a Glass-Body (as they call it) with a large and flattish Bottom, a Quantity of Water, which I (purpose-ly) spilt upon the Table, was by the Operation of the Mixture within the Glass, made to freeze, and that strongly enough, the Bottom of the Cucurbit to the Table; that stagnant Liquor being turned into solid Ice, that continued a considerable while unthaw'd away, and was in some Places about the Thickness of a half Crown piece.

3. At another Time in the same Spring, the *Weather-Glass*, which before it touched the common Water, stood at $8\frac{1}{8}$, having been left there a considerable while, and once or twice agitated in the Water, the tinged Liquor sunk but to $7\frac{2}{8}$; or at farthest, to $7\frac{6}{8}$; then the *frigorifick* Liquor being put into the Water, with Circumstances disadvantageous enough, in (about) half a Quarter of an Hour the tinged Liquor fell beneath $3\frac{1}{2}$, and the *Thermoscope* being taken out, and then put in again, an Hour after the Water had been first *infrigidated*, subsided beneath five Inches, and consequently within $\frac{1}{4}$ of an Inch of a Mark of the strongly freezing Weather.

The grand Thing that is like to keep this Experiment from being generally useful, is the Dearness of *Sal Armoniac*. But to lessen this Inconvenience, two Things may be offer'd; *First*, That *Sal Armoniac* might be made much cheaper, if instead of fetching it beyond Sea, our Country men made it here at home. *Secondly*, That though an *Armoniac* Solution being boil'd up in Earthen Vessels (for Glass ones are too chargeable) will, by piercing them, both lose some of the more subtile Parts, and thereby somewhat impair the Texture of the rest; yet I was not deceived in expecting, that the dry Salt, remaining in the Pipkins, being re-dissolved in a due Proportion of Water, would very considerably infrigidate it; as may farther appear by the following Experiment.

4. *March 29.* The *Thermoscope* in the *Air* was at $8\frac{2}{8}$ Inches; being put into a somewhat large evaporating Glass, fill'd with Water, it fell after it stay'd a pretty while, and had been agitated in the Liquor, to eight Inches: Then about half the Salt, or less, that had been used twice before, and felt much less cold than the Water, being put in and stirr'd about, the tinged Spirit subsided with a visible Progress, till it had fallen manifestly beneath four Inches; and then having caused some Water to be freshly pump'd and brought in, though the newly-mentioned Solution were mix'd with it, yet it presently made the Spirit of Wine manifestly to ascend in the Instrument, much faster than one would have expected.

The Length of the Cylindrical Pipe of the seal'd *Thermoscope*, wherewith these Observations were made, was sixteen Inches; the Ball about the Bigness of a somewhat large Walnut, and the Cavity of the Pipe, by Guess, about an eighth or ninth Part of an Inch Diameter.

To cool Drinks, with this Mixture, you may put them in thin Glasses, the thinner the better; which (their Orifices being stopp'd, and still kept above the Mixture) may be moved to and fro in it, and then be immediately poured out to be drunk. By the Help hereof, Pieces of Crystal, or Bullets, for the cooling of the Mouth or Hands of those Patients, to whom it may be allowed, may be potently cooled; and other such Refreshments may be easily procured. In which, and many other Uses, it will not be requisite to employ near so much as a whole Pound of *Sal Armoniac* at a Time. For, you may easily observe, by a seal'd *Weather-Glass*, that a very few Ounces, well powder'd and nimbly dissolv'd in about four Times the Weight of Water, will serve well enough for many Purposes.

Experiments
about Freez-
ing; by S.
Carolo Ri-
naldini, p.
71. p. 2169.

LVI. 1. A little Water being left at the Top of the *Mercury* in the *Torrice-
lian* Experiment, and exposed to the Air in Frosty Weather, was in one Night
congealed into *Ice* of a very good Consistence. Afterwards, *Rinaldini* having
compared this *Ice* with that which was produced in the open Air, found, that
the *Ice* in the Cane was in Substance altogether like that of *Hail*; that is, an
opaque and whitish Body: Whereas that which was made in the Air was trans-
parent like Crystal. Besides, he observed that the *Ice* made in the Cane was
heavier in *Specie* than that in the ambient Air, which he discover'd by putting
it into a Fluid, which was in *Specie* lighter than Water, but heavier than *Ice*
made in the open Air; whereby he found, that whereas the *Ice* made in the
Cane sunk, that in the Air floated therein.

By Dr. Li-
ster, p. 167.
p. 335.

2. December 3, 1684. At Night I exposed four Glass Bottles in the open
Air upon the Ground to freeze; viz. of the *Red Natron-Water* from *Egypt*;
of a strong Solution of *Nitrum Murarium* in fair Water, of *Sea-Water* taken
up at *Scarborough*, and more than half evaporated; of the *Sulphur Well* at
Knaflborough, that is, of *Natural Brine* evaporated to the same Height with the
Sea-Water.

The fourth in the Morning, the Solution of *Nitrum Murarium* was half of
it *Ice*, but not any of the rest.

The sixth in the Morning, the Bottle of *Nitrum Murarium* was most *Ice*;
the *Sulphur-Water* had no *Ice* that I could perceive at all in it; the *Natron* had
much *Ice* at the Bottom of the Bottle; and the *Scarborough Sea-Water* was not
without Flakes of *Ice*.

Fig. 21, 22. The *Iceicles* of the *Natron* were prettily figured, as is represented in *Fig. 21*.
The *Iceicles* of the *Sea-Water* were also figured in oblong Squares, as in *Fig.*
22. and were brittle and transparent. I set the drained *Iceicles* of *Natron* be-
fore the Fire, which did readily enough melt and dissolve into Water again;
this *Ice* was both alike salt in *Ice* and in *Water*, much like the Water, to
the Taste, out of which it was frozen. In like Manner having drained the
Sea-Water Ice, and expos'd it before the Fire, these *Iceicles* became soft and
moist by Degrees, but at length rather evaporated than quite melted away;
and having taken up a good thick Lump of common *Ice*, at least an hundred
Times their Thickness and Bulk, this in a few Moments at the same Di-
stance before the Fire, grew wetter and wetter, and dissolved into Water;
whereas the *Salt Iceicles*, after three Quarters of an Hour lying before the Fire,
did at length dry into a white Powder perfect Salt, the moisture totally evapo-
rating. Also the *Sea-Water Iceicles* tasted very salt, when first taken out of the
Water.

I repeated the same Experiment of exposing to freeze the Bottles of *Natural*
Brine of *Knaflborough Sulphur-Well*, half evaporated, and *Scarborough Sea-Water*,
the same as formerly, the seven and eighth Instant at Night, and with the
like Success, viz. no *Iceicles* in the *Natural Brine*; but the same large ones as
above described I had in the *Sea-Water*, but not till after the second Night's
keen Freezing.

These *salt iceicles* continued unthawed in the Bottles, though they were
brought into the House, and kept in a warm Room, long after all other *Ice*
within

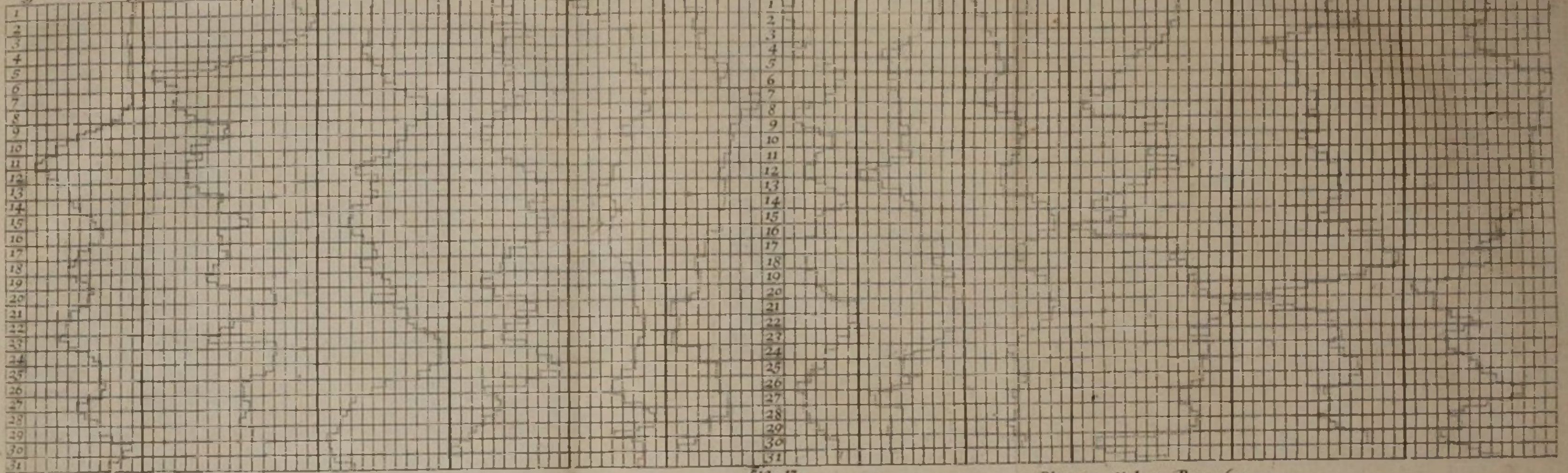


Fig. 17.

Plate 2. Vol. 2. Pag. 164.

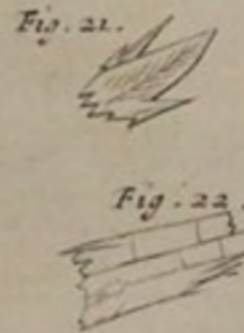
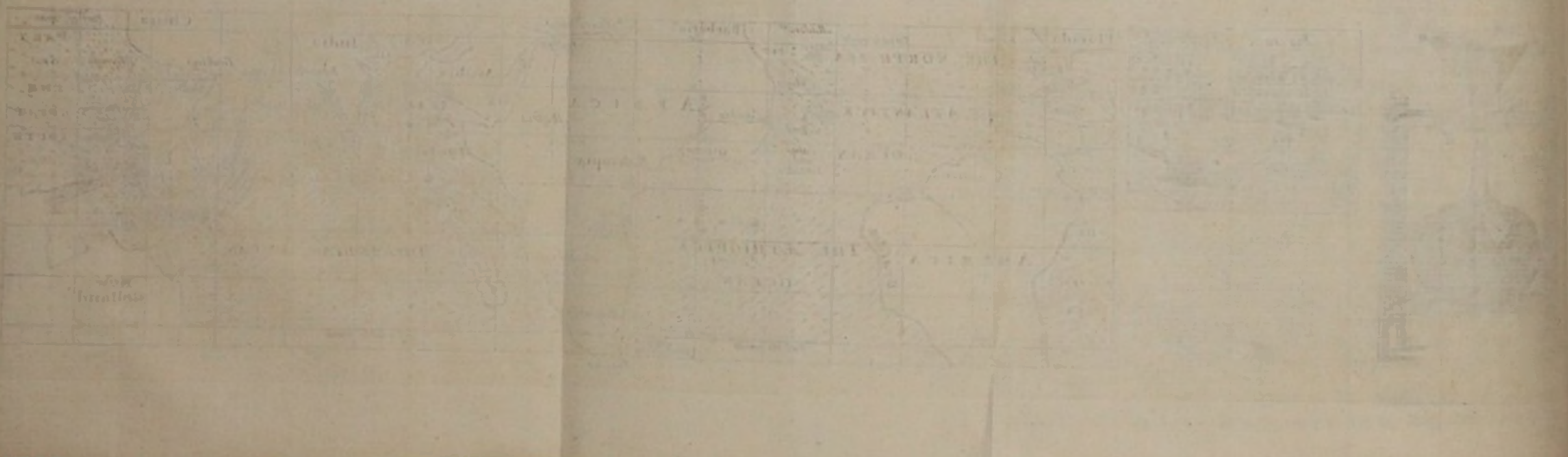


Fig. 20.

1850
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within Doors was gone, viz. till the twelfth Instant at Night, when the *Icicles* also were dissolved and vanish'd.

From these Experiments we note, 1. That there may be *Salt-Ice* from *Sea-Water* frozen, which the Experiments of this S. of the last Year did not seem to favour.

2. That there is as real Difference betwixt *Natural Brine* and *Sea-Water*, as there is betwixt the Salts themselves which they yield.

3. That the great floating Mountains of Ice in the *Northern Seas* (if upon strict Trial they shall be found to be Salt, which should be further enquired into) are not only the Effects of many Years Freezing, but also much of their Magnitude may be owing to the natural Duration of that Sort of *Ice*.

4. A Tube of $\frac{1}{4}$ of an Inch Diameter, being fill'd with Water, to the Height of two Inches, and set to freeze in a Mixture of Snow and Salt, the Water, when perfectly frozen, appeared $\frac{1}{6}$ of an Inch above the Mark it stood at before freezing.

By M. Deo
Masters, n.
245. p. 384.
n. 247.
p. 439.

Another Tube, of almost an Inch Diameter, being filled with Water to the Height of six Inches, and set to freeze as before, rose $\frac{1}{2}$ of an Inch above the Mark. The Water made Use of in these Trials, was a Sort of rough *Pump-Water*; which, according to what Trials have been made with it, does, upon the Effusion of Oil of *Tartar per Deliquium*, immediately turn milky and turbid. And the Ice made of this Water, was a Sort of very rarified white *Ice*.

The Tube of almost an Inch Diameter being fill'd to the Height of six Inches (as before) with *River-Water*, which would readily mix with Oil of *Tartar* without the least Precipitation, and set to freeze in a Mixture of Snow and Salt, it gained but $\frac{1}{3}$ of an Inch after it was frozen; whereas the *Pump-Water* got $\frac{1}{2}$ of an Inch.

It was observable, that when the *Water* (in all these Experiments) began to freeze, a great many small Bubbles continually rose from the Bottom.

A Tube being fill'd with *boiled Pump-Water*, to the Height of six Inches, and set to freeze as before, it rose hardly to $\frac{1}{3}$ of an Inch above the Mark, when as the same Water *unboiled* rose to $\frac{1}{2}$.

LVII. In *July*, 1653. It was so furiously hot in *Poland*, that in the Regiment of Foot which was the King's Guard, marching most of them Bare-foot upon Sands, more than 100 fell down altogether disabled, whereof a Dozen died outright, without any other Sickness.

Excessive
Heats in Po-
land; by M.
Fehre, n.
19. p. 352.

LVIII. If the Action of the *Sun* be considered as the only Cause of the Heat of the *Weather*, I see no Reason but that under the *Pole*, the Solstitial Day ought to be as hot as it is under the *Equinoctial*, when the Sun comes vertical, or over the *Zenith*; for this Reason, that for all the 24 Hours of the Day under the *Pole*, the *Sun's* Beams are inclined to the Horizon, with an Angle of $23\frac{1}{2}$ Deg. and under the *Equinoctial*, though he come vertical, yet he shines no more than 12 Hours, and is again 12 Hours absent; and that for

The Proportional Heat of the Sun is all Latitudes; by Mr. Edm. Halley, n. 23. p. 878.

for 3 Hours 8 Minutes of that 12 Hours he is not so much elevated as under the *Pole*; so that he is not 9 of the whole 24 higher than 'tis there, and is 15 Hours lower. Now the simple Action of the *Sun* is, as all other Impulses or Strokes, more or less forcible, according to the *Sines* of the *Angle* of *Incidence*, or to the Perpendicular let fall on the Plane; whence the *vertical* Ray (being that of the greatest *Heat*) being put *Radius*, the Force of the *Sun* on the horizontal Surface of the Earth will be to that, as the *Sines* of the *Sun's* Altitude at any other Time. This being allow'd for true, it will then follow, that the Time of the Continuance of the *Sun's* Shining being taken for a *Basis*, and the *Sines* of the *Sun's* Altitudes erected thereon as Perpendiculars, and a Curve drawn through the Extremities of those Perpendiculars, the Area comprehended shall be proportionate to the Collection of the *Heat* of all the Beams of the *Sun* in that Space of Time. Hence it will follow, that under the *Pole* the Collection of all the *Heat* of a *Tropical* Day, is proportionate to a *Rectangle* of the *Sine* of $23\frac{1}{2}$ Gr. into 24 Hours, or the Circumference of a Circle; that is, the *Sine* of $23\frac{1}{2}$ Gr. being nearly $\frac{4}{10}$ of *Radius*, as $\frac{8}{15}$ into 12 Hours. Or the *Polar Heat* is equal to that of the *Sun* continuing 12 Hours above the Horizon, at 53 Gr. Height, than which the *Sun* is not 5 Hours more elevated under the *Equinoctial*.

Fig. 23

But that this Matter may be the better understood, I have exemplified it by a Scheme, wherein the *Area* $ZGHH$, is equal to the *Area* of all the *Sines* of the *Sun's* Altitude under the *Equinoctial* erected on the respective Hours, from *Sun-rise* to the *Zenith*, and the *Area* $\odot H H \odot$ is in the same Proportion to the Heat for the same six Hours under the *Pole* on the *Tropical* Day, and $\odot H H \odot$, is proportional to the collected Heat, of twelve Hours, or half a Day, under the *Pole*; which Space $\odot H H \odot$, is visibly greater than the other *Area* $H Z G H$, by as much as the *Area* $H G \odot$ is greater than the *Area* $Z G \odot$; which, that it is so, is visible to Sight, by the great Excess; and so much in Proportion does the Heat of the twenty four Hours *Sun-shine* under the *Pole*, exceed that of the twelve Hours under the *Equinoctial*: Whence, *ceteris paribus*, it is reasonable to conclude, that were the *Sun* perpetually under the *Tropick*, the *Pole* would be at least as warm as it is now under the *Line* it self.

But whereas the Nature of *Heat* is, to remain in the Subject after the Cause that heated is removed, and particularly in the Air, under the *Equinoctial*; the 12 Hours Absence of the *Sun* does very little still the Motion impress'd by the past Action of his Rays wherein *Heat* consists, before he arise again: But under the *Pole*, the long absence of the *Sun* for six Months, wherein the Extremity of *Cold* does obtain, has so chill'd the Air, that it is as it were frozen, and cannot before the *Sun* has got far towards it, be any way sensible of its Presence; his Beams being obstructed by the thick Clouds, and perpetual Fogs and Mists, and by that *Atmosphere* of *Cold*, as the late Honourable Mr. *Boyle* was pleas'd to term it, proceeding from the everlasting *Ice*, which in immense Quantities does chill the neighbouring Air, and which the too soon Retreat of the *Sun* leaves *unthawed*, to increase again during the long Winter that follows this short interval of Summer.

But

But the differing Degrees of *Heat* and *Cold* in differing Places, depend in a great Measure upon the Accidents of the Neighbourhood of high Mountains, whose Height exceedingly chills the Air brought by the Winds over them; and of the Nature of the Soil, which variously retains the *Heat*, and particularly the Sandy, which in *Africa*, *Arabia*, and generally where such *sandy Deserts* are found, do make the *Heat* of the Summer incredible to those that have not felt it.

In Prosecution of this Thought, I have solved this *Problem* generally, viz. To give the proportional Degree of Heat, or the Sum of all the Sines of the Sun's Altitude, while he is above the Horizon in any oblique Sphere, by reducing it to the finding of the Curve Surface of a *Cylindrick Hoof*; or of a given Part thereof.

Now this *Problem* is not of that Difficulty as appears at first sight; for let the *Cylinder* $A B C D$ be cut obliquely, with the *Ellipse* $B K D I$; and by the Center thereof H , describe the Circle $I K L M$; I say the Curve Surface $I K L B$, is equal to the Rectangle of $I K$ and $B L$, or of $H K$ and $2 B L$, or $B C$: And if there be supposed another Circle, as $N O P Q$, cutting the said *Ellipse* in the Points P, Q ; draw $P S, Q R$, parallel to the *Cylinder's* Axe, till they meet with the aforesaid Circle $I K L M$, in the Points $R S$; and draw the Lines $R T S, Q V P$, bisected in T and V . I say again; That the Curve Surface $R M S Q D P$, is equal to the Rectangle of $B L$, or $M D$, and $R S$, or of $2 B L$, or $A D$, and $S T$, or $V P$; and the Curve Surface $Q N P D$, is equal to $R S \times M D$ —the Arch $R M S \times S P$, or the Arch $M S \times 2 S P$: or, it is equal to the Surface $R M S Q D P$, subtracting the Surface $R M S Q N P$. So likewise the Curve Surface $Q B P O$ is equal to the Sum of the Surface $R M S Q D P$, or $R S \times M D$, and of the Surface $R L S Q O P$, or the Arch $L S \times 2 S P$.

Fig. 24.

This is most easily demonstrated from the Consideration, That the *Cylindrick* Surface $I K L B$ is to the inscribed *Spherical* Surface $I K L E$, either in the Whole, or in its analogous Parts, as the Tangent $B L$ is to the Arch $E L$; and from the Demonstrations of *Archimedes, de Sphæra & Cylindro, Lib. 1. Prop. 30, 37, and 38*; and *Doctor Barrow's* learned *Lectures* on that Book, *Prob. 9.* and the *Corollaries* thereof.

Now to reduce our Case of the Sum of all the Sines of the Sun's Altitude in a given Declination and Latitude to the aforesaid *Problem*, let us consider the *Analemma* projected on the Plan of the Meridian; Z , the *Zenith*; P , the *Pole*; HH , the *Horizon*; $a a$, the *Equinoctial*; $\textcircled{S} \textcircled{S} \textcircled{V} \textcircled{V}$, the two *Tropicks*; $\textcircled{S} I$, the Sine of the Meridian Altitude in \textcircled{S} ; and equal thereto, but perpendicular to the *Tropick*, erect $\textcircled{S} 1$, and Draw the Line $T 1$, intersecting the *Horizon* in T , and the Hour Circle of 6 in the Point 4, and 6, 4 shall be equal to 6 R, or to the Sine of the Altitude at 6: And the like for any other Point in the *Tropick*, erecting a Perpendicular thereat, terminated by the Line $T i$. Through the Point 4, draw the Line 4 5 7, parallel to the *Tropick*, and representing a Circle equal thereto; then shall the *Tropick* $\textcircled{S} \textcircled{S}$ in *Fig. 25.* answer to the Circle $N O P Q$, in *Fig. 24.* The Circle 4 5 7 shall answer to the Circle $I K L M$; $T 4 i$ shall answer to the *Elliptick* Segment $Q I B K P$; 6 R, or 6 4 shall answer to $S P$, and 5 1 to $B L$, and the Arch $\textcircled{S} T$ to the Arch $L S$,

Fig. 25.

L S,

LS , being the Semidiurnal Arch in that Latitude and Declination; the Sine whereof, though not expressible in *Fig. 25.* must be conceived as analogous to the Line TS , or VP in *Fig. 24.*

The Relation between these two Figures being well understood, it will follow from what preceeds, That the Sum of the Sines of the Meridian Altitudes of the Sun in the two *Tropicks* (and the like for any two opposite Parallels) being multiplied by the Sine of the Semidiurnal Arch, will give an Area analogous to the Curve Surface $RMSQDP$; and thereto adding in Summer, or subtracting in Winter, the Product of the Length of the Semidiurnal Arch (taking according to *Van Ceulen's Numbers*) into the Difference of the above-said Sines of the Meridian Altitude; the Sum in one Case, and Difference in the other, shall be as the Aggregate of all the *Sines* of the Sun's Altitude during his Appearance above the *Horizon*; and consequently of all his *Heat* or Action on the Plane of the *Horizon* in the proposed Day: And this may also be extended to the Parts of the same Day; for if the afore-said Sum of the *Sines* of the Meridian Altitudes be multiplied by half the Sum of the *Sines* of the Sun's horary Distance from Noon, when the Times are before and after Noon; or by half their Difference, when both are on the same Side of the Meridian; and thereto in Summer, and therefrom in Winter, be added or subtracted, the Product of half the Arch answerable to the proposed Interval of Time, into the Difference of the *Sines* of Meridian Altitudes; the Sum in one Case, and Difference in the other, shall be proportional to all the Action of the Sun during that Space of Time.

I foresee it will be objected, that I take the *Radius* of my Circle, on which I erect my Perpendiculars always the same, whereas the Parallels of *Declination* are unequal; but to this I answer, that our said Circular *Basis* ought not to be analogous to the Parallels, but to the Times of Revolution, which are equal in all of them.

It may perhaps be useful to give an Example of the Computation of this Rule, which may seem difficult to some. Let the *Solstitial Heat*, in \odot and ϖ , be required at *London*, *Lat.* 51, 32.

38° — 28' <i>Co. Lat.</i>		<i>Diff. Ascen.</i> — 33° — 11'.
23 — 30 <i>Decl. ☉</i>		<i>Arc. Semidi. Æstiv.</i> 123 — 11.
61 — 58 <i>Sinus</i> = 0,828674		<i>Arc. Semidiur. Hyb.</i> 56 — 49 <i>Sin.</i> 0,836923
14 — 58 <i>Sinus</i> = 0,258257		<i>Arc. Æstiv. mensura.</i> 2,149955.
<i>Summa</i> 1,140931		<i>Arc. Hyber. mensura.</i> 0,991683.
<i>Diff.</i> 0,624417		

Then 1,140931 in 0,836923 + 0,624417 in 2,149955 = 2,29734.

And 1,140931 in 0,836929 — 0,624417 in 0,991638 = 0,33895.

So that 2,29734 will be as the *Tropical Summer's Day's Heat*, and 0,33895 as the *Action* of the Sun in the Day of the *Winter Solstice*.

After this Manner I computed the following Table, for every tenth *Deg.* of *Latitude* to the *Æquinoctial* and *Tropical Sun*; by which an Estimate may be made of the intermediate *Degrees*.

Lat.

Lat.	Sun in $\gamma \cong$	Sun in σ	Sun in \wp
0	20000	18341	18341
10	19696	20290	15834
20	18794	21737	13166
30	17321	22651	10124
40	15321	23048	6944
50	12855	22991	3798
60	10000	22773	1075
70	6840	23543	000
80	3473	24673	000
90	0000	25055	000

From this Rule there follow several *Corollaries* worth Note : As, 1. That the *Equinoctial Heat*, when the Sun comes vertical, is as twice the Square of *Radius* ; which may be proposed as a Standard to compare with in all other Cases. 2. That under the *Equinoctial*, the Heat is as the Sine of the Sun's Declination. 3. That in the *Frigid Zones*, when the Sun sets not, the Heat is as the Circumference of a Circle into the Sine of the Altitude at 6. And consequently, that in the same *Latitude* these *Aggregates of Warmth* are as the *Sines* of the Sun's Declinations ; and in the same Declination of the Sun, they are as the *Sines* of the *Latitudes* ; and generally they are as the *Sines* of the *Latitudes* into the *Sines* of Declination. 4. That the *Equinoctial Day's Heat* is every where as the *Co-sine* of the *Latitude*. 5. In all Places where the Sun sets, the Difference between the Summer and Winter Heats, when the Declinations are contrary, is equal to a Circle into the Sine of the Altitude at 6, in the Summer Parallel ; and consequently those Differences are as the *Sines* of *Latitude* into or multiplied by the *Sines* of Declination. 6. From the Table I have added, it appears, that the *Tropical Sun* under the *Equinoctial* has, of all others the least force : And under the *Pole* it is greater than any other Days Heat whatsoever, being to that of the *Equinoctial*, as 5 to 4.

From the Table and these *Corollaries* may a general Idea be conceived of the Sum of all the Actions of the Sun in the whole Year, and that Part of the Heat that arises simply from the Presence of the Sun, be brought to a Geometrical Certainty : And if the like could be performed for Cold ; which is something else than the bare Absence of the Sun (as appears by many Instances) we might hope to bring what relates to this Part of *Meteorology* to a perfect Theory.

LIX. 1. May 10, 1666. About five of the Clock in the Afternoon, the Thunder (which I had heard before at some Distance) coming nearer to us, it began to rain ; and soon after (the Rain withal increasing) the Thunder

grew very loud and frequent, and with long rattling *Claps* (tho' not altogether so great, as I have sometimes heard:) And the *Lightning* with *Flashes* very bright (notwithstanding the clear Day-light) and very frequent; when at the fastest, scarce a full Minute between one *Flash* and another; many Times not so much, but a second *Flash* before the *Thunder* of the former was heard: The *Thunder*, for the most Part, began to be heard about eight or ten second-Minutes after the *Flash*; as I observed for a great Part of the Time by my Minute-watch; but once or twice I observed it to follow (in a Manner) immediately upon it, as it were, in the same Moment; and the *Lightning* extreme *red* and fiery; so that had it been by Night as it was by Day, it would have been very terrible. And though I kept within Doors, yet I sensibly discover'd a stinking *Sulphurous* Smell in the Air. About seven of the Clock it ended, before which Time I had News brought me of a sad Accident upon the Water at *Medley*, about a Mile, or somewhat more, distant from hence. Two Scholars of *Wadham-College*, being alone in a Boat (without a Waterman) having newly thrust off from Shore, at *Medley*, to come homewards, standing near the Head of the Boat, were presently with a Stroak of *Thunder* or *Lightning*, both struck off out of the Boat into the Water, the one of them stark dead, in whom, though presently taken out of the Water (having been, by Relation, scarce a Minute in it) there was not discerned any Appearance of Life, Sense, or Motion: the other was stuck fast in the Mud, with his Feet downwards, and his upper Parts above Water, like a Post, not able to help himself out; but, besides a present Stunning or Numbness, and no other Hurt; but was for the present, so disturbed in his Senses, as that he knew not how he came there out of the Boat, nor could remember either *Thundring* or *Lightning* that did effect it; and was very feeble and faint upon it: which (though presently put into a warm Bed) he had not thoroughly recovered by the next Night; and whether since he have or no, I know not.

Others in another Boat, about ten or twenty Yards from these (as by their Description I estimate) felt a Disturbance and shaking in their Boat, and one of them had his Chair struck from under him, and thrown upon him, but had no Hurt. Those immediately made up to the others, and some (leaping into the Water to them) presently drew them either into the Boat or on Shore; yet none of them saw these two fall into the Water (not looking that Way) but heard one of them cry out for Help presently upon the Stroke, and smelt a very strange *stinking Smell* in the Air, such as is perceived upon the striking of *Flints* together.

He that was dead, was the next Morning brought to Town; and Dr. *Willis*, Dr. *Mullington*, Dr. *Lower*, and my self, with some others, went to view the Corps, where we found no *Wound* at all in the Skin, the Face and Neck swarthy and black, but not more than might be ordinary by the settling of the Blood: On the Right-side of the Neck was a little blackish Spot about an Inch long, and about a Quarter of an Inch broad at the broadest, and was as if it had been *scar'd* with a hot Iron; and, as I remember, one somewhat bigger on the Left-side of the Neck below the Ear. Straight down the Breast, but towards the Left-side of it, was a large Place, about
three

three Quarters of a Foot in Length, and about two Inches in Breadth, in some Places more, in some less, which was burnt and hard, like Leather burnt with the Fire, of a deep blackish red Colour, not much unlike the scorched Skin of a roasted Pig: and on the Fore-part of the Left-Shoulder such another Spot, about as big as a Shilling; but that in the Neck was blacker, and seemed more fear'd. From the Top of the Right Shoulder, sloping downwards towards that Place in his Breast, was a narrow Line of the like scorched Skin; as if somewhat had come in there at the Neck, and run down to the Breast, and there spread broader.

The Buttons of his Doublet were most of them off; which some thought might have been torn off with the *Blast*, getting in at the Neck, and then bursting its Way out: For which the greatest Presumption was (to me) that, besides four or five Buttons wanting towards the Bottom of the Breast, there were about half a Dozen together clear off, from the Bottom of the Collar downwards; and I do not remember, that the rest of the Buttons did seem to be near worn out, but almost new. The Collar of his Doublet, just over the Forepart of the Left Shoulder, was quite broken asunder, Cloth and Stiffning, straight downwards, as if cut or chopp'd asunder by a blunt Tool; only the inward Linen or Fuslin-Lining of it was whole; by which, and by the View of the ragged Edges, it seemed manifest to me, that it was by a Stroak inwards from without, not outwards from within.

His Hat was strangely torn, not just on the Crown, but on the Side of the Hat, and on the Brim. On the Side of it was a great Hole, more than to put in one's Fist through it; some Part of it being quite struck away, and from thence divers Gashes every way, as if torn, or cut with a dull Tool, and some of them of a good Length, almost quite to the Edges of the Brim. And besides these, one or two Gashes more, which did not communicate with that Hole in the Side. This also I judged by a Stroak inwards; not so much from the View of the Edges of those Gashes (from which there was scarce any Judgment to be made either way) but because the Lining was not torn, only ripp'd off from the Edge of the Hat (where it was sew'd on) on that Side, where the Hole was made. Yet his Hat not being found upon his Head, but at some Distance from him, it did not appear against what Part of the Head that Hole was made.

The Night following, the three Doctors above-mentioned, and my self, with some Chirurgeons (besides a Multitude of others) were present at the opening of the Head, to see if any Thing could be there discover'd; but there appear'd no Sign of *Contusion*; the *Brain* full and in good Order; the *Nerves* whole and sound; the *Vessels* of the *Brain* pretty full of Blood. But nothing was by any of them discern'd to be at all amiss. Some of them thought, that they discern'd a small *Fissure* or Crack in the *Skull*; and some who held it while it was sawing off; said, they felt it jarring in their Hands, and there seemed to the Eye something like it; but it was so small, as that, by Candle-light we could not agree it certainly so to be.

Some of the *Hair* on the Right Temples was manifestly singed or burnt, and the lower Part of that Ear blacker than the Parts about it, but soft; and

it might be only the settling of the Blood. The upper Part of the Left Shoulder, and that Side of the Neck, were also somewhat blacker than the rest of the Body; but whether it were by the Blow, which broke the Collar, and scorched the round red Spot thereupon, or only by settling of the Blood, I cannot say; yet I think it might very well be, that both on the Head and on this Side of the Neck, there might be a very great Blow, and a *Contusion* upon it (and it seems to have been so, by the tearing of the Hat, and breaking the Collar, if not also cracking of the *Skull*) and yet no Sign of such *Contusion*, because dying so immediately, there was not Time for the Blood to gather to the Part, and stagnate there (which in Bruises is the Cause of Blackness) and it was but as if such a Blow had been given on a Body newly dead, which does not use to cause such a Symptom of a Bruise, after the Blood ceases to circulate.

Having done with the *Head*, they opened the *Breast*, and found that *Burning* to reach quite through the *Skin*, which was, in those scorched Places, hard and horny, and shrunk up, so as it was not so thick as the soft *Skin* about it: But no Appearance of any Thing deeper than the *Skin*; the Muscles not at all disorder'd or discolour'd (perhaps upon the Reason that was but now said, of the Head, Neck and Shoulder.) Having then taken off the *Sternum*, the *Lungs* and *Heart* appear'd all well, and well colour'd without any Disorder.

In Hampshire; by Mr. Tho. Neale, n. 14. p. 247.
 2. Jan. 24, 166 $\frac{1}{2}$. One Mr. Brooks of Hampshire, going from Winchester towards his House near Andover, in very bad Weather, was himself slain by Lightning, and the Horse he rode on, under him. For about a Mile from Winchester he was found with his Face beaten into the Ground, one Leg in the Stirrup, the other in the Horse's Mane, his Clothes all burnt off his Back, not a Piece as big as a Handkerchief left entire, and his Hair and all his Body singed; with the Force that struck him down, his Nose was beaten into his Face, and his Chin into his Breast, where was a Wound cut almost as low as to his Navel. The torn Pieces of his Clothes were so scatter'd and consumed, that not enough to fill the Crown of a Hat could be found. His Gloves were whole, but his Hands in them singed to the Bone. The Hip-bone and Shoulder of his Horse burnt and bruised, and his Saddle torn in little Pieces. This was what appeared to the Coroner's Inquest.

At Stralsund in Pomerania; by ---- n. 65. p. 2084.
 3. June $\frac{1}{2}$, 1670. (being Sunday) After several less strong Reports of Thunder, the whole Town and particularly the Congregation in St. Nicholas Church (when the Minister was Preaching) was strangely surpris'd with a most terrible Flash of Lightning and a fearful Thunder Clap, which lighted down through the lesser Steeple upon the Body of the Church, and through the large round Hole in the upper Vault within the same, in the Shape (as some observ'd) of a black fiery Ball, directly upon the Altar, causing such an hideous Crack, Fire-flash, Smoak, and Damp there, as if many Fire-Balls had been thrown down thither from the said Vault, and bursted all at once, begetting a dismal Consternation among the People, and leaving an ill sulphurous Smell behind.

The Candle on the South-side of the Altar was put out by the Blow ; the other remained burning. Two of the *Chalices* there were overthrown, and the *Wine* spilt, and the *Wafers* scatter'd about: But the empty *Chalice* stood firm. All three were somewhat *smutted* at the Foot, and one of them a little bent there, and in two Places pierced thro', as if it had been by Hail-shot: and the *Wafer-boxes* were likewise a little *smutted* towards the Bottom. The *Church-Book* was flung on the inner Passage: The Covers of the Altar were singed in divers Parts, as by Powder, and somewhat burnt and *smutted* here and there, as also torn in some Places. A strong Piece of *Wainscot* with a Picture upon it, behind the great Altar, was split in two. Of the *Church-Clock*, in the *West-End*, at the same time, both the Brass and Iron Wires of the Whole and Quarter-hour Hammers were partly broken, and the rest could not be found; and an oaken Post, fix'd in the Wall for the Support of the Dial was half torn, and beneath the same divers Bricks were struck out of the two Head Pillars supporting the Steeple. On the Top of the Southern Steeple, an oaken Gutter and a strong Beam and Supporter were shatter'd.

One of the Ministers, though sitting near the Altar to the South, had no Hurt at all. Divers of the People seated round about the Altar, fell down to the Ground with the Fright. One Youth that stood next the said Minister's Pew, not being able to recover his Senses, was carried home. On the North Side of the Altar four Persons fell down, and one of the oaken Seats being split under him that sat thereon, that Person was much hurt by it, and more than any other. Some that stood in or by the Belfrey, near the Clock, were slightly hurt here and there; and among them a Mariner, leaning on a lined oaken seat there, had his right Arm bruised; and another Man, though but slightly hurt, yet could not remember how he got home from Church.

There issued forth a huge Damp like unto Smoak out of the Southern Steeple; but the *Church-Carpenter*, upon search, met only with a present Noise and thick Damp, which, tho' it frightened him at first into an Apprehension of *Fire*, yet getting to the Windows, and opening them, the Damp issued with great Violence; but there appear'd no Fire any where, save only a little in the shatter'd Parts of the Steeple, which was soon quenched.

The Church-Dial was also *smutted* in sundry Parts, soiling the gilt Figures, that they could scarce be discerned. The gilt Weather-Cocks upon both the Steeples were likewise *smutted* on the one Side of their Tails, without any other Mark. Nor could it be in the least discovered in either of the Steeples, which way the Claps entred, by all the Search that was made.

It was observ'd afterwards, that among the eight Persons that were hurt, one who stood in the Belfrey, had the upper back Part of his Cloth-Coat, as also his Shirt and Skin somewhat torn; but the Lining of that Coat, which was Red-Frize, had no Hurt at all.

Another sitting betwixt the rest, in a Pew under the Organs, and leaning on the Door, whilst the Pew-lock (then close to his Body) was so violently struck out, that it hung only by one Nail, had no Damage at all by it himself, nor any other that sat or stood by there, when the Stroak happen'd;

happen'd ; though they fell all to the Ground by the Fright, at the Instant when it was given.

And as for him that had his Arm bruised, it was somewhat strange that afterwards there was found a Hole passing his Coat, Waist-coat and Shirt, on the Fore-part of his Body, without in the least hurting the Body ; the Hole appearing just as shot through. His Waist-coat (being of a red Sarcenet) kept its Colour every where, but at the Place where the Arm was hurt : And the small Silver-Edging was smutted almost every where, and about the Neck too, where the Party wore a Cravat. One half of his Shoe was also torn off, the Soal being pierced as with Hail-shot ; and a Piece of his Stocking's Foot on the same Foot struck away, near an Hand-breadth, without any other Hurt to either Foot or Leg, but that for some Days that Foot was benumbed.

Lastly, One of them that sat by the Altar, had his Breeches and Leather-Drawers on both Sides pierced through as by Hail-shot, and Part of it plainly scorched and shrunk up, as by *Fire* : And divers of such small Holes in his Shirt too, yet without any hurt in his Body, save that he found some Pain in his Foot. One Side of his Shoe was also torn, and the Soal sideways pierced through, as 'twere, with Hail-shot.

At Dantzick; by Mr. Chr. Kirby, n. 96. p. 6092.

4. About the latter End of *March* and *April*, 1673. we had much and violent *Thunder* and *Lightning*, which had this unhappy Effect upon all the Parcels of *Wheat* and *Rye*, of the last Year's-Growth, in our Granaries, that, tho' over-night they were dry, sweet, and fit for Shipping, the next Morning they were become clammy and stinking ; so that the *Owners*, if they would not lose their Grain, were forced to cause it to be turned over two or three times a Day ; and yet it required six Weeks, if not longer, before it was recovered. This is a Thing which often happens to Corn that hath not lain in the Granary a whole Year, or not sweat thoroughly in the Straw before it be thrash'd out.

At Portsmouth; by --- n. 177. p. 1212.

5. *Octob. 23*, 1685. On Board the *Royal-James*, a Flash of *Lightning* and *Thunder* together took the Mast, which was put into her for careening, being a made Mast, and bound with Iron Hoops from one End to the other, and shiver'd it down to the Deck, breaking one of the Iron Hoops in the Body of the Mast, so that Splinters are forc'd out of the Middle of the Mast a Foot and half long (and a *Ball of Fire* was seen to run to and fro on the Deck) insomuch that the Mast is wholly unserviceable, and must be taken out.

On Board the *Coronation*, notwithstanding the Ship's Head was to Windward, a great *Ball of Fire* came into the Gun-room Ports, and threw a Boy out of one of the Ports, and he was drowned ; and several Work-men being on Board, as Carpenters, Joyners, and Seamen were struck down and made senseless for some time ; and the *Ball of Fire* ran up and Struck on the Starboard-side of the Wardrobe, and left a Place scorched round upon the Side, and between the two Ring-bolts, as if it had been a Shot, and beat the Wainscot over to the Side, all scorched as if with Fire ; and run up against the Doors and Hinges, away, and run into several *Balls of Fire* on the Deck amongst

amongst the Men; and some Part of it broke in at the Windows of the Round-house, and shiver'd off a great deal of the Wainscot, and broke the Glasses of the *Perspective-Glass*, and make a *Hole* through a Letter that lay in the Window eight double, the Circumference of a Musket-Bullet, and no more; it also shivered the Timber that holds the *Ensign-Staff* on the *Poop*.

6. *March* 20, 1693. About eight at Night there arose a very violent Gust of Wind at South-west, which lasted an Hour and an half, during which time it rain'd very fast. A Quarter of an Hour, or thereabout, after Nine, fell a mighty Storm of Hail intermixt with Rain, which lay very white, and some Depth on the Ground, and to me appeared to have Snow mixed with it. During that Storm happen'd two *Flashes* of *Lightning*, very violent and strange; it was extraordinary blue, and of a sulphurous Smell; it seem'd to stand still in the House some considerable time, and was so great, that a Gentleman, who sat below Stairs, thought that the House had been on *Fire* above, and that the Flames rolled down Stairs. The Clap of *Thunder*, which immediately followed, seem'd to all like the sudden Discharge of five or six Field-pieces; not with that rolling deep Noise *Thunder* usually carries along with it. The second *Flash* and *Clap* followed within a few Minutes of the first, but not with that Violence as the former: Which Flash fired the Steeple, I cannot say, but a Piece of Wood to which the Lead of the Windows was nail'd, was set on fire, and kindled very fast, and might have done a great deal of Mischief, had not the Earliness of the Night and timely Help prevented it. This Storm seem'd to run in a direct Course; for several of our Side Towns perceived little of it; and I believe it broke chiefly over us. At *Kettering* one of their Bells, as some say, received some Damage, and the Wires of the Chimes were twist'd one with another. The Wind was very blustering all the Night after.

*A: Oundle
by Mr. W. R.*

7. *Aug.* 13, 1693. About three a Clock in the Morning it began to thunder and lighten, and rain; about four a Clock came a Clap of *Thunder* and *Lightning* all at the same Moment of Time, that was so smart and violent, that I thought the Ship had been split in pieces; an Alarm went presently through the Ship, of *Fire, Fire*, the dreadfullest Word that can happen on Board, and put us all into Confusion. But it happen'd to rain briskly about that time, and so with the help of our Buckets, the Fire, which was occasioned by the *Balls* of *Lightning* that came between Decks, was soon put out. In the *Gangway* was one Man knock'd down, and lay sometime before he recovered himself; a second near him was blown almost the Length of the Quarter-deck; a third was burnt all down his Back with the *Lightning*, in his Hammock. Our *Main Top-Gallant-Mast* was split in pieces, our *Top-mast* not touched; our *Main-mast* split from the Top down to the very Deck.

*On Board
the Suffolk
in the Bay of
Biscay; by
Dr. Oliver,
n. 204 p.
911.*

8. *July* 24, 1696. We had an extraordinary pleasant Forenoon, with continual Sun-shine, till about half an Hour after three in the Afternoon, when we had some Rain, after which happened two *Claps* of *Thunder*, though not very great, and then a great Shower of *Hail*, in which time happen'd a third *Clap*, which made all our loss. We were sixteen in Number, none of us happening to be out or absent at the Time. The most Part of them were stand-
ing

*Near Aber-
deen in Scot-
land; by
n. 222 p. 311*

ing about me in the School, hard by my Chamber-door; the two foresaid Claps of *Thunder* being over, we thinking nothing of them; and now there being a great Shower of *Hail*, on a sudden there happen'd such a *Flash* of *Lightning*, which I saw, and, as I thought, fill'd the whole House; but of the *Clap* I minded nothing, but only I think that I heard, as it were, some sharp Clink or Sound; but our Neighbours in the Town, such as the Minister and his Wife, told, they never heard a louder: But however, I think all our Loss was by the *Fire*, which was over in an Instant, and after which we had Darknes in the *School*, by Reason of the *Smok*, with a most violent sulphurous Smell, and the burning of some Leaves of Books. There are five Breaches in the Walls, one in the Roof, exactly in shape like a Cannon-ball, another under the Chimney, a third came through the back Wall, and quite thro' the other Wall opposite it; and the Chimney was split in pieces, and some that came to the School-Door, and made a Breach there, rending the Stones in pieces, and carrying them out. There were four kill'd, and many of the rest hurt, having their Legs or Arms ruined; but are all, I thank God, recovered. And as for my self, I never was in greater Danger; for there was one kill'd before me, another at my Left-hand, and not half a Foot from me there was a Breach made in the middle Wall of my Chamber; and yet I thank God, I received no Hurt, only I was bled in the Mouth, but how, I cannot tell. As to the Children's Bodies that were kill'd, I found none of their Bones broken; my Brother had a Cut in his Head; and all of them, where they received the Strokes, had their Clothes cut, as if it had been eat out with Rats. They all received their Strokes on their vital Parts, and about their Shoulders, which were in Colour of a brownish-black. All the Children that were killed, were in different Places, and, as it were, pick'd out.

A: Smyrna,
by Mr. R.
Mawgridge,
n. 235. p.
782.

9. Nov. 26, 1696. A sad and astonishing Accident happened to the *Trumbull Galley* by *Lightning* and *Thunder*. For as we lay at Anchor at *Smyrna*, about one of the Clock in the Morning, she was staved in several Places; the *Bulk-head* of her *Round-house* was staved all to pieces into the Captain's Cabin, and hurt his Shoulder; her *Mizzen-Mast* was staved all to pieces, and the *Spindle* in the Head of the Mast was melted at both Ends with the *Lightning*; the *Main-Top Sail-Yard* was lashed in the Top, yet notwithstanding the *Yard* was thrown out, and stuck in our *Awning* right an End. The Quarter-Master (one *John Page*) was on the Deck by the *Mizzen-Mast*, and one *John Allen*, who were both struck down flat thereon with the *Lightning*. *Page* had one Side of him stupified for three Days, but, under God, I recovered him in six Days; *Allen* was very well the next Day, when his fright was over. The *Lightning* did strike the Plank for six Foot off the Outside of the Galley all to pieces, and the Timber was like a Brush; and three Planks of the Cieling were started, whereof two Foot and seven Inches was staved out from the rest, within ten Inches of my Head. My Velvet Cap was hanging on a Nail in the same Piece of Cieling, the Inside whereof, next unto the *Lightning*, had not one Stitch amiss, but the Outside had all the Seams burst to pieces. A great weighty Nail was started out of the said Cieling, and fell over my Head, and lay upon my Pillow, and I thought my Head with the
Lightning

Lightning had been in a Flash of Fire. Whilst I could but just shut my Eyes and open them again, the *Lightning* went down into the Hold, and ran out like a Train of *Wild-fire*, and burst out through the Galley's Side, and rent ten or eleven Foot of the outside Plank off, within a Foot of the Water's Edge. Some of the *Lightning* shot up between the Timbers and the Cieling into the Gun-Room, and staved a Beam, and set three or four Bundles of armed Match all on Fire. The Gunner, *George Hardy*, was lying in his Cabbin at the same time, and the *Lightning* blistred one of his Feet, and sing'd his Hair off his Head. The Master's Cabbin was between the Gunner's and mine, but had no Damage.

10. July 27, 1691. In *Everdon Field*, near *Daventry* in *Northamptonshire*, divers were at Work reaping Corn. The Morning was fair and clear; but before Noon there came a violent Storm of *Thunder* and *Lightning* and *Rain*; which caused the Reapers being about twenty in all, to retreat for Shelter to a *Quickset Hedge*, with a Ditch by the Side of it. Of these Persons four were kill'd, viz. *Simon Marriot*, *Robert Marriot*, *Richard Wells*, and *Thomas Burroughs*; and eight others dangerously hurt: of the rest several were struck down, but not much hurt.

In North-
ampton-
shire; by
Dr. Wallis,
n. 236. p. 5.

Upon the first Tidings of this Accident, Mr. *Edwards* (the Minister of *Badby*) repaired to the Place; where *Robert Marriot* lay on his Back out of the Ditch, having struggled (as was said by the By-standers) after the Stroke. Mr. *Edwards* says, he saw no Marks or Sign of Hurt on the Body: But the Woman who laid him out, and the rest, say, there was a Hole about the Bigness of a Goose-shot in the Pit of his Stomach, and many more about his Legs. There was in the Hedge a Pollard-Ash, under which sat *Simon Marriot* and *Richard Wells*; but *Thomas Burroughs* sat at the Distance of two or three Yards from thence. In this Tree were cut or rased four (or more) Grooves or Furrows, from the Top to near the Bottom, deeper than the Bark, and about an Inch broad, each of them, on that Side of the Tree on which the Men sat; but no Damage appeared on the Tree elsewhere, there being a Knot on the opposite Side, which is supposed to have diverted the Stream of the fiery Matter. The green *Thorns* were scorched, and the Place smelt rank of *Sulphur*.

Simon Marriot had the Crown of his Hat cut into the Shape of a bearded Arrow, and at the Band-place cut smooth, almost round about from the Brim. His Clothes on one Shoulder cut jaggedly to the Skin, where was a Scar about four Inches in length, of a long oval Figure, the transverse Diameter whereof was deepest, of a darkish red Colour, as hard as *Horn* all over. He had Snuff on his Hand, as if just ready to take it.

Richard Wells had a little Dog on his Lap, or between his Legs, dead. His Hand upon the Dog's Head, his Eyes open, and with Bread and Cheese (or one of them) in his Hand, as if going to give the Dog a Bit. His Shoulder (as his Relations say) was struck down, and in a manner severed from his Body.

Thomas Burroughs sat as looking up to the Heavens, his Head turning toward one Side, as viewing the Clouds; his Eyes open. He had in his Pocket

a Copper Tobacco-Box, which had one little round Hole struck quite thro' it; and a little of the Metal on one Side seem'd to have run. By these Postures it is evident they died in a Moment.

Mr. *Edwards* adds, that he took *Simon Marriot's* Hat, and some of his Clothes, and held them against the Light, and they appear'd full of Holes, as a Skimmer or Cullendar. But (at which he wondred most) the Woman who laid them out, told him, their Buttocks which sat upon the Ground were pitifully mangled, and their Privy-Members rent and torn to pieces; and more especially those of *Thomas Burroughs*, as if small Bars of red hot Iron had been thrust up into them in many Places.

The Hair of their Heads was burnt very much. Some had no Harm that were hard by: But others were wounded at a Distance, and their Wounds were cured with more Difficulty than ordinary Burns.

It was (before the Storm) a pretty still Day. But before each *Thunder Clap*, was heard a great whirling Noise in the Trees, like Wind. The *Lightning* was observed by Persons at a Distance, all falling perpendicularly upon them. Those who recovered had their Clothes full of Holes, as if they had been shot through. Not a Drop of Blood appear'd upon any of them. Their Hurts were like dry, scorched, scarred, or healed Wounds.

Simon Marriot and *Robert Marriot* were struck back; the other two, supported, as is suppos'd, by the Hedge at their Back, continued in the Posture wherein they were kill'd, three or four Hours after, when Mr. *Richard Bulker* of *Preston* saw them.

Several of those who were hurt, were taken up for dead, but soon came to themselves without any Application: But some of them were fain to be carried home.

William Gregory's Wife had four little Holes in her Knee, like Shot-holes; which turned to Sores, and had Cores come out of them.

Mary Bird (a Woman with Child) had, all over her Body near an hundred Wounds, some as large as a Man's Hand, on each Arm one, and one on each Side of her Belly. Out of most of her Wounds came Cores, some bigger, some less; the biggest were bigger than a Walnut, dry and black like Leather. She had two Sores on the Soles of her Feet, but her Shoes and Stockings not touched. She fate next to those that were kill'd. She was taken out of the Ditch for dead, and was suppos'd to be kill'd. She was sensible of the Stroke, and sensible that her Husband look'd pale, and then swooned away. She and her Husband were both blooded, she within an Hour after, and her Husband eight Hours after; and they bled freely. Their Legs were mightily swell'd before they were carried out of the Field. The Woman was very sore, and full of Pain, so that she could hardly bear any Clothes to touch her. She was three Weeks ill before she could rise, and continued ill about a Quarter of a Year. No Medicines used for Burns did any good, but occasioned great Torment to her. The first that they perceived to do good to her was Oil of *St. John's-Wort*, and after the Cores were come out, the *Black-Salve*. She went out her full Time: The Child had no Marks or Blemish at all upon this Occasion, and is yet living. About
that

that Time of the Year she hath been blooded ever since. She finds a great Tingling, and hath little Pimples like Stinging of Nettles, and cannot be well until she hath been blooded.

The Wounds of all those that were hurt, were like those of this Woman, but slighter; and some of them had no Cores come out of them.

This is the best Account I can give you out of the broken Remarks which I had in Writing from Mr. *Edwards* and Mr. *Butler*, the two Gentlemen above mentioned.

11. Dec. 22, 1698. *Jeremiah Skelton* at *Warley*, in the Vicarage of *Halli-fax* in *Yorkshire*, observing a Storm coming upon him, stepp'd aside for Shelter within a Barn-Door, and while there, was struck with a dreadful *Flash of Fire*: A young Woman that lived with her Father, in the House that belonged to this Farm, being sadly affrighted with the *Thunder* and *Lightning* (for Part of the sulphurous Matter came down the Chimney, and filled the House with a strong Scent, like that of Gun-powder after firing) she leaves the House, and not seeing the young Man about the Barn, goes with Speed, and tells the Family he was related to, that she fear'd he was slain. They came to the Barn, and found it even so: A sad Spectacle! the young Man cast down, and many Stones about him; he was laid upon his Face, wholly naked, save a small Part of his Shirt about his Neck, and a very little of a Stocking upon one Foot, and so much of a Coat-Sleeve as covered the Wrist of one Arm; his Clogs driven from his Feet, one not to be found, and the other clogen; his Hat not to be found after Search, and the rest of his Garments torn into small Shreds, and cast at considerable Distances one Bit from another; the *Hair* of his *Head* and *Beard* singed, as though it had been with a Candle, and a little Hole below his left Eye, which they supposed might be made with the Fall upon a Stone; for there was a great Breach made upon the Barn, the Door-tops, both of Stone, broken, and the Wall above them fallen, with the Slate and Water-Tables.

In York-
shire, 1698.
by Mr. R.
Thoresby,
n. 249. p. 51.

12. April 27, 1700. We had (at *Leeds* in *Yorkshire*) a pretty severe Storm of *Thunder* and *Lightning*; one Clap particularly was very loud, and seem'd to me to be very low and near us. It fell upon a Cottage, and broke down Part of the Chamber Chimney, and thence made its Way through a Chink or Nick in the Floor to the lower Room, whereby the Flame thus contracted was either more intensely hot, or at least directed more immediately to a Shelf, where it melted several Holes in two Pewter Dishes; it melted also, and run into little Lumps, several Places in a Pewter Candlestick, and of a Brais Mortar, yet burnt not some Bits of Fringe, and other combustible Matters within it; it burnt also some Holes in a Tin Vessel, and smutted a white Stone Plate it stood upon, as if it had been with *Lamp-Black*, and filled the Room with such a *Bituminous Smell* (like fired Gun-powder) as almost stifled the poor Woman, who was all alone in the House: But upon opening the Door, she received no farther Damage. I bought the Candlesticks, to preserve as a Memorial of so uncommon an Accident.

In York-
shire, 1700;
by Mr. R.
Thoresby,
n. 264. p.
577.

I have enquired of one in that Neighbourhood, concerning a more fatal Accident, of which the *Parish-Register* has this Note. *Sept. 2, 1672.* was buried *Thomas*, the Son of *James Lambert*, Junior, deceased, of *Holbeck*, slain the Day before, being the Lord's-Day, by a *Thunderbolt*. His Skin, as I am informed, was perfectly burnt black, and was shrunk up hard like Parchment, or Leather burnt with Fire. There were other Children in Company, who were also cast down by the Storm, amongst whom the Party I spoke to had a Brother and Sister; he had a Pair of new Stockings burnt off his Legs, and himself was so scorched, that he never recovered his natural Complexion: She having a Waistcoat clasp'd before (as the Fashion then was) was so burnt betwixt her Breasts, that the Scars thereof remain to this Day: Another had the stiffed Neck of his Doublet struck off.

But all recovered except *Lambert's* Boy, who was found with his Face upwards, whereas all the rest had theirs to the Earth: Which reminds me of our Coal-Miners Practice, who, when any swoon away by their sulphurous Damps, dig a Hole in the Earth, and lay them on their Bellies, with their Mouths in it, which, if it prove not an absolute Suffocation, recovers them.

The Direction of Ship-Compasses changed with Thunder and Lightning; by n. 127. p. 647.

LX. 1. Mr. *Haward*, who has been Master of several Ships, and is a Man of good Credit, tells me, That in a Voyage to *Barbadoes*, in Company of another Ship, commanded by one *Groston* of *New-England*, they were, in the Latitude, as I remember, of *Bermudas*, suddenly alarmed with a terrible Clap of Thunder, which broke this *Groston's* Fore-mast, tore his Sails, and did some Damage to his Rigging: But by that Time the Noise, together with the Danger of this frightful Accident was past, Mr. *Haward*, to whom this Thunder had been more favourable, was however no less surpris'd, to see his Companion's Ship steer directly homeward again. When they were almost out of Call, he tack'd and stood after them, and found, That Mr. *Groston* did indeed steer by the right Point of his Compass, but that the Card was turn'd round, the North and South Points having changed Positions; and though with his Finger he brought the *Flower de Lys* to point directly North, it would immediately, as soon as at Liberty, return to this new unusual Posture, and upon Examination, he found every Compass in the Ship of the same Humour: Which strange and sudden Accident he could impute to nothing else but to the Operation of the Lightning and Thunder newly mentioned. He adds, that he lent *Groston* one of his Compasses to finish the Voyage, and withal, that those Thunder-strucken ones did never, to his Knowledge, recover their right Positions again.

By Sir R. S. n. 157. p. 520.

2. July 24, 1681. The Ship called the *Albemarle*, whereof Mr. *Edward Lad* was then Master, being a hundred Leagues from *Cape Cod*, in Lat. 488, about 3 h. p. m. met with a Thunder-storm; the Lightning burnt the Main-Top-Sail, split the Main-Cap in pieces, rent the Mast all along: there was in special one dreadful Clap of Thunder, in Report bigger than that of a great Gun, at which all the Ship's Company were amazed; then did there fall something from the Clouds upon the Stern of the Boat, which broke into many

many small Parts, split one of the Pumps, and the other Pump much hurt a so; it was a bituminous Matter, *smelling* much like fired Gun-powder: It continued burning in the Stern of the Boat; they did with Sticks dissipate it, and poured much Water on it, and yet they were not able by all that they could do, to extinguish it until such Time as all the Matter was consumed.

When Night came, observing the Stars, they perceived that their *Compasses* were *changed*; as for the *Compasses* in the *Bittack*, the *North-Point* was turned clear *South*. There were two other *Compasses* unhung in the *Locker* in the *Cabin*, one of which the *North Point* stood *South*, like that in the *Bittack*; as for the other, the *North Point* stood *West*; so that they sailed a thousand Leagues by a *Needle*, whose *Polarity* was quite *chang'd*. As for the *Compass* wherein the *Lightning* had made the *Needle* to point *Westward*, since it was brought to *New-England*, the *Glass* being broken, it has, by means of the *Air's* coming to it, wholly lost its *Virtue*.

Mr. *Edward Randolph* (who has been four times employed to *New-England*, in his Majesty's Service) being enjoined by Mr. *Flemsted* to make Enquiry into this Matter, at his Return to *Boston* in *Dec.* 1683. spoke with Mr. *Lad* himself. He affirmed the same Thing, and dictated to him an Account suitable to what you have. But that which you have was in the Hands of Mr. *Mather*, a Minister, to whom Mr. *Lad* had also presented one of the *Compasses*, as he had done the other to an *English Merchant* in *Amsterdam*, who gave it to the State-house.

LXI. 1. About *Christmas* 1693. at *Harlech* in *Merionysshire*, sixteen Ricks of Hay, and two Barns, whereof one was full of Corn, the other of Hay, were set on Fire by a kindled Exhalation, which was often seen to come from the Sea, and lasted at least a Fortnight or three Weeks; and it annoyed the Country, as well by poisoning their Grass, as firing the Hay, for the Space of a Mile, or thereabouts. Such as have seen the Fire, say it was a blue weak Flame, easily extinguished, and that it did not the least Harm to any of the Men, who interposed their Endeavours to save the Hay, tho' they ventured (perceiving it different from common Fire) not only close to it, but sometimes into it. All the Damage sustained happen'd constantly in the Night. *Dec.* 24. *Richard Griffith* of *Lechweob-du*, *Humphrey Owen* of *Garreg-wenn*, and *Richard Davydd* of *Erw-wenn*, each of them lost a Rick of Hay. 27. That Night was burnt one Rick of Hay of *John Philips* of *Ynyllarwangel*, y *Trallbau*, two Ricks of Hay of *Griffith John Owen* of *Cefn-Trefvorbach*, and *Katharine Williams*, Widow of *Cefn Trefor suar*, lost two Ricks. 29. That Night *Francis Evans* of *Glas-cryn* had one Rick burnt. *Richard Davydd* of *Erw-wenn*, had a Barn full of Hay of three Bays of Buildings, burnt down to the Ground.

There are three small Tenements in the same Neighbourhood (call'd *Ty-din Ston Wyn*) whereof the Grass is so infested, that it absolutely kills all manner of Cattle that feed upon it. The Grass has been infestious these three Years, but not thoroughly fatal till this last.

A Fiery Exhalation or Damp; by Mr. Maurice Jones, n. 208. p. 49.

By Mr. Edw.
Lhwyd, n.
213. p. 223.

2. An intelligent sober Person that lives near *Harlech*, assures me, that the *Fire* still [*Aug.* 1694] continues there; that it is observed to come from a Place call'd *Morva-byeban* in *Caernarvonshire*, about eight or nine Miles off, [over Part of the Sea.] That Cattle of all sorts, as Sheep, Goats, Hogs, Cows, and Horses, still die apace; and that for certain any great Noise, as Winding of Horns, Drums, &c. does *repel* it from any House or Barn, or Stacks of *Hay*; upon Account of which Remedy they have had few or no Losses since *Christmas*: That it happened, during this Summer, at least one Night in a Week, and that commonly either *Saturday* or *Sunday*; but that now of late it appears something oftner. The Place from whence it proceeds is both sandy and marshy.

Fairy-Circles
by Mr. Jol-
son, n. 117.
p. 394.

LXII. I have often been puzzled to give an Account of those *Phenomena*, which are commonly called *Fairy-Circles*. I have seen many of them, and those of two sorts; one sort *Bare*, of seven or eight Yards Diameter, making a round Path something more than a Foot broad, with green Grass in the Middle; the others like them, but of several Bignesses, and encompassed with a Circumference of Grass, about the same Breadth, much *fresher* and *greener* than that in the Middle. But my worthy Friend Mr. *Walker*, gave me full Satisfaction from his own Experience. It was his Chance one Day to walk out among some Mowing Grass (in which he had been but a little while before) after a great Storm of *Thunder* and *Lightning*, which seem'd by the Noise and Flashes to have been very near him: He presently observed a round *Circle*, of about four or five Yards Diameter, the Rim whereof was about a Foot broad, newly burnt bare, as the Colour and Brittleness of the Grass Roots did plainly testify. He knew not what to ascribe it unto but the *Lightning*, which, besides the odd *Capricio's*, remarkable in that Fire in particular, might, without any Wonder, like all other Fires, move round, and burn more in the Extremities than the Middle. After the Grass was mowed, the next Year it came up more *fresh* and *green* in the Places burnt, than in the Middle, and at Mowing-time was much taller and ranker.

The Cause of
Lightning
and Thun-
der consid-
red, by Dr.
Liber, n.
257. p. 517.

LXIII. 1. There are two sorts of Instances (that often occur in History) which very much favour my Opinion, That *Thunder* and *Lightning* owe their Matter from the sole *Breath* of the *Pyrites*.

The first sort of them are those which tell us, that in *Italy* it rained Iron in such a Year, and in *Germany* a great Body of Iron-stone fell at such a time; the like *Avicen* affirms. *Julius Scaliger* says, that he had by him a Piece of Iron which was rained in *Savoy*, where it fell in divers Places. *Cardan* reports 1200 Stones to have fallen from Heaven, and one of them weigh'd an hundred and twenty Pound, some of them thirty, some forty Pound, very hard, and of the Colour of Iron. Now that which is very remarkable (says *Gilbert*, where those Instances are reckon'd up) and a very probable Argument for the Truth of such like Instances, is, that it is no where recorded, that it ever rained Gold or Silver Ore, or Tin, or Lead; but Copper hath been also said to have fallen from the Clouds.

But

But where-ever the *Pyrites* is mentioned by the Antients, it is always to be understood of the *Copper Pyrites*; they scarce having had any Knowledge of the *Iron Pyrites*. And therefore the raining of Copper makes it yet more probable, because of its great Affinity with Iron.

Now this *Ferrum* or *Æs Nubigenum*, if there was ever any such, was concentered of the *Breath* of the *Pyrites*, which we have elsewhere shewn to be the *Pyrites*, *ex tota Substantia*.

The other Instance (which is owing to our Registers) is of *Lightning* being *Magnetick*. This I am sure of, I have a petrified Piece of Ash, which is *Magnetick*; that is, the *Pyrites in Succo*; which makes it probable it may be *Magnetick* also in Vapour.

2. *Thunder* and *Lightning* are so very like the Effects of fired *Gun-powder*, that we may reasonably judge them to proceed from like *Causes*. Now the principal Ingredients in *Gun-powder* are *Nitre* and *Sulphur* (the Admission of *Char-coal* being chiefly to keep the Parts separate, for the better kindling of it) So that if we suppose in the Air a convenient Mixture of *Nitrous* and *Sulphurous* Vapours, and those by Accident to take Fire, such *Explosion* may well follow, with such Noise and Light, as in the firing of *Gun-powder*. And being once kindled, it will run from Place to Place, as the Vapour leads it, as in a Train of *Gun-powder*, with like Effects.

The Cause of Hail, Lightning, and Thunder considered by Dr. Wallis. n. 231. p. 655.

This *Explosion*, if high in the Air, and far from us, will do no Mischief, or not considerable; like a Parcel of *Gun-powder* fired in the open Air, where is nothing near to be hurt by it: But if near to us (or amongst us) it may kill Men or Cattle, tear Trees, fire *Gun-powder*, break Houses, or the like; as *Gun-powder* would do in the like Circumstances. This Nearness or Farness may be estimated by the Distance of Time between seeing the *Flash of Lightning*, and hearing the Noise of the *Thunder*. For though in their Generation they be simultaneous; yet (*Light* moving faster than *Sound*) they come to us successively. I have observed, that commonly the Noise is about seven or eight *Seconds* after the *Flash* (that is, about half a Quarter of a Minute) but sometimes much sooner, in a *Second* or two, or less than so, and almost immediately upon the *Flash*. And at such time the *Explosion* must needs be very near us, or even amongst us. And, in such Cases I have (more than once) prefiged the Expectation of *Mischief*, and it hath proved accordingly.

Now, That there is in *Lightning* a *sulphurous Vapour*, is manifest from the *sulphurous Smell* which attends it, and a sultry Heat in the Air, which is commonly a Fore-runner of *Lightning* soon after. And that there is also a *nitrous Vapour* with it, we may reasonably judge, because we do not know of any Body so liable to a sudden and violent *Explosion*.

As to the kindling of these Materials, in order to such *Explosion*, I am told that a Mixture of *Sulphur* and *Filings of Steel*, with the Admission of a little *Water*, will not only cause a great Effervescence, but will of it self break forth into an actual Fire. I say, a little *Water*, because too much will hinder the Operation, or quench the Fire, which I take to be the Cause of the *Bath Waters*.

n. 233. p. 729.

Waters, and other *hot Springs*, where *Steel* and *Sulphur* cause a great *Efferve-
scence*, but no *Flame*.

n. 211.
p. 657.

So that there wants only some *Chalybeat* or *Vitriolick Vapour* (or somewhat *equivalent*) to produce the whole *Effect* (there being no want of aqueous *Mat-
ter* in the *Clouds*). And there is no doubt, but that amongst the various *Es-
fluxia* from the *Earth*, there may be copious *Supplies* of *Matter* for such *Mix-
tions*.

m. 255.
p. 730.

The same *Account* may be also given of *Aetna* (and other *Burning-Mountains*)
where the *Mixture* of *Steel* and *Sulphur* may give a *Flame*; which is oft attend-
ed with prodigious (*Explosions* and *Earthquakes*) from great quantities of *Nitre*,
as in springing a *Mine*.

n. 211.
p. 657.

This may also suggest somewhat as to the *Generation* of *Hail*, which is very
oft an *Attendant* of *Thunder* and *Lighning*. 'Tis well known, in our artifi-
cial *Congelations*, that a *Mixture* of *Snow* and *Nitre* (or even common *Salt*)
will cause a present and very sudden *Congelation* of *Water*. And the same in
Clouds may cause that of *Hail-stones*. And the rather, because there seems
somewhat like *Snow*, rather than *Ice*, in the *Midd* of them. And as to those
in particular so very large (as to weigh half a *Pound*, or three *Quarters* of a
Pound) supposing them to fall from so great a *Height*, as 'tis manifest they
did by the *Violence* of their *Fall*; 'tis very possible, that, though their
first *Concretion*, upon their sudden *Congelation*, might be but moderately
great, as in other *Hail*, yet in their long *Descent*, if the *Medium* through
which they fall were alike inclined to *Congelation*, they might receive a great
Accession to their *Bulk*, and divers of them incorporate into one: Like as
in that strange *Show*er of *Hail* in *December* 1672. wherein there did
hang on the *Trees* a great deal in the *Form* of *Iceicles*, a *Foot* or more in
length.

Phil. sup. p.
XLIV.

Phil. sup. p.
LI.

n. 215 p. 9.
Phil. sup. p.
LIX. 10.

These *Considerations* may also furnish us with some *Account* of the *na-
tural Causes* of those particular *Circumstances* which attended the *Acci-
dent* at *Everdon*, where four *Persons* were kill'd, and others hurt with *Ligh-
ning*.

It seems to me, that in and over the *Ditch* there was *Plenty* of some *Cau-
stick Vapour* of a like *Nature* with the *Ingredients* of *Gun-powder*; and per-
haps even under those who were killed or wounded. And if this *explosive* *Quali-
ty* were attended with that of *Glaciation*, as *Thunder* is often accompanied with
Hail (*Nitre* being a proper *Efficient* of both) there might be such *Concretions*,
in the *Nature* of *Hail*, as might (by such *Explosion*) be scattered like *Hail-
shot* out of a *Gun*, and cause such *Holes* as are said to have been in the *Clothes*
and *Flesh* of those *Persons*. And what is said to have been observed by
others at a *Distance*, like a *Ball* of *Fire* falling down directly upon the *Place*,
might, be a *Propagation* of the *Flame* kindled above, and continued, as the
Vapour directed it to the *Place* (as would be in a *Train* of *Gun-powder*) and
might there hurt some, and spare others, according as it was here or there
more copious. For we are not to presume that it was in all *Places* equally
mixed.

The *Cores*, which came out of the *Wounds*, seem like *Escars* made by a
Caustick

Cauftick or other Burnings. And I take them to be scorched Skin, mortified, (beat into the Flesh by that *Hail Shot*) and appearing like burnt Leaves: Which must be worked out before the Wound could be healed; as is usual, when other heterogeneous Matter is forced into the Flesh.

That some of the People, not far off, might be thrown down, and not otherwise considerably hurt, is not strange; who might be within the *Blast*, though not within the Reach of the Fire; as we see in the *Explosion of Gunpowder* (to which I take this to be very like) when Windows (and other Things at a Distance) are shaken and shatter'd by the *Blast*, or great Concussion of the Air, though the *Flame* do not reach them.

LXIV. 1. *Decemb. 25, 1666.* In the Evening here (*viz* at *Madrid*) was a great *Halo* about the *Moon*; the Semidiameter whereof was about $23^{\circ} 30'$. *Aldebaran* was just in the North-East Part of the Circle, and the two *Horns of Aries* just enclosed by the South-West of the Circle, the *Moon* being in the Center. I note this the rather, because 5 or 6 Years ago, *viz. Nov. 21, 1661.* an Hour after Sun-set, I saw a great *Halo* about the *Moon*, of the same Diameter, at *Tangier*, the *Moon* being very near the same Place where she was now.

Halo's, At Madrid; by E. of Sandwich, n. 22. p. 390.

2. *May 12, 1667.* An *Halo* or Circle about the *Sun*, was observ'd by the *Philosophical Society at Paris*. The Diameter of this Circle was found to be of 44 Degrees, and the Breadth of the Limb thereof, about half a Degree. The upper and lower Part were of a *vivid red* and *yellow*, with a little *purple* Colour, but especially the upper; the *red* was within the Circle. The other Parts appeared but *whitish*, and of little Clearness. The Space within the *Halo* was a little darker than that about it, especially towards the Parts that were *coloured*. Besides, there was seen the *Proportion* of another *great Circle*, which touched the *Halo* above, and whose Extremities were bent downward, as is represented in the *Figure*. This *Portion* of a Circle had also its Colours like those of the *Halo*, but fainter. The Height of the *Sun* at the Beginning of the Observation, was about 46 Deg. There were in the Air little white Clouds, which somewhat tarnish'd the blue Colour of the Heavens, and lessened the Brightness of the *Sun*, which shone as in an *Eclipse*. The Weather was cold, considering the Season of the Year; and it was affirmed for certain, that it had *frozen* the Night before. This *Halo* appear'd in the same Beauty and Splendor of Colours unchanged from 9 in the Morning (when it began to be observ'd) until about half an Hour past 10; after which time it became fainter and fainter till two of the Clock in the Afternoon (when it ended) after it had resumed a little more Force some time before it disappear'd.

At Paris by M----- n. 60. p. 1065.

Fig. 26.

3. *Jan. 1. St. N. 1676. H. 3. 46'.* Durante *Eclipsi*, ingens *Halo Lunam* cinxerit.

At Dantzick; by M. Hevelius, n. 122. p. 589. At Oxford; by M. Halley, n. 129. p. 724.

4 *Aug. 21, 1676.* At 12 h. $40'$. At Night a *Halo* encompassed the *Moon*; in whose Circumference was *Saturn*, the *Pleiades*, *Capella*, and the following of the *Foot of Perseus*.

Parbelia ob-
served in
France; by
M... ..
13. p. 219.

LXV. 1. *April 9, 1666.* About half an Hour past 9, there appeared three *Circles* in the *Sky*. One of them *SCHN*, was very great, a little interrupted, and *White* every where, without the Mixture of any other Colour. It passed through the *Midst* of the *Sun's* *Disk*, and was parallel to the *Horizon*. Its *Diameter* was above 100 *Degrees*, and its *Center* not far from the *Zenith* *A*.

Fig. 27.

The *second DEBO*, was much less and defective in some Places, having the *Colours* of a *Rainbow*, especially in that Part which was within the great *Circle*. It had the true *Sun R* for its *Center*.

The *third HDN*, was less than the *first*, but greater than the *second*; it was not entire, but only an *Arch* or *Portion* of a *Circle*, whose *Center* was far distant from that of the *Sun*, and whose *Circumference* did, by its *Middle*, join to that of the *least Circle*, with which it was confounded at *D*, and intersected the *greatest Circles*, by its two *Extreams*. In this *Circle* were discerned also the *Colours* of a *Rainbow*, but they were not so strong as those of the *second*.

At the Place, where the *Circumference* of this *third Circle* did close with that of the *second*, there was a great *Brightness* of *Rainbow Colours* mix'd together: And at the two *Extremities*, where this *second Circle* intersected the *first*, appeared two *Parbelia's* or *Mock-suns*, *H, N*; which shone very bright, but not so bright, or so well defined, as the *true Sun*. The *Midst* of these two *false Suns* was *white* and very luminous; and their *Extremities* towards *D I*, were tinged with the *Colours* of a *Rainbow*. The *false Sun H*, that was towards the *South*, was bigger, and far more luminous than that towards the *East*.

There was also upon the *first* great *Circle*, a *third Mock-Sun, C*, situated to the *North*, which was less, all *white*, and far less shining than the two others. There was a Space very dark betwixt *R* and *D*.

This Appearance is look'd upon as one of the notablest that can be seen, by Reason of the *Eccentricity* of the *Circle HDN*, and because that the *Parbelia* were not in the *Intersection* of the *Circle DEBO*, with the great *Circle SCHN*, as they appear'd at *Rome, March 29, 1629.* but in that of the *Semicircle HDN*.

Cartesii Me-
mor. c. 10.

In Hungary;
by Dr. Edw.
Brown, n.
47. p. 953.

2 A Learned *Jesuit*, call'd *Father Mikael*, who lives at *Preshurgh*, communicated to me an Account of two *Parbelia's*, which were seen *Jan. 30, 1669.* *St. N.* about one of the *Clock* in the *Afternoon*, over the *City of Cassovia* in *Hungary*.

There was one on each *Side* of the *true Sun*, and they were so resplendent, that the *naked Eye* could not bear the *Brightness* thereof. One of them (the *lesser* of the two) began to decay before the *other*, and then the *other* grew bigger, and continued well nigh two *Hours*, projecting very long *Rays* from it self, They were *both*, on that Part which was towards the *Sun*, tinged with a pale *Yellow*, the *other* Parts being somewhat fuscous. There were at the same time seen several *Rainbows*, together with the Segment of a great *white*

white Circle, of a long Duration, passing through the two *Parbelia's* and the *Sun*: And all this at a time, when the Air was almost free from Clouds, tho' here and there were scatter'd some very thin ones.

3. *An.* 1670. *Oct.* 11. *St. N. H.* 7. 40' *Tres Parbelii* apparuerunt.

4. *Feb.* 5, 1674. *St. N.* Not far from *Marienburg* in *Borussia*, I saw the *Sun* (in a Sky every where serene enough) being yet some *Degrees* above the *Horizon*, and shining very bright, yet launching out very long and reddish Rays, 40 or 50 *Degrees* toward the *Zenith*. Under the *Sun*, towards the *Horizon*, there hung a somewhat dilute small Cloud, beneath which there appear'd a *Mock-Sun*, of the same *Signels* (to *Sense*) with the *true Sun*, and under the same *Vertical*, of a somewhat *Red Colour*. Soon after, the *true Sun* more and more descending to the *Horizon* towards the said Cloud, the *spurious Sun* beneath it grew clearer and clearer; so that the *Reddish Colour* in that *apparent Solar Disk* vanish'd and put on the *genuine Solar Light*, and that the more, the less the *genuine Disk* of the *Sun* was distant from the *false Sun*; till at length, the upper *true Sun* pass'd into the lower counterfeit one, and so remain'd alone.

Upon this Appearance there soon followed here an exceedingly intense and bitter *Frost*, whereby the whole *Sinus Puzensis* was frozen up, from this Town of *Dantzick*, as far as *Hela* in the *Baltick Sea*, which lasted unto the 25th of *March*; and the *Bay* was frozen so hard, that with great Safety People ran out into it with *Sleds* and *Horses*, for several of our *Miles*.

5. *Aug.* 28, 1698. About 8 a *Clock* in the *Morning*, some Persons at *Sudbury* in *Suffolk*, saw the Appearance of *three Suns*; 'tis said, then the Appearance was most full, or a little after. About half an *Hour* after 8, I myself saw it; there was in the *East*, a dark, dusky, watry Cloud, and below it towards the *Middle*, was the *true Sun*, shining with fierce and piercing Beams, that Persons could not look upon it; on each *Side* were the *Reflections* with the *true Sun* in the *Middle*. Elsewhere much of the *Firmament* was of an *azure*, light-blue *Colour*. The *Circles* which I saw, were not of *Rainbow Colours*, but *white*. There was also, higher in the *Firmament*, more over our *Heads*, and toward the *South*, at the same time, at a considerable *Distance* from the other, the *Form* of a *Half Moon*; but I think it was more than twice the *Signels* of a *Half Moon*, with the *Horns* turned upward, and within of a fiery *Red Colour*, and more like a *Rainbow Colour*; these all faded gradually; they continued, in all, I suppose, two *Hours*.

6. *Feb.* 26, 1698. About half an *Hour* after 3 in the *Afternoon*, chancing to look out of a *Window* that faced *South-East*, I saw not far from the *South* to the *West-ward*, an Appearance of somewhat not much unlike the *Sun* when seen through *Clouds*, viz. with its *Periphery* not exactly defined: From which it likewise differed, in that one half of it was coloured deep *Red* and *Yellow*, the other *White*. I went immediately into the *Garden* and saw an Appearance exactly like the former, but on the opposite *Side* of the *Sun*. The *Distance* of this was 23° from the *Sun* to the *Westward*; but before I could take the *Distance* of the *Eastern* one, it vanished,

Ar Dantzick; by M. Hevelius, n. 66. p. 2026. Ar Marienburg in Borussia; by M. Hevelius, n. 102. p. 26. Fig. 28.

Fig. 29.

Fig. 30.

In Suffolk; by M. Petrus, n. 250. p. 107.

At Sudbury; by Mr. St. Gray, n. 251. p. 326.

but soon after re-appear'd, and then I perceived manifestly, that they were both situate in the Extremities of a *Semicircle* (whose Center was the *Sun*, passing betwixt it and the *Zenith*. This Appearance continued about half an Hour.

At Canterbury, by M. St. Gray, n. 262, p. 535. Fig. 31.

7. Apr. 7th, 1699. Between 4 and 5 a Clock, there appeared on each Side the *Sun* *A*. a *Parabellion*, *BC*, connected by an *Halo* *BD C*, of the usual Diameter; they had each of them a *Tail* of a whitish Colour, extended opposite to the *Sun*, of about 15 or 20 Degrees in Length; the upper Part of the *Halo* was touched at *D*, by the Arch of a Circle, whose Ends were turned towards the *Zenith* *Z*; it had the Colours of the *Iris*, but faintly; betwixt this and the *Zenith* was another Portion of a Circle *E*, which had the Colours of the *Iris* with greater Vivacity than the former.

Rainbows observed in France; by M. Estienne, n. 13, p. 221. Fig. 32.

LXVI. 1. An. 1665. Aug. 10. About half an Hour past 6 in the Evening, two odd Rainbows appeared at *Chartres* in France, crossing one another almost at right Angles. The *Rainbow*, which was opposite to the *Sun*, in the usual Manner, was more deeply colour'd than that which cross'd it: and its greatest Height was about 45 Degrees. The feebler *Rainbow* lost one of its Legs, by growing fainter, about 20 Degrees above the stronger; and the Leg below appeared continued to the *Horizon*. This seem'd to be a Portion of a great Circle; and the stronger was but a Portion of a small Circle, as usually.

The *Sun*, at their Appearance, was about 6 Degrees high above the *Horizon*. The River of *Chartres*, which runs very near from South to North, was betwixt M. *Estienne* (the Observer) and the *Rainbow*, and he stood level with the River, whence he was distant not above 150 Paces.

At London; by Mr. Edm. Halley, n. 240, p. 195.

2. Mar. 11th, 1696. It rained pretty thick a small Rain, and the *Sun*, about 2 of the Clock, shone directly down *Abchurch-Lane*, as I was passing along it with my Back to him, when I perceived the Arch of the primary *Rainbow* in the Drops of Rain, spanning the Street like an Arch of a Building, under which I was to pass, the Crown whereof was not much higher than my Head, and the Diameter thereof scarce so wide as the Street, which is but 5 Yards; and it moved along with me as fast as I went; the Colours being very vivid and distinct, though the Arch it self appear'd but narrow, and the Houses were every where behind it. This, tho' very uncommon, will not appear strange to those who have well consider'd the Nature of the *Iris*.

At Chester; by Mr. Edm. Halley, n. 240, p. 193.

3 Aug. 6th, 1698. Between 6 and 7 a Clock in the Evening, I observed an *Iris*, exceedingly vivid, as to its Colours, at first on the South-side only, but in a little Time with one entire Arch; and soon after, the Beams of the *Sun* being very strong, there appear'd a secondary *Iris*, whose Colours were more than ordinary bright, but inverted, as usually; that is, the *Red* was inwards, which in the primary *Iris* is outward, and *è contra* for the *Blues*. But what I took most notice of was, that with these two concentrick Arches, there appear'd a third Arch, near upon as bright as the secondary *Iris*, but coloured in the Order of the Primary, which took its Rise from the Interfection of the *Horizon* and primary *Iris*, and went cross the Space between the two, and inter-

interfected the *Secondary*, as in the *Figure AFCG* intersects the *secondary Iris* *Fig. 33.*
EFGD, dividing the Arch *ED* into three equal Parts, as near as I could
 then guess: But at first the Arch *AF* did not appear, which afterwards be-
 came as bright as the former. I observed the Points *F*, and *G*, to arise, and
 the Arch *FG*, gradually to contract, till at length the two Arches *FHG*,
 and *FG*, became coincident; when, for a great Space, the *secondary Iris* lost
 its *Colours*, and appear'd like a white Arch at the Top. I observed also, that
 at the Points *F*, and *G*, the Intersection of the interior *Red* of the *secondary*
Iris, and the exterior *Red* of the Arch was much more intensely red than the
 outward Limb of the *primary Iris*; and that during the whole Appearance,
 the upper Part of the *third Iris* was not at all visible, beyond the Inter-
 sections *FG*. This uncommon Sight entertained me for about 20 *Min.* when
 the Clouds blowing away, the whole vanished. I was at first amazed with
 the Sight, but afterwards, recollecting that the Sun shone along the River
Dee, which, from thence empties it self into the *W.N.W.* where the Sun
 then was, I concluded this secondary Arch *AFHGC*, was produced by the
 Beams of the Sun reflected from that Water, which at that time was very
 calm; and it had been much more bright, had it been at that time about
 high, as it was low Water, when all the Sands were bare. I was soon con-
 firmed that my Supposition was right, and that it answered all the Appearance
 without any Scruple, and that the Arch *AFHGC*, was no other than that
 Part of the Circle of the *Iris*, that would have been under the Earth, bent up-
 wards by Reflection.

I remember not to have read of any such *Iris* in any Author. *Des Cartes*
 indeed speaks of an inverted *Iris* by *Reflection*; but it is not possible to be
 seen as he describes it: And I query whether ever any such has been really
 observed.

LXVII. The Observation of the *Halo*, which appeared at *Paris*, *May 12*, The Cause of
Halo's and
Parhelia,
consider'd, by
M. Hugen.
n. 60. p.
1066.
Vide supra,
q. LXIV.
 1667. engaged *M. Hugen* to propose to the Academy there, what he had me-
 ditated some Years before, not only of these *Halo's*, but also of the *Parhe-
 lia*. As for *Halo's*, he said, that they were formed by small and round *Grains*
 made up of two Parts, one transparent, the other opaque; the latter being
 inclosed in the former, as a Cherry-stone is in a Cherry. Thus *AA*, represents
 one of these *Grains*, and *B* the *Kernel* or opaque Part.

He related the Observations of those who have seen *Hail* formed after this *Fig. 34.*
 Manner, and explain'd how that some of these little *Grains*, which swim up
 and down in the Air betwixt us and the Sun, being less distant from the *Axis*,
 which extends it self from the Sun to our Eye, than of a certain Angle, do ne-
 cessarily hinder the Rays, which fall on them, from coming to our Eyes, in
 Regard that the opaque *Kernel* is the Cause that there is behind every such
Grain a Space of a *Conical Figure*, as *MNO*, in which the Eye of the Specta-
 tor being situated, cannot see the Sun through that *Grain*, tho' it may see him
 when posited elsewhere, as somewhat in *P*.

And to make the Company the more distinctly to understand the Effect
 which these *Grains* suspended in the Air must produce, he drew the *35 Fig.* in *Fig. 35.*
 which *B* is the Place of the Eye; *BA*, the *Axis* which passeth from the Eye
 to

to the Sun : *C, M, F*, some of the *Icy Grains* with their Kernel, making them half opaque : Among which the *Grain C*, being in the Axis *B A*, and the Lines *C K, L H*, representing the Rays of the Sun nearest to the Axis, the Passage of which is not hindred by the Opacity of the *Kernel*, it is certain, not only the *Grain C*, will not be able to transmit any Ray of the Sun towards *B*, but also that, imagining the Superficies of a Cone, whose Top is in the Eye, and its Sides *B D, B E*, parallel to the Rays *C K, L H*; all the *Grains M M*, which this Superficies shall comprize, will likewise not suffer any Ray to pass to the Eye, because it must needs be in their Cone of Obscurity; but those that shall be without this Superficies, as the *Grains F F*, will let them pass, because the Eye is without their Cone of Obscurity. Whence it follows, that the Angle of this Cone *B D E*, is that which determines the Diameter of the *Halo*, which depends from the Proportion the opaque *Grain* hath to the transparent, in which it is inclosed. For if this Diameter is of 44 Degrees, as is observed in most *Halo's*, the Bigness of the opaque *Grain* will be to the transparent, as 40 to 19. But he said, that this Proportion was not always the same, and that the Diversity of it was the Cause, that sometimes there were seen many *Halo's*, one about the other, all having the Sun for their Center.

He added, That it was easy to know, why these *Halo's* were always of a round Figure, whether the Sun be little or much raised above the Horizon; as also to give a Reason of their Colours, which is the same with that in the triangular Glass *Prisms*; as is evident by the *Tangents A, C*, drawn to the *Grain A*, at the Points, where the Ray *D A* enters or comes out.

Farther, he took notice, That it was also manifest why the Red Colour is in the interior Circumference of the *Halo*, and why the Space, which it taketh in, and chiefly near the most lively colour'd Parts, appears obscurer than the Air about; viz. because it is there, where most Grains are, which transmit no Rays of the Sun to our Eyes, and so do nothing but darken the Air, as the Drops of Water when it raineth.

Fig. 16.

As to the *Arch* of the *Circle*, which above touched the *Halo*, seen May 12, 1667. as also that the Colours were more vivid in this Place, and in that below, that in the rest of the *Circle*; he said, that these Effects did not proceed from the Grains he had been speaking of, but from another Cause, which did also serve for the Production of the *Parbelia*, and the *Circles* which almost always accompany them. Touching which *Circles* and *Parbelia's*, he told the Company, that besides the round and half dark Grains, there were also formed in the Air certain little *Cylinders* of the like Nature: Which being suppos'd to be oblong *Icy Grains*, and roundish at both Ends, having the inner Kernel of the same Shape, it was found, that from their different Dispositions all the Appearances of the *Parbelia* and their *Circles* did necessarily follow.

And first, That some of these *Cylinders* being erect, in the Situation which probably he ought to have in being formed there, must appear in the Heavens a great white *Circle*, parallel to the Horizon, passing thro' the Sun, and of near the same Breadth with him; as hath been observed in the *Phenomenon*

non of Rome, An. 1629. of which Gassendus and Des Cartes have written, and which is here exhibited.

That this Circle *LKNM*, is caused by the Reflection of the Rays of the Sun Fig. 37. upon the Surface of these *Cylinders*, it being easy to demonstrate, that there are none but those which are raised at the same Angle above the *Horizon* with that of the Height of the Sun, that can reflect his Rays to our Eyes: Whence it manifestly follows, that it must appear white, and throughout of equal Altitude with the Sun it self, and by Consequence parallel to the *Horizon*. That considering afterwards the Transparency of these perpendicular *Cylinders*, and their opaque *Kernels*, it is easily seen, that those of the white Circle, which are distant from the Sun at a certain Angle, begin to give Passage to his Rays to strike our Eyes in the same Manner as hath been said of the round half dark Grains. That these *Cylinders* are those, which on each Side of the Sun make us see a *Parbelion* in the great white Circle, as hath been noted in the Observation of Rome where they are mark'd with *K* and *N*, and in many others. That these *Parbelia* have commonly luminous Tails, because the *Cylinders*, which follow those first ones that form the *Parbelia*, and which are yet farther distant from the Sun, let also pass his Rays to our Eye; so that these Tails may be 20 Degrees and more in Length. That the same *Parbelia* are always colour'd, because they are made by Refraction as the Halo.

That besides, there are two other Images of the Sun generated by these perpendicular *Cylinders*, and so disposed in the great white Circle, that the Spectator turning his Face towards the true Sun, hath them behind him; as in the Roman Observation are the *Parbelia L* and *M*. That these are produced by two Refractions and one Reflection in these *Cylinders*, in the same Manner as the ordinary Rainbow in the Drops of Water, according as M. Des Cartes hath declared: So that the opaque *Kernels* do nothing to the Production of these two Suns, but that they may be sometimes so big as to make them not appear. That according to the Altitude of the Sun, more or less, these two *Parbelia* are more or less nigh to one another. That they should appear colour'd as the Rainbow, and that sometimes they have been seen such; but that when they are faint, they may also seem white, even as the Halo's when they are not very bright.

That these same perpendicular *Cylinders* can also produce an Halo about the Sun, by reason of the rounding of their two Ends; which maketh, that being distant from the Sun at a certain Angle, on what Side soever it be, they begin from thence to give Passage to the Rays, transmitting them to the Eyes of the Spectator.

And that these Halo's are probably those, we see almost always pass thro' the two *Parbelia* that are on the Sides of the true Sun, as the Halo *GKNI*, in the Phenomenon of Rome.

That there is yet another Situation of these *Cylinders* very considerable, which is of those that are couchant, so as their Axis are Parallel to the Plane of the *Horizon*, but turned divers Ways, some one, some another Way, like Needles confusedly thrown on the Ground: Which Horizontal Disposition is very natural to those *Cylindrick* Bodies supported by the Vapours, which rise from

from the Earth, as may be made out experimentally in Bodies thus figur'd, being let fall in the Air.

That it is in these *Cylinders* that the *Arches* which touch the *Halo's* above or below, are formed; such as there were in the *Phænomenon* observ'd at *Rome A. 1630.* which is described by *P. Shenir*, in a Letter to *M. Gassendus*; as also in all those which *M. Hevelius* had related at the End of his *Mercurius in Sole.*

And that the *Arch*, which appeared upon the last *Halo* at *Paris, A. 1667.* was of the same Kind. That the Figure of these *Arches* is different according to the different Altitudes of the *Sun*, and the several Magnitudes of the Diameters of the *Halo's.*

That when the *Sun* is very nigh the *Horizon*, such an *Arch* appearing upon an ordinary *Halo* of 44 Degrees, must represent, as 'twere, two *Horns*, as in *Fig. 38. AB, AC.* But that the *Sun* rising higher, those *Horns* become lower in proportion, and make such *Arches* as are represented in the same *Fig.* where each Height of the *Sun* is mark'd near the *Arch* which it is to make.

That the Place of the *Arches* where they touch the *Halo's* being more strongly enlightned and colour'd than the rest, maketh us judge that there are *Parbelia* in those Places. That the Reason why these *Arches* do ordinarily touch a *Parbelion*, was, that the same *Cylinders couchant*, which produce the *Arch*, produce also that *Parbelion*, by the Means of their two round and transparent Ends, in the same Manner as hath been said of the *perpendicular Cylinders.* And that the *Parbelion* last seen at *Paris*, had been form'd in these *couchant Cylinders.* That that was also confirmed, by Reason that it was brighter in the superior and inferior Part than any where else; which necessarily comes to pass in a *Parbelion* caused by *Cylinders* thus disposed; whereas when produced by the round *Grains*, it must appear every where equally strong.

That in these same *Cylinders parallel* to the *Horizon*, there is also found the Cause of the *white Cross*, observ'd together with the *Paraselenes* or *Mock-moons*, by *M. Hevelius*, and exhibited at the End of his *Mercurius in Sole*; the perpendicular Fillet of that *Cross* coming from the Reflection of the Rays of the Moon upon the Surface of these *Cylinders*; as the other Fillet, parallel to the *Horizon*, is produced by the Reflection of the perpendicular *Cylinders*, which make the great white Circle, of which this Fillet is a Part. That yet the Moon must not be very high above the *Horizon*, to the end that the couching *Cylinders* may produce this Effect: And that it should be well heeded, when the like *Meteors* shall appear, whether the perpendicular Fillet be not narrower where it passeth through the Moon, than in other Places, and especially upwards, where it must grow larger, and disappear. That besides the perpendicular *Cylinders*, and those that are couched parallel to the *Horizon*, there are often a great many, which move to and fro in the Air, in all sorts of Positions; and that those, by the same Reason that the round *Grains* do, must produce an *Halo* about the *Sun*, and even a more vivid one than that which is caused by the *Grains*, forasmuch as each *Cylinder* sends many more Rays to the Eye, than each of these little Spheres. That the little *Halo* *DEF*, in the *Roman Phænomenon* (*Fig. 37.*) may very well have been caused by such *Cylinders.*

As to those *Mock-suns*, which sometimes shew themselves directly opposite to the true Sun (such an one as was published by M. *Hevelius*, and observ'd Feb. 23, 1661.) that he could find nothing, neither in the round Grains nor in the Cylinders, which should make these *Suns* necessarily to meet in the great white Circle, parallel to the Horizon; and that if that should be always verified by future Observations, the Cause of it must be look'd for elsewhere: But that in the mean time he did believe, that that happened not but by Chance; which being so, a Reason might be given of these *Suns*, by the same Supposition, which served also for the *Antihelion*, observed by M. *Hevelius*, Sep. 6, 1661. in which there were two colour'd Arches of a Circle, opposite to the Sun, which did intersect one another, their Intersection being the Place of the false Sun. Which although it be represented in the Figure of *Hevelius*, at the same Height with the true Sun, yet it was in Truth higher by 15 Degrees or more; as he hath acknowledged himself afterwards: So that, if there had been a great white Circle in this *Phenomenon*, the *Parhelion* was not at all to have been in it.

That for the Generation of these *Suns*, he did suppose a Number of small Cylinders with opaque Kernels, as the precedent, which were carried in the Air, neither perpendicularly nor couching, but inclined to the Plane of the Horizon at a certain Angle, being near a half right one; to which were particularly appropriated those Cylinders, which M. *Des Cartes* saw fall from the Heavens, having Stars at both Ends; as may be seen experimentally by forming Cylinders of that Fashion, which is represented in Fig. 39. and letting them descend in the Air; or in Water. That in these Cylinders was found, the following *Calculus* to be given in another Treatise of *Parhelia's*, not only the Cause of the *Antihelia* made by the Intersection of two Arches as in Fig. 40. but also that of some other extraordinary Arches and Rods, that are sometimes observed near the Sun, of which notwithstanding there could nothing be as yet affirmed with Certainty, for want of exact and faithful Observations.

To make all these different Effects of the Cylinders manifest to the Eye, M. *Hugens* produced one of Glass, a Foot long, of the Shape of that in Fig. 36. and for the Kernel opaque in the middle of a Cylinder of Wood, and in the ambient Space filled with Water instead of transparent Ice: Which Cylinder being expos'd to the Sun, and the Eye put in such Places as was requisite, there were successively seen all those Reflections and Refractions, that have been discours'd of. Whence it might be concluded, that a great Number of the like Cylinders, altho' very small in Comparison to that, being found in the Air, and having the several Postures that have been supposed, all the Appearances of the *Parhelia* and their Circles must exactly follow.

It was wish'd, for an entire Confirmation of the Truth of this *Hypothesis*, that some of those small Cylinders could be observed to fall to the Ground, at the time when any *Parhelia* do appear: Which yet he shew'd could not easily be done, because that the Vapours, which then rise from the Earth upwards, and which are the Cause of their Cylindrical Figure, keep them also suspended in the Air. He added, that it was not to be thought strange,

that such small Grains of Hail were thus kept in the Air by the Vapours, for as much as these, by being rarified and dilated upwards, might have Motion enough for this Effect; and that that was much more easy to conceive, than to imagine how these same Vapours could keep suspended a very great and weighty Circle of Ice, such as Mr. *Des Cartes* supposeth to explicate the Cause of *Parhelia's*, and of the great white Circle of the *Roman Phænon*.

Optical Af-
fections con-
cerning the
Rainbow,
by Mr. Fr.
Linus, n.
117. p. 386.

LXVIII. 1. Every the least Drop of Rain, when illuminated by the Beams of the Sun, sends from it a perfect *Iris*, not only as to the Colours, but also exactly like that which we see in the Heavens, as to their Order, Situation, and Circular Figure.

2. For the Sun-beams entering the Drop, and returning towards the Sun again after two Refractions and one Reflection, are coloured at their breaking out of the Drop, and with the same Colours that we see in the Rainbow; that is, become Red, Yellow, Green, Blue, and Purple.

3. These Rays thus coloured, being transmitted to the Eye from a multitude of Drops illuminated by the Sun in a rainy Sky, cause that Sensation which we have of the Rainbow.

4. Now in every Drop there are two Rings, a greater and a lesser, endued with distinct Colours of the *Iris*; the lesser of which is distant from the Axis, or from the Radius passing through the Center of the Drop, about 21 Degrees; but the greater is distant from the same Axis 78 Degrees. Now the Rays that are incident upon the lesser Ring are reflected from thence upon the greater; from whence breaking forth into the Air, they are imbued with the said Colours of the *Iris*.

5. Therefore these Colours arise from the Sun-beams; but not from them alone, as has been hitherto thought, but also from the Rays of the Air itself, which surrounds the Body of the Sun.

6. But neither do these Colours arise from all the Rays, whether of the Sun or of the Air, which enter into the Drop, but only from those which are emitted by the Limb of the Sun itself, and from the Air that is near it.

7. Also of those Rays which are thus transmitted into the Drop from the Limb of the Sun and the neighbouring Air, not all belong to the said Colours, or break out colour'd; but those only of which the Angle of Incidence is not less than 45 Degrees, nor greater than 75 Degrees.

8. Therefore the Colours of the *Iris* proceed from the Solar Limb and the neighbouring Air, yet all the five do not immediately flow from thence, but four only; that is, the Red, Yellow, Blue, and Purple. For the Green arises from the Yellow and Blue Rays mix'd together.

9. Therefore these four Colours arise from the aforesaid Limb, yet not all from one and the same Part of that Limb; but two of them from one Part of the Limb, and the other two from that Part which is directly opposite to it. That is, the Blue and Purple proceed from the upper Limb, and the Red and Yellow from the lower Limb.

10. Now as to the reason why such different Colours arise from Limbs that are so similar to each other, there appears to be no other but this; that

in

in one case the Limb of Air is above the Solar Limb, and in the other the Solar Limb is above that of Air. And this Difference seems to be sufficient here, because in respect of that different Situation, sometimes the Solar Rays are bent by Refraction above the Airy Rays, and sometimes on the contrary.

11. Therefore these Colours arise by the said refracted Rays, yet so refracted that they are very much condensed by that Refraction. For all the Rays from 45 to 60 Degrees are contracted into the Space of one Degree in the lesser Ring. Into which narrow Space also are contracted, by Retrogradation, all the Rays from 60 to 75 Degrees.

12. When several Men see a Rainbow at the same time, there are so many Rainbows seen as there are Men to see them.

13. He that looks upon a Rainbow, every Moment sees a different Rainbow.

LXIX. To those that have carefully considered the Phenomena of the Rainbow, it has always been manifest, that the Rays of the Sun, reflected by a watry Cloud, have entered the Eye at some certain Angle; whence proceeds its Form of a Bow. But the reason of its Colours, as also of the Magnitude of that Angle, by which we find the Rainbow constantly to be distant from the Point opposite to the Sun, has given much trouble both to the Ancients and Moderns. Nor did they do any thing to the purpose, till the famous *Des Cartes*, calling to his Assistance the Mathematical Sciences, informed us by many Examples, that these Physical Speculations might and ought to be treated in a stricter Method of Argumentation. And among other things he has given us the Theory of the Rainbow. From his Demonstrations it is plain, that the primary Iris is produced by such Rays of the Sun, in which the Excess of the two refracted Angles above the one Angle of Incidence, is the greatest of all possible Angles. That the secondary Iris is formed by those Rays only, in which the Excess of the three refracted Angles above the one Angle of Incidence, in like manner is the greatest possible. And so we might go on to the third, fourth, or any other Iris, which are made when the Rays emerge out of the Drops, after three, or four, or more Reflexions. Now in all these there is a general Rule, that the Excess of four or five or more refracted Angles, (that is, the Number of Reflexions must be increased by an Unit,) above one Angle of Incidence, must be the greatest of all. Now that greatest Excess being doubled is always the Distance of the Iris from the Point opposite to the Sun, when the Number of Reflexions is odd. But if that Number be even, the double of that greatest Angle is the Distance of the Iris from the Sun itself.

Now that those greatest Excesses may be had, the Refraction of any Liquid being given, or the Ratio of the Sine of Incidence to the Sine of the refracted Angle; we must take Notice that the Excess of two refracted Angles above one Angle of Incidence is then greatest, when the momentary Augment of the Angle of Incidence is exactly double to the momentary Augment of the refracted Angle. But of three refracted Angles the Excess is then greatest, when the momentary Augment of the Angle of Incidence is triple to the Moment of the refracted Angle: And so of the rest. And this is manifest of itself. Now

*The Colours
and Diameter
of the
Rainbow,
from the gi-
ven Propor-
tion of Re-
fraction, and
the contrary.
by Mr. Edm.
Halley, n.
267. p. 714.*

we shall obtain the Angles themselves by premising the following Lemma, which we must demonstrate.

Lemma. The Legs of any plain Triangle continuing the same, if the Vertical Angle be encreased or diminished by any Angle less than any given one, the Moments or instantaneous Mutations of the Angles at the Base, will be to one another reciprocally at the Segments of the Base.

Fig. 41.

Let ABC be a Triangle, whose Vertex is A , the Legs AB and AC ; and the Base BC ; upon which let fall the Perpendicular AD . Then let the Angle BAC be encreased by any indivisible Moment CAc , and draw the Lines Bcd and cD , which will differ from the Lines BCD and CD only intellectually. I say the Moment of the Angle ABC , that is CBc , is to the Moment of the Angle ACB or ACD , as CD to BD , that is reciprocally as the Segments of the Base. For as the Angle ACD is the Sum of the Angles ABC and BAC , its Moment will also be the Sum of the Moments of those Angles, or $CAc + CBc$. But CAc is equal to the Angle CDc ; for because of the right Angle at D , the Points A, D, C, c , are at the Circumference of a Circle whose Diameter is AC , by Eucl. 3. 9. And therefore the Sum of the Angles CBc and CDc , that is the Angle Dcd , will be the Moment of the Angle ACD , or ACB . But the Angles CBc and Dcd , being indefinitely little, are to one another as their opposite Sides, or as cD or CD to BD , that is, reciprocally as the Segments of the Base. Q. E. D. Now if either of the Angles B or C is acute, changing what is to be changed, the Lemma will be demonstrated as above.

Corol. Hence it follows, that the Moments of the Angles at the Base are to one another directly as the Tangents of those Angles.

Fig. 42.

By the Help of this Lemma we may easily obtain the Diameter of any Rainbow, either by a Geometrical Construction or by Calculation. For assuming any right Line CA , first let it be divided in D , so that CA may be to CD in the Ratio of Refraction, which in Water is as 250 to 187, or more accurately as 529 to 396. Then let CA be divided in E , so that CE may be to AE , as Unity is to the Number of Reflexions which a Ray of the Sun suffers, proper to produce the proposed Rainbow. Then with the Diameter AE let the Semicircle ABE be described, and with Center C and Radius CD draw the Arch BD , meeting the Semicircle ABE in the Point B . Lastly, drawing the right Lines CB and AB , upon AB produced let fall the Perpendicular CF , and EB Parallel to it. I say the Angle CBF will be the Angle of Incidence, and CAB the refracted Angle, as were required; and these will produce the proposed Rainbow.

Fig. 42.

Demonstration. Since the Triangles ACF and AEB are similar, it will be AF to BF , so is AC to EC , that is, as the Number of Reflexions encreased by Unity is to Unity, by the Construction. Therefore the Moment of the Angle CBF will be to the Moment of the Angle CAF in the same Proportion; by the foregoing Lemma. But the Sine of the Angle CBF is to the Sine of the Angle CAF in the Ratio of the Sides CA and CB , that is, the Ratio of the given Refraction, also by Construction. Therefore the Angle of Incidence CBF has its corresponding refracted Angle CAF , and their Moments are in the Ratio proposed; therefore they are the Angles required. Q. E. D.

And now

now multiplying the refracted Angle by the Number of Reflexions encreased by Unity, and from the Product subtracting the Angle of Incidence, we shall have half the Distance of the Rainbow from the Sun, if the Number of the Reflexions is even, or from the Point opposite to the Sun if odd, as said before.

Hence by a Construction that is neat enough and not inelegant, we may exhibit by Way of Synopsis the Incidences of all Rainbows in order, in any Liquid, the Refraction of which is known. For if the assumed Line AC is divided in two equal Parts at E , in three at e , in four at e , in five at n , and so on; and with the Diameters AE , Ae , Ae , An , &c. are described the Semicircles ABE , Abc , $A\beta e$, $A\nu n$, all which are met by the Circular Arch $DBb\beta v$; described with Center C and Radius CD , (which Radius is to AC in the given Ratio of Refraction,) in the Points B , b , β , v ; I say that drawing the Lines AB , Ab , $A\beta$, $A\nu$, they will constitute with the Line AC the Angles CAB , CAb , $CA\beta$, $CA\nu$, equal to the refracted Angles; and with the Rays CB , Cb , $C\beta$, $C\nu$, respectively, Angles equal to the Angles of Incidence required. That is, ABC , or rather its Compliment to a Semicircle for the primary Rainbow, AbC for the secondary, $A\beta B$ for the third, and $A\nu C$ for the fourth; and so on.

Now if any one is desirous to investigate these Angles by an exact Calculation, from the same Source an Analyst will easily discover, that making Radius = 1, and the Ratio of Refraction as r to s , the Sine of Incidence will be $\sqrt{\frac{4-1rr}{3-3rr}}$; but the Sine of the refracted Angle will be $\sqrt{\frac{4rr-1}{3rr-3}}$, from which Angles the primary Rainbow proceeds. But for the secondary $\sqrt{\frac{9-1rr}{8-8rr}}$ will be the Sine of Incidence, and $\sqrt{\frac{9rr-1}{8rr-8}}$ the Sine of the refracted Angle. For the third, the Sine of Incidence will be $\sqrt{\frac{16-1rr}{15-15rr}}$, and the Sine of the refracted Angle will be $\sqrt{\frac{16rr-1}{15rr-15}}$. For the fourth the Sine of Incidence will be $\sqrt{\frac{25-1rr}{24-24rr}}$, and the Sine of the refracted Angle $\sqrt{\frac{25rr-1}{24rr-24}}$. And so of the rest. Admitting the Ratio of *Des Cartes* you will find by Calculation, that the primary Rainbow is distant from the Point opposite to the Sun $41^{\circ} 30'$. The secondary $55^{\circ} 55'$. The third $40^{\circ} 20'$. and the fourth $45^{\circ} 33'$. from the Sun itself. These last I know not whether any one will be able to see, because of the Light of the Sun growing more and more feeble in every Reflexion and Refraction. And this may suffice concerning the Magnitude of the Rainbow in the transparent Drops of a Fluid, whose refractive Power is known. We must now add something concerning the Colours with which the Rainbows are painted, and their Order in each; being varied by the Refraction through all possible Degrees.

First it must be known, that all Light of the blue kind is refracted something more than any red Light; from which Difference arises the Breadth of the Rainbows, which is hardly to be determined by Observation, because of the uncertain Limits of the Colours in the Cloud. But the greater is the Ratio of Inequality between CA and CD , or the greater the Refraction is, so much the

greater

greater is the Distance of any Rainbow from the Sun, and therefore the Limits of Rainbows that are more remote from the Sun always shine with purple Colour, and the nearer are intensely ruddy. This may always be seen in the primary Iris, which vanishes opposite to the Sun, if the Sine of Incidence is to the Sine of the Angle of Refraction, as CA to CE , or as 2 to 1. If that Ratio be greater, no primary Rainbow can be seen at all.

But it is to be observed, that the secondary Iris goes off in a Point opposite to the Sun, whenever the Ratio of Refraction is, as 1 to 0,847487... Thence it returns to the Sun itself, and there vanishes, if the said Ratio is, as 3 to 1, or as CA to Ce . But in intermediate Ratios, such as obtain in all known Fluids except Air, the greater the Ratio is, so much the more the Iris is distant from the opposite Place of the Sun, or rather from the Sun itself, reckoning the Arch beyond the Semicircle. And therefore the Colours will be found in an inverted Order from the Primary, in these returns, unless the Distance of the Iris from the Sun is taken in this Sense. And this is to be observed every where in the rest.

The third Rainbow is lost in Opposition to the Sun, when the Ratio of Refraction is, as 1 to 0,91855... And thence recurs to the Sun in the Ratio of 1 to 0,6825... Whence again, the Order of the Colours being restored, in the Ratio of 4 to 1, or of CA to Cz , it ceases opposite to the Sun. But the fourth Iris beginning from the Sun in the Ratio of Equality, passes over in Opposition to it in the Ratio of 1 to 0,94895... and thence returns to the Sun, if the Ratio be as 5 to 4. Hence again it is spread to the Sun's Opposition, in the Ratio of 1 to 0,56337... And in this Space are included the known Refractions of all Fluids. Lastly, the Ratio being as 5 to 1, or as CA to Cn , it vanishes in the Sun itself: The Colours being every where inverted 'as to Sight in the return to the Sun, but direct in the Egress from it. Hence in watry Clouds, the primary and fourth Iris object their scarlet Colours to the Sun, but the secondary and third their Purple.

But whence the different refractive Virtue of Fluids arises, is a Problem of no small Difficulty, and may very justly be reckoned among the Secrets of Nature, not yet discovered by our Senses or our Argumentation. For among Fluids pure Water is found to refract the Rays of Light least of all. But imbued by any Salts dissolved in it, the Refraction is increased according to the Quantity of the Salts and its own Weight. And corrosive Spirits, which are much heavier than Water, turn aside the Rays of Light much more. Nor is it a wonder since they are denser Bodies, and therefore may be conceived the more to obstruct the Passage of Light. But it does not appear by a like Argument, why so great a Refraction is found in any ardent Spirits or Oils, especially in Spirit of Turpentine or Wine, since they are very light Fluids in respect of Water, and consist much of ethereal Particles. This seems to require a very intimate Knowledge of the Nature of Light, as also of Matter.

Now from the given Distance of the Iris from the Sun, to deduce the Ratio of Refraction, supplies the Curious with an Occasion of observing very accurately, and with little Trouble, the Refraction of any Fluid whatever. For if a Drop of any transparent Fluid hangs at the lower Part of a small Glass Tube, and the

the Sun being near the Horizon, but shining clearly, it be observed under what Angle with the opposite Place to the Sun the Colours of the Iris are seen in the Drop; the Ratio required may be had by a little Calculation. The Equation arising is Cubick, explicable but by one Root, by which the Ratio is computed from having the primary Iris given. The Equation is $T^3 - 3Tt + 4rrt = 0$, where T is the Tangent of the Angle of Incidence required, and t the Tangent of half the Distance of the Iris from the Point opposite to the Sun, to Radius $r = 1$. Whence according to *Cardan's* Rules arises this Theorem. From the Cube of t subtract the Product of $2tr$ into the Excess of the Secant of the same Arch above the Radius; the Difference will be a lesser Cube. And the Sum of the same, adding $4trr$, will be a greater Cube. The Sum of the Sides of each Cube, and of t , will be equal to the Tangent of the Angle of Incidence, half of which will be also the Tangent of the Angle of Refraction; whence arises the Ratio required.

Of this take the following Example. In a Drop of Oil of Turpentine the Distance of the primary Iris from the Point opposite to the Sun is observed to be $25^\circ. 40'$. The Ratio of Refraction is required.

$$t = \text{Tang. } 12^\circ. 50' = 0,2278063$$

$$s = \text{Secant of the same} = 1,0256197$$

$$t^3 = 0,01182217$$

$$s - r \text{ in } 2tr = 0,01167265$$

$$\text{Difference, or lesser Cube} = 0,00014952. \sqrt[3]{0,0530773}$$

$$\text{Sum } 0,02349482$$

$$4trr \text{ } 0,91122525$$

$$\text{Greater Cube } 0,93472007. \sqrt[3]{0,9777486}$$

$$t = 0,2278063$$

$$T = \text{Tang. Incid. } 51^\circ. 32' \text{ } 1,2586322$$

$$\frac{1}{2} T = \text{Tang. Refract. } 25^\circ. 11' \text{ } 0,6293161$$

Finally, as $\sqrt{TT + 4}$, is to $\sqrt{TT + 1}$, so is r to s , so is 1 to 0,68026. And this Ratio approaches nearly to that, which we find by Experiment obtains in Glass, and most other pellucid Solids. But a Diamond does not only exceed all other diaphanous Bodies in Hardness and Value, but also in this refractive Virtue; its Ratio being nearly as 5 to 2, or more truly, as 100 to 41. But of these perhaps more at large in a proper Place.

While I was employed in writing this, the very skilful Geometrician, Mr. *de Moivre*, at my Request, took the Pains to find a like Equation for the Ratio of the secondary Iris, when the Diameter is given. By this the Ratio may be determined very accurately, but the Equation being Biquadratick, the Calculation cannot be performed with the same ease. The Equation is $T^4 - \frac{2}{3}T^3 -$

$T^3 - 2TTr - \frac{1}{3}r^3 = 0$. Here T is the Tangent of the Angle of Refraction, t the Tangent of half the Distance of the Rainbow from the Point opposite to the Sun, and the Radius $r = 1$. Now this Equation is of such a Form, as always to be explicable by one affirmative and one negative Root, one of which being the lesser is the Tangent of the Angle of Refraction in the Regress to the Sun, that is, when the Purple Colours are the nearer to the Sun. But the greater Root is the Tangent of the Angle of Refraction, in the Iris going from the Sun, as we have observed above, that is in a Fluid of lesser Ratio. In Oil of Turpentine the Distance of this Iris from the Point opposite to the Sun is observed to be $81^\circ. 30'$. Whence the curious Reader may derive the Roots $0, 80822\dots$ and $-2, 98131\dots$ the Tangents of the refracted Angles. Hence is computed the Ratio of greater Inequality, as 1 to $0, 67995\dots$ Such it is in Oil of Turpentine. But from the greater Root proceeds the lesser Ratio, as 1 to $0, 9540\dots$ nearly. Such it would be in a Fluid exhibiting the secondary Iris of the same Diameter, but which would look towards the Sun with its red Colours, after the manner of a primary Rainbow.

A strange Appearance near Upsal; By Dr. And. Spole, Pb. Col. n. 5. p. 146.

LXX. In the Year 1679, in *May*, near the City *Joukoping*, on a certain Hill that is pretty high, under which at the Distance of a Quarter of a Mile lies a Lake of fresh Water, called *Vetter*. On the Surface of this, which was then very calm, and not agitated by a Breath of Wind, the Island *Wisingsburg* situate in that Lake was represented to me in so lively a manner, that it could not have been better drawn by the most skilful Painter. For I could discern the Windows, and Men, and Women, tho' the Island itself did not yet come into my View, because of the Hills intervening, and was distant from me at least three Miles and a Quarter, where ten *Swedish* Miles make almost one Degree. At that time the Sun was just risen, and my Eye was between that Place in the Lake, where these Things were represented, and the Sun. When I departed from this Place, I could see no such Thing in the Lake, as also another Day when I came again to the same Place at the same time. Nothing like it appeared, nor was the Lake so calm.

An unusual Meteor; by Dr. Wallis, n. 135. p. 368.

LXXI. *Sept. 20, 1676*, about 7 of the Clock at Night, or soon after, there appeared a sudden *Light*, equal to that of Noon-day; so that the smallest Pin or Straw might be seen lying on the Ground. And above in the Air, was seen (at no great Distance as was supposed) a long Appearance as of *Fire*; like a long Arm (for so it was described to me) with a great Knob at the End of it, shooting along very swiftly: And at its disappearing, seemed to break into small Sparks or Parcels of *Fire*, like as *Rockets* and such *Artificial Fire-works* in the Air are wont to do. 'Twas so surprizing, and of so short Continuance, that it was scarce seen by any who did not then happen to be abroad. I am told by some, that it scarce continued longer than while one might tell 15 or 20 at the most; which will be less than half a Minute. All this might happen well enough from some *fiery Meteor* in our Air; as a *Draco Volans* (as some have been pleased to call this) or the like. But that which makes it the more surprizing to me is this, that I find the same to have been seen in most Parts of *England*, and at or near the same time: As, not only at *Oxford* and in *Oxfordshire*, but also in *Northamptonshire*, *Gloucestershire*,

cestershire, Worcestershire, Somersetshire, Devonshire, Hampshire, Sussex, Surrey, Kent, Essex, and particularly by the Watermen on the Thames, in their Passage between Gravesend and London.

This is a great Breadth of Ground, and too much for any ordinary Meteor, in our lower Region of the Air, to be seen in at once; which argues, that either it was higher than it was imagined to be, (though the Light of it reached the Earth,) or else, that it had a very swift Motion. This made me then conjecture, that it might be some small Comet, whose *Linea Trajectoria* passed very near our Earth, or upon it; and might, when farther distant from us, appear as a Comet. And that Comet which hath since appeared in *April* and *May* confirms me in the same Opinion; which I conjecture may be the very same which passed by us in *September* last. Why it was not sooner seen, I cannot tell; save what is the common Fate of most Comets, that they are seldom observed till after their nearest Distance from us: And, perhaps, it may have been so near the Sun (as to its visible Place) as not to be much above our *Horizon*, save in the Day time: And for the like reason it may be, that in *September* last, when it passed by us, it was not more seen abroad in other Parts: it might pass them in the Day time, being but in the Twy-light with us, and, had it been one Hour sooner, the Day-light would have hindered us from seeing it. Which way its Motion was when near us, I cannot conclude, so as to satisfy myself. For most that saw it being suddenly surprized, took little more notice of it, than that it suddenly appeared, and was suddenly gone, but saw it so little time as scarce to mark which way. By the Account I had from one in *Northamptonshire* (between *Brackley* and *Banbury*) it should seem to have moved there towards the South-west. By the Account I had from one who saw it in *Hampshire* (between *Winchester* and *Southampton*) it should seem to be towards the South-east; from others I have nothing of Certainty, and therefore can conclude nothing. Its Motion might then seem to us the swifter, if its proper Motion were then one Way, and the Earth's Motion here, at the same time, contrary to it. And it is not impossible that its dashing against the Earth might disturb its Motion; as when Clouds in their Passage meet with Mountains.

LXXII. 1. Some Members of the *R. Society* did, with two different sorts of Instruments, make divers Experiments for finding the Proportions of the Compression of Air under Water, in the Month of *July* at *Sheerness*, in the Mouth of the River *Medway*, at the time of high Water, where the Depth was then about 19 Fathom, and the Proportion of the Weight of the *Salt-water* to that of the same Quantity of fresh Water taken out of the River *Thames*, was as 41 to 42.

One of the Instruments was a Glass-Bottle that held a Quart of Water, having a brass Ring fastened to the Mouth of it, with a *Valve* or Flap that opened inward, so well fitted, that the Bottle being filled more or less with Water, none dropped out tho' forcibly shaken. This let down 33 Foot into the Water, the Mouth downwards, and after a little Stay drawn up, was

found to be so very near half full of Water, at several Trials, that it was thought fit to state the Compression of Air at that Depth to that Measure.

The Quantity of *Compression* was known by weighing the Bottle with the Water in it, after that a forcible Depression of the Flap had made way for the Eruption of the compressed Air (which kept it up even when the Bottle was placed with the Mouth upwards,) and then filling the Bottle full of the same Water, and weighing it again; and lastly, by weighing the Bottle after the Water was all let forth; the Weight whereof being deducted, the first Quantity of Water weighed just half as much as the second, or so near it that the Fraction was not considerable. Whence it was concluded, that the Quantity of the Air that filled the Bottle before it was immersed in the Water, was at the Depth of 33 Feet compressed into half the Space it took up before, and so proportionable at other Depths.

Fig. 43.

The other Instrument was a Cylinder of Glass, some 2 Foot long, close at one End, and having the other End drawn small with a Lamp, and turn'd down a little way, after the Manner expressed in the *Figure*. This Cylinder was immersed perpendicularly with the crooked End uppermost, by which, as it sunk in the Water, the Pressure thereof did gradually force in so much Water as compressed the Air proportionably to every Depth, till the Cylinder was so far immersed, that the Hole in the crooked Part of it was just 33 Feet under Water; and then it being drawn up, by measuring from the Bottom of the Cylinder to the Height of the Hole in the crooked Part, by a Pair of Compasses, the Water was found to fill the Cylinder so near the half, that the Motion of the Superfice of the Water, and the Minuteness of the Difference being considered, it was thought fit to state it to just half.

According to these Experiments, confirmed by Trials at other Depths, the ensuing Table was computed.

The Proportion of the Weight of Salt Water to that of Fresh, was found by weighing some Ounces of both in a Bottle, whereof the Weight was exactly known, and which was made with so small a Neck, that the Addition or Diminution of one single Drop in it was discernible.

n. 5. p. 2240.

The Table is on these Grounds computed, upon the supposed Depths from the Surface of the Water to the Bottom of the Air included in a Cylinder of 60 Inches, closed at one End, and having the open End downwards.

Depths in Water.		Air compressed, to		Depths in Water.		Air compressed, to	
Feet.	Fathoms.	Parts.	Inches.	Feet.	Fathoms.	Parts.	Inches.
00	00	1	60	7	0	$\frac{11}{40}$	$49\frac{1}{2}$
1	0	$\frac{11}{34}$	$58\frac{4}{17}$	8	0	$\frac{11}{41}$	$48\frac{2}{11}$
2	0	$\frac{11}{33}$	$56\frac{4}{7}$	$8\frac{1}{2}$	0	$\frac{4}{5}$	48
3	$\frac{1}{2}$	$\frac{11}{36}$	55	9	$1\frac{1}{2}$	$\frac{11}{42}$	$47\frac{2}{7}$
4	0	$\frac{11}{37}$	$53\frac{12}{17}$	10	0	$\frac{11}{43}$	$46\frac{2}{13}$
5	0	$\frac{11}{38}$	$52\frac{2}{19}$	11	0	$\frac{11}{44}$	45
6	1	$\frac{11}{39}$	$50\frac{10}{13}$	12	2	$\frac{11}{45}$	44

Depths

Depths in Water. Air compressed, to				Depths in Water. Air compressed, to			
Feet.	Fathoms.	Parts.	Inches.	Feet.	Fathoms.	Parts.	Inches.
13	0	$\frac{1}{46}$	$43\frac{1}{23}$	660	110	$\frac{1}{21}$	$2\frac{6}{7}$
14	0	$\frac{1}{47}$	$42\frac{6}{47}$	693	$115\frac{1}{2}$	$\frac{1}{22}$	$2\frac{11}{22}$
15	$2\frac{1}{2}$	$\frac{1}{48}$	$41\frac{1}{48}$	726	121	$\frac{1}{23}$	$2\frac{14}{23}$
16	0	$\frac{1}{49}$	$40\frac{2}{49}$	759	$126\frac{1}{2}$	$\frac{1}{24}$	$2\frac{1}{24}$
$16\frac{1}{2}$	0	$\frac{2}{50}$	40	792	132	$\frac{1}{25}$	$2\frac{2}{25}$
17	0	$\frac{1}{51}$	$39\frac{1}{51}$	825	$137\frac{1}{2}$	$\frac{1}{26}$	$2\frac{4}{26}$
18	3	$\frac{1}{52}$	$38\frac{2}{52}$	858	143	$\frac{1}{27}$	$2\frac{2}{27}$
19	0	$\frac{1}{53}$	$38\frac{1}{53}$	891	$148\frac{1}{2}$	$\frac{1}{28}$	$2\frac{1}{28}$
20	0	$\frac{1}{54}$	$37\frac{2}{54}$	924	154	$\frac{1}{29}$	$2\frac{2}{29}$
21	$3\frac{1}{2}$	$\frac{1}{55}$	$36\frac{1}{55}$	957	$159\frac{1}{2}$	$\frac{1}{30}$	2
22	0	$\frac{1}{56}$	36	990	165	$\frac{1}{31}$	$1\frac{2}{31}$
23	0	$\frac{1}{57}$	$35\frac{1}{57}$	1023	$170\frac{1}{2}$	$\frac{1}{32}$	$1\frac{2}{32}$
24	4	$\frac{1}{58}$	$34\frac{2}{58}$	1056	176	$\frac{1}{33}$	$1\frac{1}{33}$
25	0	$\frac{1}{59}$	$34\frac{1}{59}$	1089	$181\frac{1}{2}$	$\frac{1}{34}$	$1\frac{1}{34}$
26	0	$\frac{1}{60}$	$33\frac{2}{60}$	1122	187	$\frac{1}{35}$	$1\frac{1}{35}$
27	$4\frac{1}{2}$	$\frac{1}{61}$	33	1155	$192\frac{1}{2}$	$\frac{1}{36}$	$1\frac{2}{36}$
28	0	$\frac{1}{62}$	$32\frac{2}{62}$	1188	198	$\frac{1}{37}$	$1\frac{1}{37}$
29	0	$\frac{1}{63}$	$31\frac{3}{63}$	1221	$203\frac{1}{2}$	$\frac{1}{38}$	$1\frac{1}{38}$
30	5	$\frac{1}{64}$	$31\frac{1}{64}$	1254	209	$\frac{1}{39}$	$1\frac{1}{39}$
31	0	$\frac{1}{65}$	$30\frac{2}{65}$	1287	$214\frac{1}{2}$	$\frac{1}{40}$	$1\frac{1}{40}$
32	0	$\frac{1}{66}$	$30\frac{1}{66}$	1320	220	$\frac{1}{41}$	$1\frac{1}{41}$
33	$5\frac{1}{2}$	$\frac{1}{67}$	30	1353	$225\frac{1}{2}$	$\frac{1}{42}$	$1\frac{1}{42}$
66	11	$\frac{1}{68}$	20	1386	231	$\frac{1}{43}$	$1\frac{2}{43}$
99	$16\frac{1}{2}$	$\frac{1}{69}$	15	1419	$236\frac{1}{2}$	$\frac{1}{44}$	$1\frac{1}{44}$
132	22	$\frac{1}{70}$	12	1452	242	$\frac{1}{45}$	$1\frac{1}{45}$
165	$27\frac{1}{2}$	$\frac{1}{71}$	10	1485	$247\frac{1}{2}$	$\frac{1}{46}$	$1\frac{2}{46}$
198	33	$\frac{1}{72}$	$8\frac{4}{72}$	1518	253	$\frac{1}{47}$	$1\frac{1}{47}$
231	$38\frac{1}{2}$	$\frac{1}{73}$	$7\frac{1}{2}$	1551	$258\frac{1}{2}$	$\frac{1}{48}$	$1\frac{1}{48}$
264	44	$\frac{1}{74}$	$6\frac{2}{74}$	1584	264	$\frac{1}{49}$	$1\frac{1}{49}$
297	$49\frac{1}{2}$	$\frac{1}{75}$	6	1617	$269\frac{1}{2}$	$\frac{1}{50}$	$1\frac{1}{50}$
339	55	$\frac{1}{76}$	$5\frac{1}{76}$	1650	275	$\frac{1}{51}$	$1\frac{1}{51}$
363	$60\frac{1}{2}$	$\frac{1}{77}$	5	1683	$280\frac{1}{2}$	$\frac{1}{52}$	$1\frac{1}{52}$
396	66	$\frac{1}{78}$	$4\frac{2}{78}$	1716	286	$\frac{1}{53}$	$1\frac{2}{53}$
429	$71\frac{1}{2}$	$\frac{1}{79}$	$4\frac{1}{2}$	1749	$291\frac{1}{2}$	$\frac{1}{54}$	$1\frac{1}{54}$
462	77	$\frac{1}{80}$	4	1782	297	$\frac{1}{55}$	$1\frac{1}{55}$
495	$82\frac{1}{2}$	$\frac{1}{81}$	$3\frac{3}{81}$	1815	$302\frac{1}{2}$	$\frac{1}{56}$	$1\frac{1}{56}$
528	88	$\frac{1}{82}$	$3\frac{2}{82}$	1848	308	$\frac{1}{57}$	$1\frac{1}{57}$
561	$93\frac{1}{2}$	$\frac{1}{83}$	$3\frac{1}{83}$	1881	$313\frac{1}{2}$	$\frac{1}{58}$	$1\frac{2}{58}$
594	99	$\frac{1}{84}$	$3\frac{1}{84}$	1914	319	$\frac{1}{59}$	$1\frac{1}{59}$
627	$104\frac{1}{2}$	$\frac{1}{85}$	3	1947	$324\frac{1}{2}$	$\frac{1}{60}$	1

The Calcula-
tion by M--
n. 75. p. 2239
Fig. 44.

2. Let ED represent the *Tube* = x .
 AB , the Distance of the upper Part of the *Tube* from the Surface of the Water, above or under it = b .
 FC , the Depth of the Water from its Surface to the Bottom of the Air within the *Tube* = a .
 CB , that Part of it which remains filled with Air, within the Water.
 CD , the rest thereof, which is full of Water.
 And any two of the three first, x , b , and a , being given, the other is known; and consequently the rest also.

For, if by the incumbent Weight of 33 Feet Depth in Water, the Air in the *Tube* is compressed into Half the Space it filled before, then the said 33 Feet Depth of Water equals the Weight, or *Pressure* of the incumbent Air on the Surface of the Water. Now, as the Weight or *Pressure* of the Air on the Surface of the Water, is to the Depth of the Water, from the Surface thereof to the Bottom of the Air within the *Tube*; so is the Length of the *Tube* fill'd with Air, to the Length thereof filled with Water: That is, according to the said Experiments, putting z for 33, or whatever, at other Times or Places, shall be found to be the Weight or *Pressure* of the Incumbent Air on the Surface of the Water (for it is not always the same exactly;)
 $z : a :: a + b : a^2 x ab = CD$.

$$\text{And therefore } \frac{a^2 + ab + za + zb}{z} = x.$$

$$\text{Wherefore } \frac{z}{z + a} x - a = b.$$

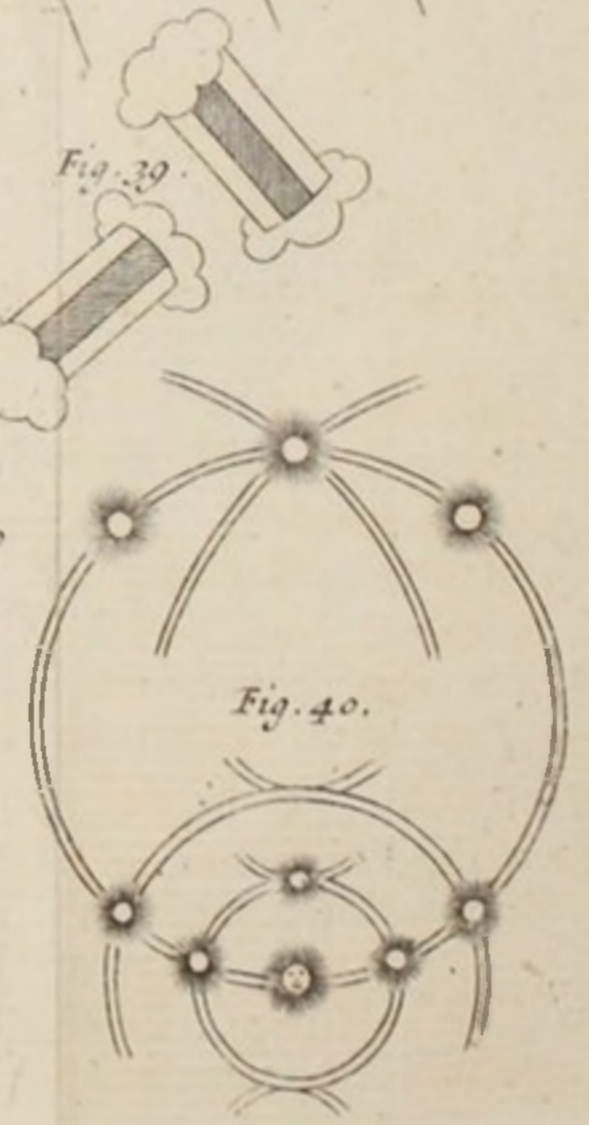
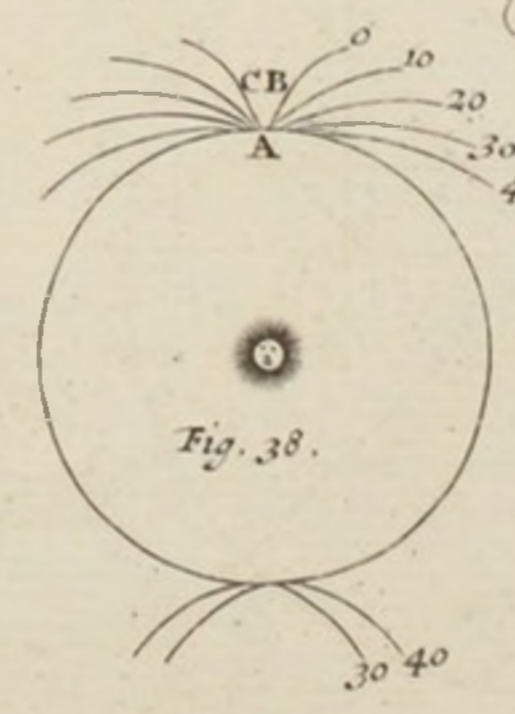
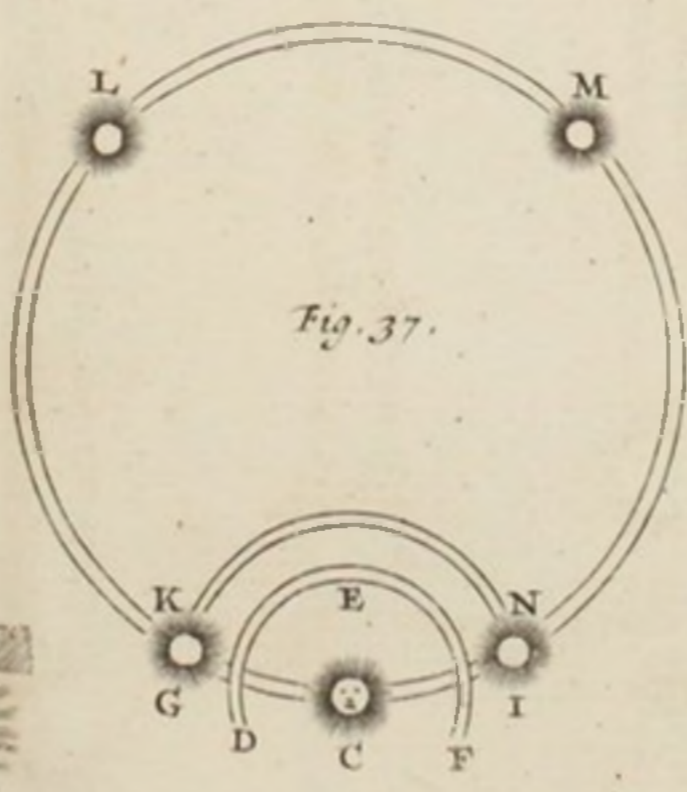
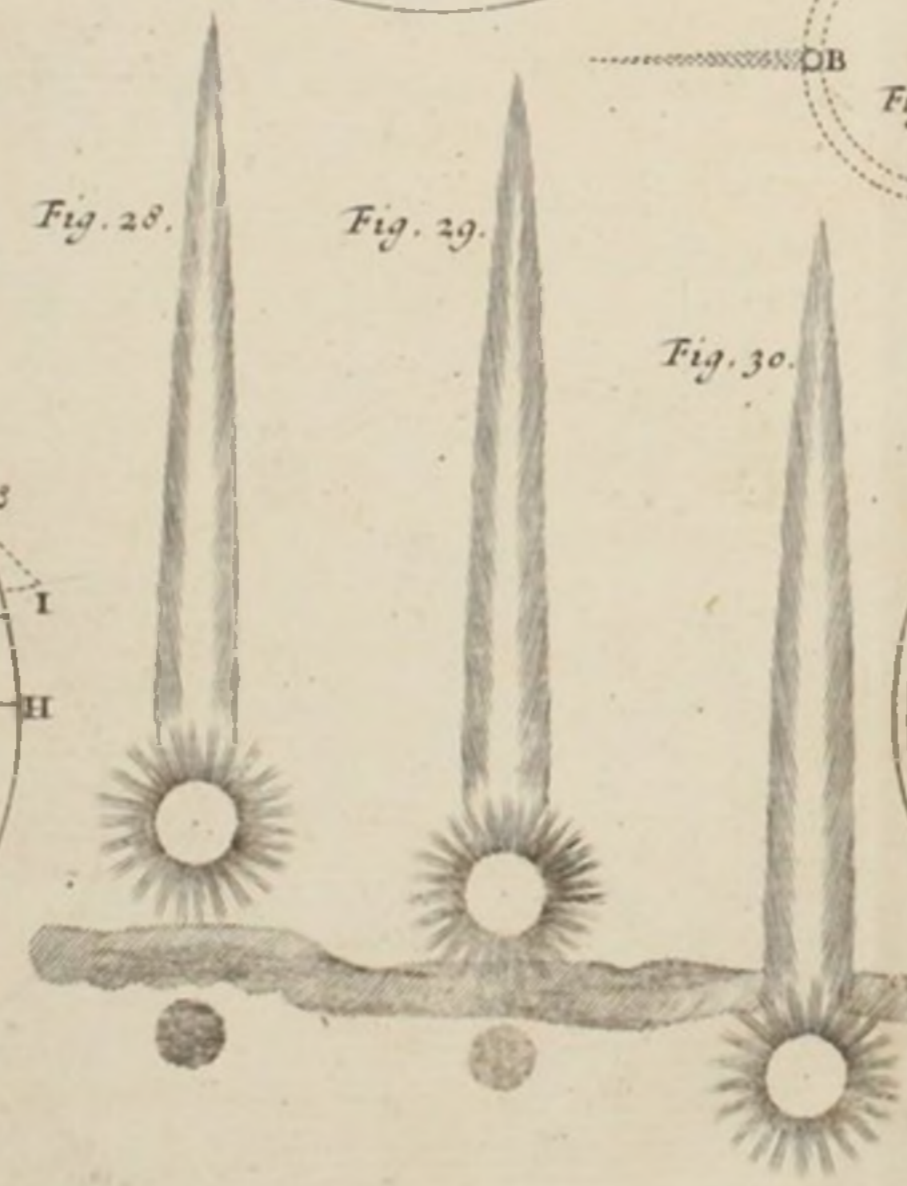
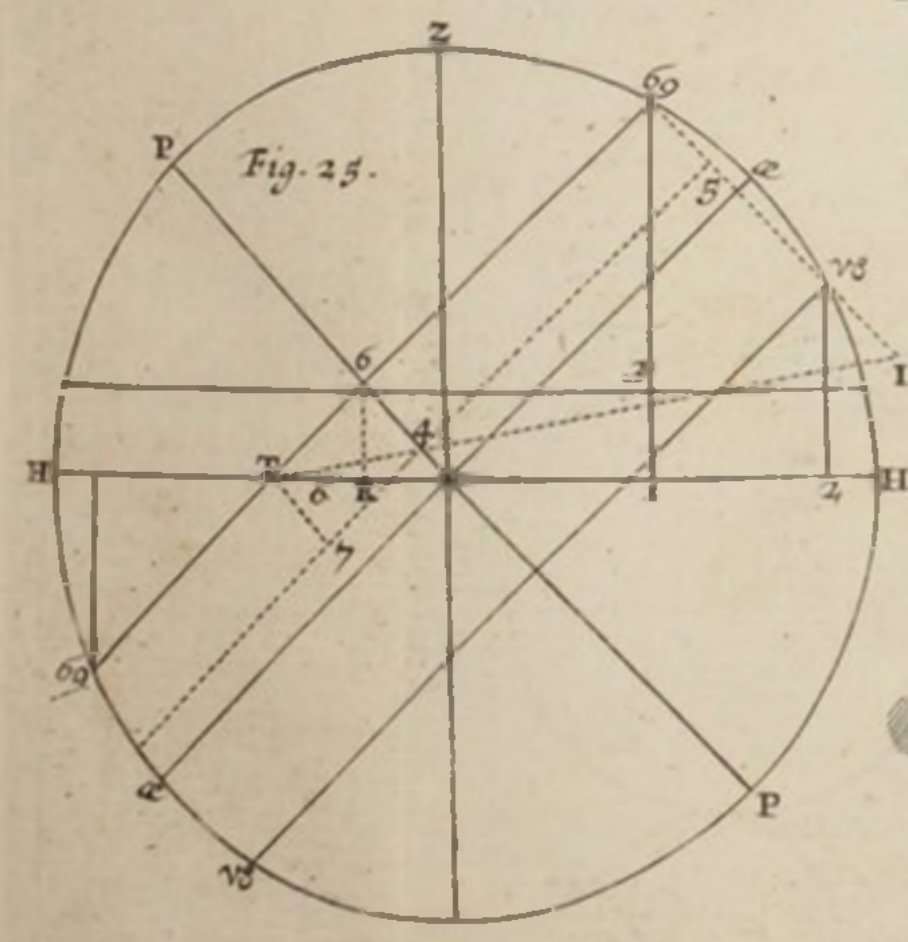
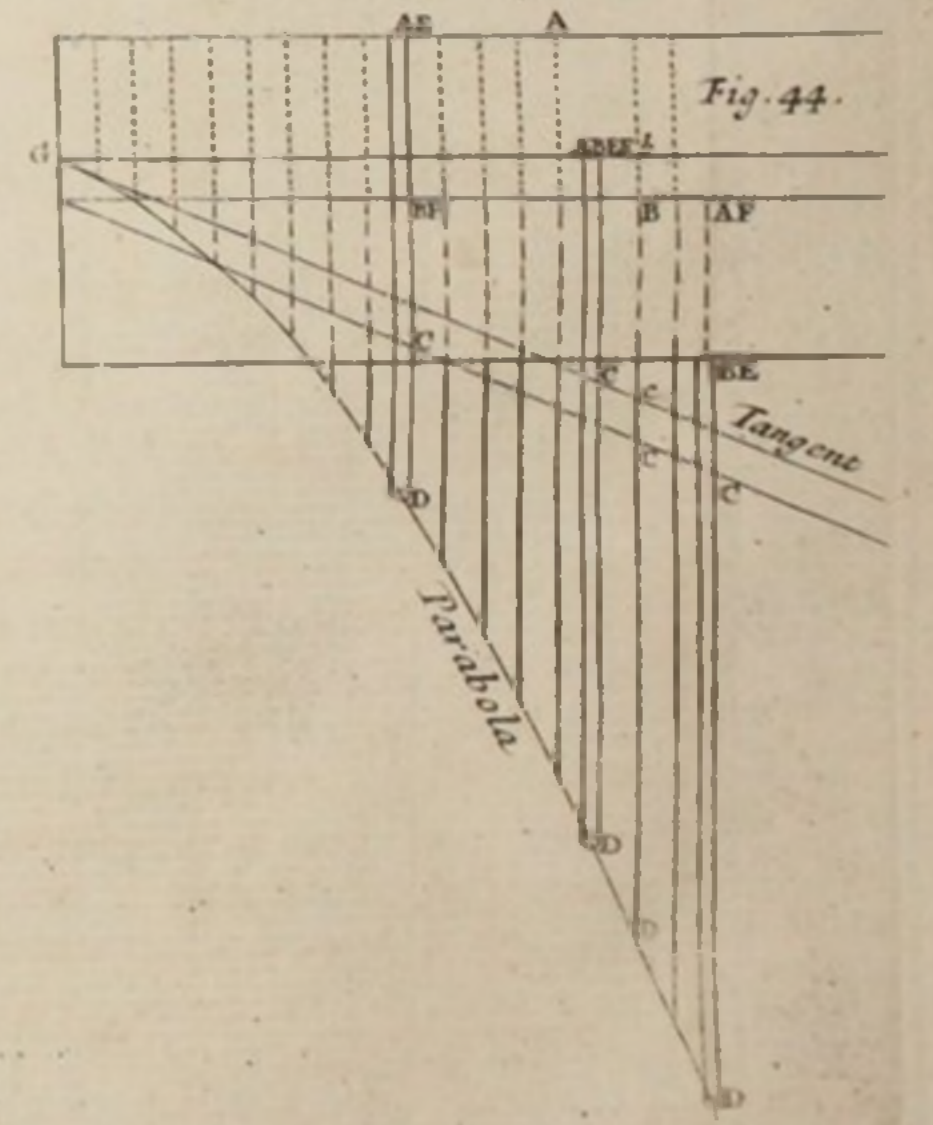
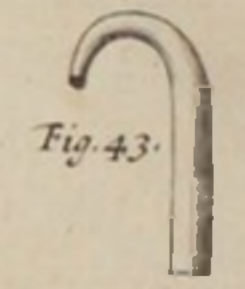
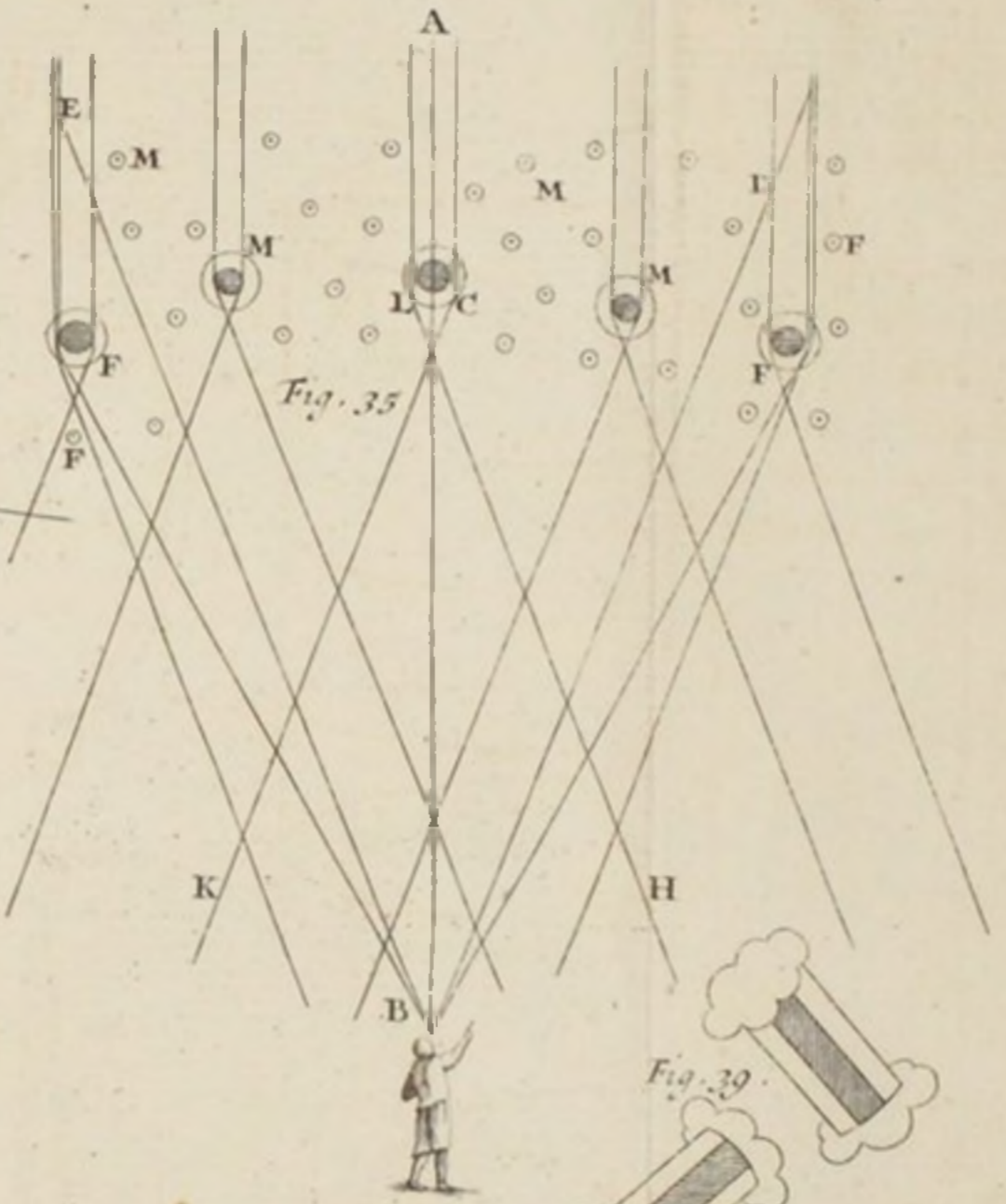
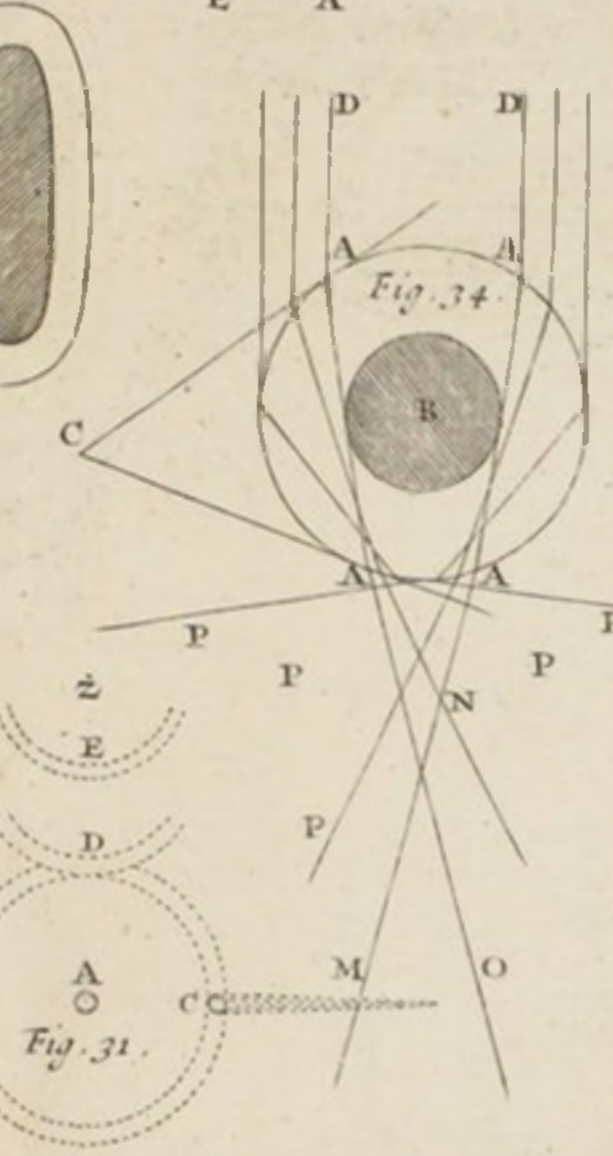
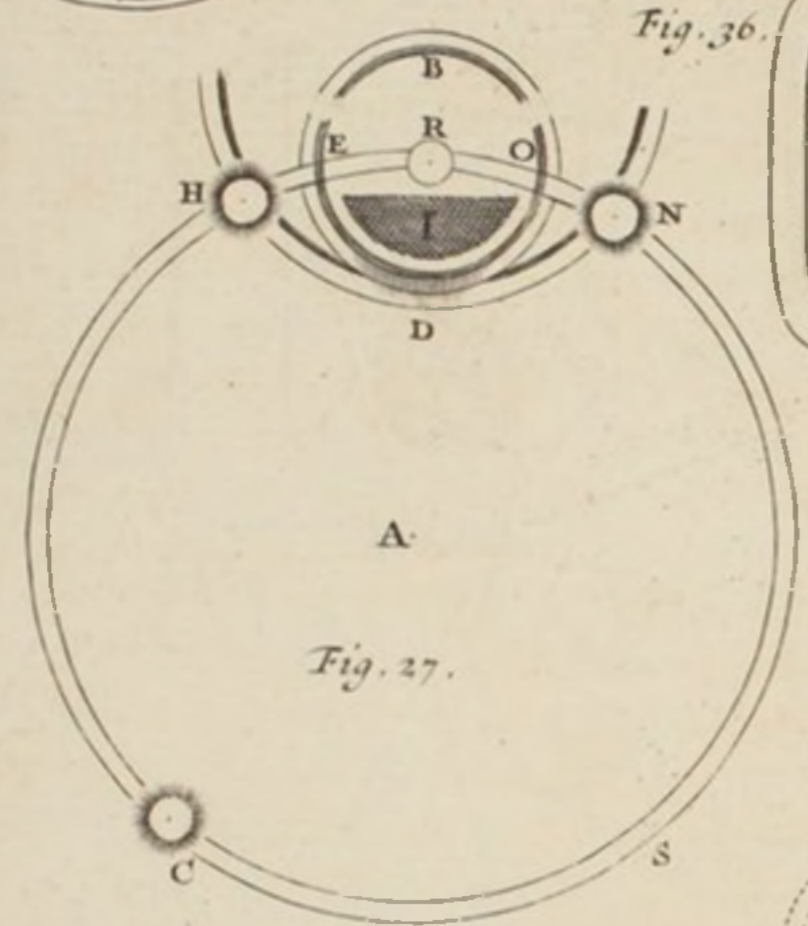
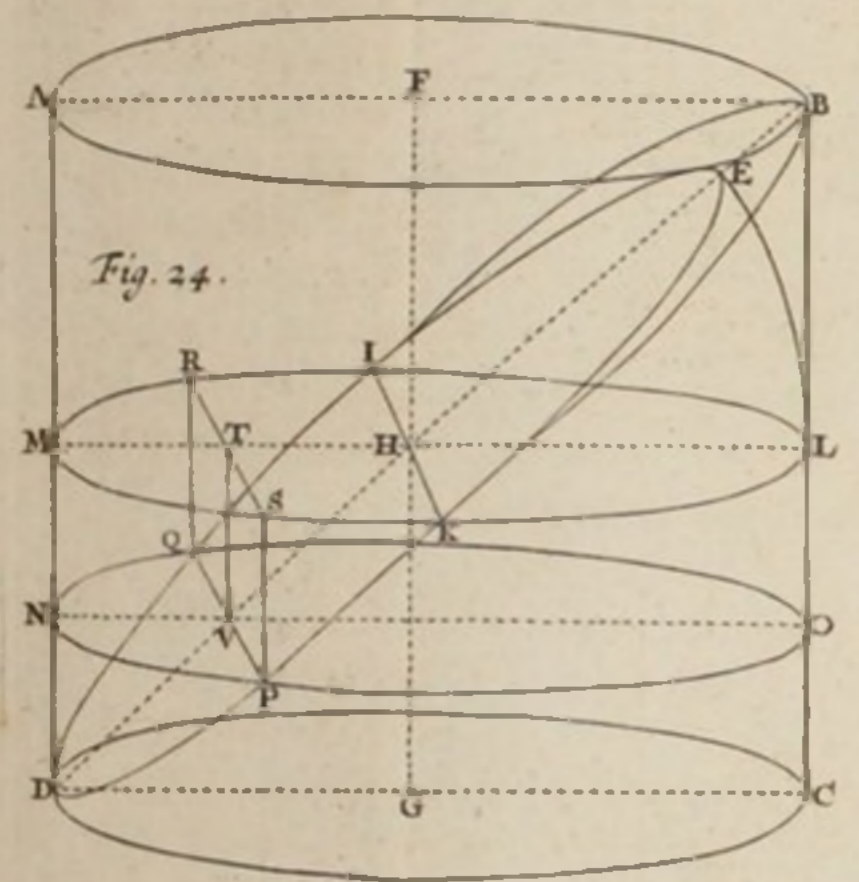
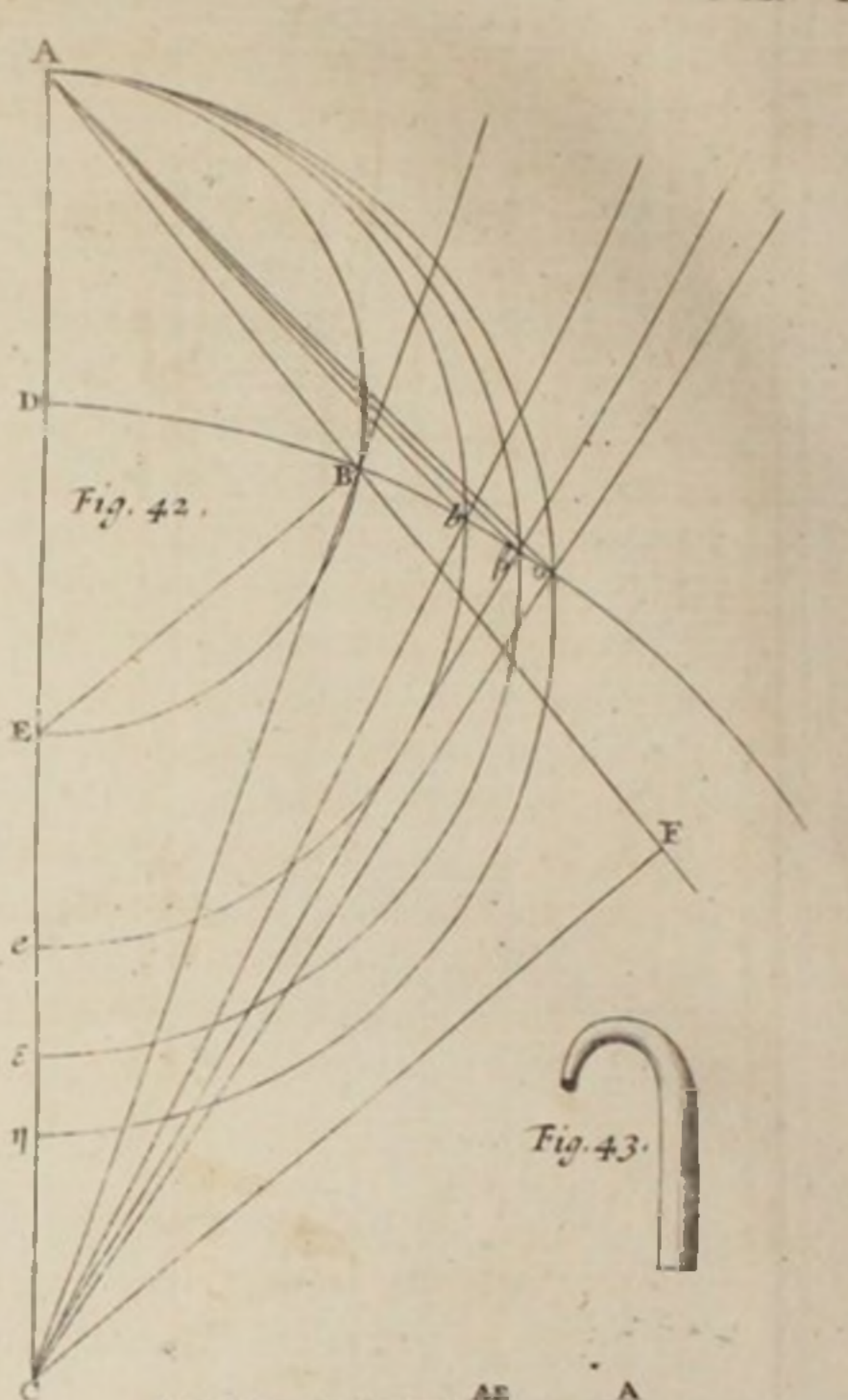
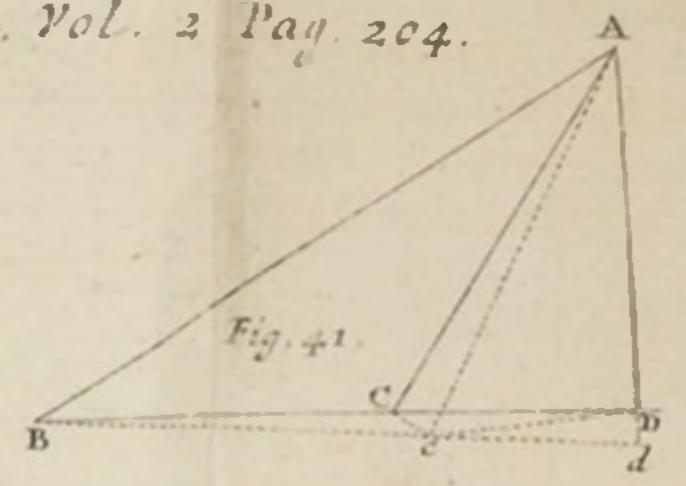
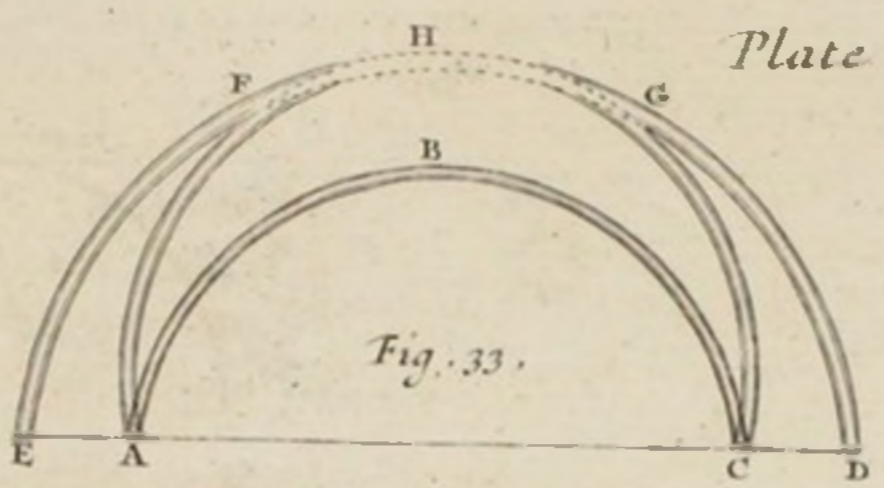
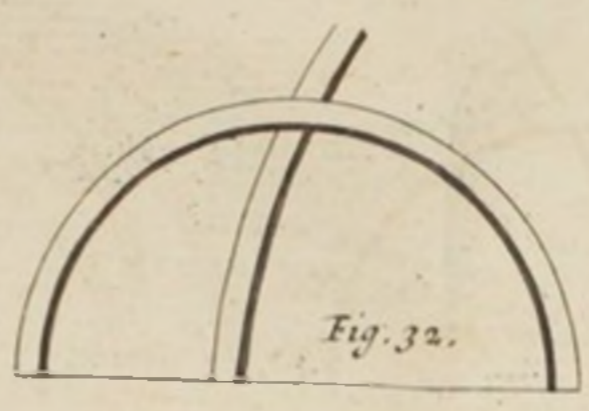
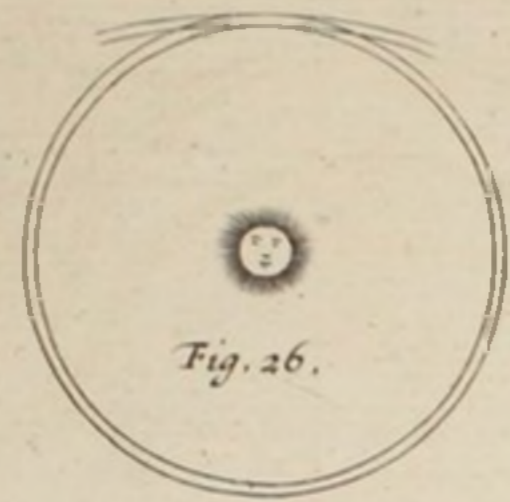
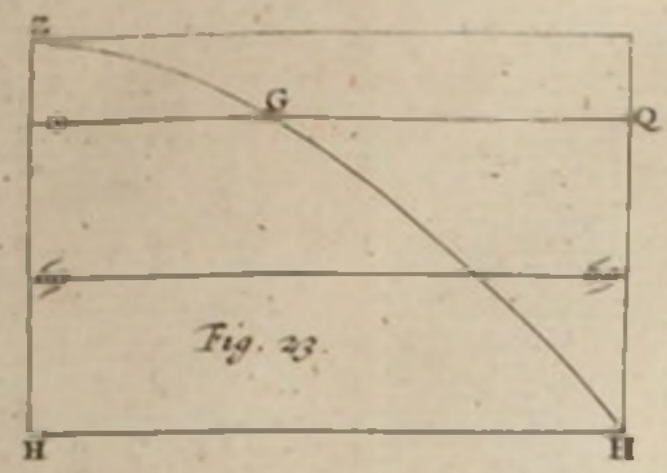
$$\text{And } bb + zb + zx + b - z = a.$$

Therefore a and b being given, x is known by the *first Equation*; and a and x being given, b is known by the *second*; and b and x being given, a is known by the *third*.

The Horizontal Line $BFB AF$, is substituted for $GABEFb$, when the *Close End* of the *Tube* is not even with the Surface of the *Water*, to void the Breach $cC = b$ $B = \frac{1}{4} x b^2$, in the Length of the *Tube*.

Effects of
the varying
Weight of
the Atmos-
phere upon
Bodies in
Water; By
Mr. Rob.
Boyle, n. 91.
p. 5156.

LXXIII. I caused to be blown at the Flame of a Lamp three small round Glass-Bubbles about the Bigness of Hazel-nuts, and furnished each of them with a short and slender *Stem*, by whose means they were so nicely *poised* in *Water*, that a very small Change of Weight would make them either emerge if they but lightly leaned on the Bottom of the Vessel, or sink, if they floated on the Top of the Water. This being done at a time when the *Atmosphere* was of a convenient Weight, I put them in a wide-mouth'd Glass furnished with common Water, and leaving them in a quiet Place, where yet they were frequently in my Eye, and were suffered to continue many Weeks (or some Months) I observed, as I expected, that sometimes they



they would be at the *Top* of the *Water*, and remain there for divers *Days*, or perhaps *Weeks*; and sometimes would fall to the *Bottom*, and after having continued there for some time (longer or shorter) they would again emerge. And though sometimes (especially if I removed the *Vessel* that contained them to a *Southern Window*) they would rise to the *Top*, or fall to the *Bottom* of the *Water*, according as the *Air* was *hot* or *cold*; yet 'twas not difficult to distinguish these *Motions* from those produced by the *varying Gravity* of the *Atmosphere*. For when the *Beams* of the *Sun*, or *Heat* of the ambient *Air*, by rarefying the *Air* included in the *Bubbles*, made that *Air* drive out some of the *Water*, and consequently made the whole *Bubble* (consisting of *Glass*, *Air* and *Water*) somewhat lighter than a *Bulk* of *Water* equal to it, though the *Bubble* did necessarily swim as long as the included *Air* was thus *rarefied*, yet when the *Absence* of the *Sun*, or any other *Cause* made the *Air* lose its adventitious *Warmth*, there would ensue a *Condensation* of the *Air* again; and thereupon an *Intrusion* of more *Water* (to succeed the *Air*) into the *Glass*, and consequently a *sinking* of the *Bubble*; and this would commonly happen at *Night*, if it did not happen sooner. But when it was upon the *Account* of the *varying Weight* of the *Atmosphere* that the *Bubbles* either rose or fell, it appeared by the *Baroscope*, that the *Atmosphere* was so heavy or so light, that they ought to do so. Inasmuch that I divers times predicted, whether I should find the *Mercury* in the *Baroscope* high or low, by observing the *Situation* and *Posture* of the *Bubbles*; and consulting that *Instrument*, it verified my *Conjectures*. And though whilst the *Atmosphere* was not too considerably either light or heavy, the *Changes* of the *Air* as to *Heat* or *Cold*, would (as I was saying) place the *Bubbles* sometimes at the *Top*, and sometimes at the *Bottom* of the *Water*, within the *Compass* of a *Day*; yet if the *Atmosphere* were either very heavy or very light, the *Bubbles* would continue at the *Bottom* or at the *Top* of the *Water* for many *Days* together, in *Case* the *Atmosphere* did not in all that time change its *Gravity*. And I remember, that I did for *Curiosity's* sake, when the *Quick-silver* was high in the *Baroscope*, put the *Glass* two or three *Days* in a *South-Window* about *Noon* (and for a good while after) and that in sun-shining *Weather*, and yet even then the *Bubbles* did not emerge, though it appeared by a good *seal'd Weather-Glass*, which I kept in the same *Window*, that the ambient *Air* was much warmer than at other times, when I had observed the *Bubbles* to keep at the *Top* of the *Water*.

N. B. 1. It being very difficult to *poise* several *Bubbles* precisely, as well one as another, I thought it not strange that all the three *Bubbles* did not constantly (though for the most part they did) rise and fall together, but sometimes two of them, and now and then (though seldom) one alone, would sink or emerge, when the *Change* of the *Weight* of the *Atmosphere* was not considerably enough to operate sensibly upon the rest. And therefore 'tis not amiss to *poise* a great Number of *Bubbles* together, that after *Trial* made of all, the *best* may be chosen. For I have observed it sometimes to happen that a *Bubble* that floated when it was first *poised*, would after a while

a while subside without any manifest Cause, or if it were made to sink by such a Cause, it would continue at the Bottom of the Water, though that Cause were removed; which difficult *Phænomenon* seeming to depend upon a kind of Imbibition made of certain Particles of an aerial Nature by the Water, the Consideration of it belongs to another Place, not to this, where it may suffice, that the Experiment did sometimes actually answer Expectation, as that above related did, wherein my main Drift was to shew, that since, as the *Atmosphere* is heavier or lighter, 'tis capable to work upon Bodies under Water, so as to procure their sinking, or their Emerſion; the Air (though a Fluid a thousand times lighter) must lean or press upon the *Water* itself, by whose Intervention it produces these Effects, which confirms what I elsewhere teach, that the *Atmosphere* is incumbent, as a heavy Body, upon the *terraqeous Globe*.

To take Exhausted Receivers away from the Air Pump, by M. Papin, n. 120. p. 477.

n. 121. p. 544.

LXXIV. I caused the Edges of my *Recipient* to be well ground, so as that being apply'd, it every where touched a Glass Plate, which had also been very smoothly ground to serve for a Cover to the same; and I spread a Piece of *Lamb-skin* wetted, over the said Plate, and having thus applied it to the *Engine*, I put my *Recipient* over it: But in one Place there was a Hail-shot of Lead, which kept the *Receiver* from being exactly applied to its Cover, that so the Air might more freely get out. And having afterwards whelmed another great *Receiver* over all, I caused the *Pump* to be plyed. All being well evacuated, I shook the *Engine* so as that the little *Receiver* fell off from the Hail-shot, and stood every where close to the Skin, expanded over the Cover of the Glass Plate. Then I had no more to do but to suffer the Air to re-enter into the great *Receiver*, and this Air pressing upon the little one kept it so closely fastened to its Cover, that it was impossible for me to sever them. And I am assured, that the Air enters not into the small *Receiver*, when 'tis thus applied upon the Skin; for I have often put *Gages* in them, which always kept at the same Height, altho' the Air was permitted to re-pass into the great *Receiver*. You might also let alone the putting under of the Hail-shot to keep up the little *Recipient*, because the *Air* by its *Spring* would lift it up sufficiently; but then the *Vacuum* would not be so perfectly made.

When I first began to keep *Receivers* thus void of *Air*, I apply'd *Eel-Skins* to the Cover: But I found them not proper for Things that are intended to be conserved a long Time, because by drying they grow *springy*, and this *Spring* is capable to raise the whole Pillar of *Air* that presses the *Receiver* against its Cover; and so the Air gets in between, and fills the place exhausted.

Afterwards I employed *Mutton-Skins*; but that sticks yet less close than an *Eel-Skin*: For, as soon as the external Air comes to press upon it, it makes all the *Water*, which wetteth the Skin, that stands over without, enter into the emptied *Receiver*; and you may see little Drops of Water coming out of the Pores of the Skin that is under the *Receiver*; and after the Water is all entred, the Air quickly gets in the same Way.

At length I took a *Lamb-Skin*, and by means thereof I have kept *Receivers* empty 8 Days together, and never perceived it fail. Yet, for greater security,

I do

I do put *Turpentine* round about such *Receivers* as I mean to keep staunch a long Time. Mean while, this Difference betwixt the Skins of *Mutton* and *Lambs* is somewhat remarkable, and confirms what *Physicians* say of the different Constitution of Bodies in *Youth* and *Old Age*. I afterwards found that Paper wetted serves as well as a Lamb-Skin; but you must put *Turpentine* about it before it be dry.

LXXV. Some *Lettice-Seed* being sown upon some Earth in the open Air, and some of the same Seed at the same time upon other Earth in a Glass Receiver of the *Pneumatick Engine*, afterwards exhausted of Air, the Seed exposed to the Air was grown up an Inch and a half high, within 8 Days: But that in the exhausted *Receiver*, not at all. And, Air being again admitted into the said emptied *Receiver*, to see whether any of the Seed would then come up, it was found, that in the Space of one Week it was grown up to the height of two or three Inches.

Seeds sown in the Exhausted Receiver; by ---- n. 23. p. 425.

LXXVI. *Exp. I. Oct. 29th, 1657.* Having procured a Piece of *shining Wood*, about the bigness of a Groat or less, that gave a vivid Light (for *rotten Wood*) we put it into a middle-sized *Receiver*, so as it was kept from touching the Cement; and the *Pump* being set a-work, we observed not, during the 5 or 6 first Exsuctions of the Air, that the Splendor of the included Wood was manifestly lessened (though it was never at all increased;) but about the 7th Suck, it seem'd to grow a little more dim, and afterwards answered our Expectation, by losing of its Light more and more, as the Air was still farther pumped out; till at length about the 10th Exsuction, (though by the removal of the Candles out of the Room, and by black Cloaths and Hats we made the Place as dark as we could, yet) we could not perceive any Light at all to proceed from the *Wood*.

Experiments concerning the Relation between Light and Air (in Shining Wood and Fish) By Mr. Rob. Boyle. n. 31. p. 581.

Exp. II. Wherefore we let in the outward Air by Degrees, and had the pleasure to see the seemingly extinguish'd Light revive so fast and perfectly, that it looked to us all almost like a little Flash of Lightning, and the Splendor of the Wood seemed rather greater than at all less, than before it was put into the Receiver.

But partly for greater certainty, and partly to enjoy so delightful a Spectacle, we repeated the Experiment with the like Success as at first. Wherefore being desirous to see how soon these Changes might be produced, we included the Wood into a very small Receiver of clear Glass, and found, that in this the Light would begin to grow faint at the second, or at least at the third Exsuction of the Air, and at the 6th or 7th would quite disappear. And we found by a Minute-Watch, that the sending the Candles out of the Room, the pumping out the Air till the Wood would shine no more, the re-admitting of the Air (upon which it would in a trice recover its Light) and the sending in for the Candles to consult the Watch, did in all take up but 6 Minutes.

Exp. III. Having exhausted this new Receiver till the Wood quite disappeared, we staid somewhat above a quarter of an Hour in the Dark, without perceiving that the Wood had regained any thing of Light, tho' about the End of this Time, we made the place about it as dark as we could; and then

it

it being too late at Night to protract the Experiment, we let in the Air; upon whose Admission the Wood presently recovered Light enough to be conspicuous at a Distance, though it seemed to be somewhat less vivid than before; which yet may be either a Weakness in my Sight, or an Effect of the Steams of the Cements, unfriendly perhaps to the Luminousness of the Wood.

The Night following we put in a piece of Wood bigger than the former, this being above an Inch long, and that shone very vigorously; and having by a few Sucks quite deprived it of Light, we left it in the exhausted Receiver for full half an Hour, and then coming into the dark Room again, we found all had not continued so stanch, but that some small Portion of Air had insinuated itself into the Receiver. This we concluded to be but a small Portion of Air, because the Wood was but visible to an attentive Eye. And yet that it was really some Air which was got in, that caused the little glimmering Light which we perceived, may appear by this, that it did presently (as we expected) vanish at the first or second Suck; and then the Air being let into the dark Receiver, the included Wood presently shone again as before; tho' I suspected that I discerned some little Diminution of its Brightness; which yet till farther Trials of the like Kind, and for a longer Time, have been made, I dare not affirm.

Exp. IV. Having observed on another occasion, That sometimes the Operation, which the withdrawing the Air hath upon a Body included in the Receiver, proves more considerable some Minutes after we have ceased Pumping, than immediately after the Exercise is left off, I imagined, that even in such Cases, where the Light is not made wholly to disappear (tho' it be made almost quite to do so) by the emptying of the *Pneumatical-Glass*, the suffering the Body to remain a while there, though without any Pumping (unless now and then a very little to remove the Air, that might have stolen in in the mean time) the remaining Light of the Body might probably be farther impaired, if not reduced quite to vanish. To examine this Conjecture, we put in a Body that was not Wood, which had some Parts much more luminous than the rest; and having drawn out the Air, all the others disappeared, and even the formerly brighter ones shone but faintly, when the *Pneumatical-Glass* seem'd to be exhausted. But keeping the included Body a while in that unfriendly Place, we perceived the Parts that had retained Light, to grow more and more dim, some of them disappearing; and that which was formerly the most conspicuous, being now but just visible to an attentive Eye, and that scarce without Dispute; for if we had not known beforehand, that a shining Matter had been included in the Receiver, perhaps we should not have found it out. (And he that had the youngest Eyes in the Company could not at all discern it;) but the Air being let in, the Body began to shine again.

Exp. V. The Rarefaction or Expansion of the Air, having so notable an Operation upon our shining Wood, I thought it would not be amiss to try what the Compression of the Air would do to it: For which Purpose we included a Piece of it in such a little Instrument to compress as hath been devised and proposed by Mr. Hook. But tho' we impelled the Air forcibly enough into the

the

the Glass, yet by reason of the Thickness requisite in such Glasses, and the Opacity thence arising, we were not able then to determine, whether or no any Change was made in the *Luminousness* of the *Wood*. Which I thought the less strange, because by some *Experiments* purposely devised, I had long since observed, That even a great Pressure from a fluid Body, which presseth more uniformly against all the Parts it toucheth of the consistent Body, does work a far less manifest Change even on soft or tender Substances, than one would expect from the Force wherewith it compresseth.

Exp. VI. Thinking fit to try whether a small Quantity of Air, without being ventilated or renewed, might not suffice to maintain this cold Fire, tho' it will not that of a live Coal, or a Piece of Match, we caused a Piece of shining Wood to be hermetically sealed up in a Pipe of clear and thin Glass; but tho' carrying it into the Dark, we found it had quite lost its Light, yet imagining that that might proceed from its having been over-heated (being sealed up in a Pipe not long enough to afford it a due Distance from the Flame of the Lamp we employed to seal it) we caused 2 or 3 Pieces of fresh *Wood*, amounting all of them to the Length of about two Inches, to be seal'd up in a slender Pipe between 4 or 5 Inches in Length; which being warily done, the Wood retained its Light very well, when the Operation was over, and afterwards laying it by my Bed-side, when the Candles were carried away out of the Room, I considered it a while before I went to sleep, and found it to shine vividly.

The next Morning when I awaked, tho' the Sun was risen, yet forbearing to draw open the Curtains of my Bed 'till I had looked upon the seal'd Glass, which I had fenced with a Piece of Cloth held between it and the Window, my Eyes having not yet been exposed to the Day-light, since the Darkness they had been accustomed to during the Night, made me think the *Wood* shined brighter than ever. And at Night, after 10 of the Clock, looking on it in a dark Place, it appeared luminous all its length, though not so much as in the Morning.

The Morning after, and the Night after that, the same Wood did likewise manifestly, though not vigorously, shine; especially one Piece, whose Light was much more vivid than the rest: And, for ought I know, I might have observed them to shine longer, if one of the sealed Ends of the Glass had not been accidentally broken.

Exp. VII. I caused a Piece of Iron to be forged, whose Top was of the Bigness of a Nutmeg; the rest being a Stem of an Inch, or an Inch and a half long, for which we provided a little Candlestick of Tobacco-Pipe Clay, which would not yield any Smoak to fill and darken the Receiver. Then having heated the Iron red-hot, and placed it in this Clay, so that the round Part was clearly protuberant, we conveyed it into a *Receiver* of white Glass, which was so placed, as to keep the Sides at as great a Distance as we could from the Iron, lest the excessive Heat should (as we much feared it would) break the Glass. Then sending away the Candles, and making the Room dark, we hastily pumped out the Air, but could not perceive the withdrawing of it had any Operation on the glowing Iron. And though it continued shining long enough

to give us an Opportunity to pump out and let in the Air three several Times, yet we could not observe, that the Air had any manifest Operation one Way or other. For though upon the withdrawing of the Air the Iron grew dimmer and dimmer, yet that I attributed to the cooling of it; and the rather, because having (to examine the Conjecture) let in two or three times the Air, when the *Receiver* had been exhausted, there appeared no manifest Increase of Light upon the sudden Admission of it.

Exp. VIII. Some curious Persons would perhaps, if they had been present, have desired to see a Trial made, whether or no a small Piece of *shining Wood*, being so included in the *Receiver*, as that the pumping out of the *Air* should have no injurious Operation upon the Body of it, its Light would, upon the withdrawing of the *Air*, be manifestly diminished: This Way I was the less backward to try, because it did not readily occur to my Memory, that by any manifest Experiment it appeared, that a Body, more thin than *Air*, will, or can, transmit Light, as well as other Diaphanous Mediums. Wherefore having *hermetically sealed* up a Piece of shining Wood in a slender Pipe, and placed it in a small *Receiver* that was likewise made of clear Glass, we exhausted it of *Air*, and afterwards let in again that which we had excluded. But by neither of the Operations could we perceive any sensible Decrement or Increase of the Light of the Wood; though by that very Observation it appeared, that the Glass had been well sealed, since otherwise the included *Air* would have got out of the Pipe into the *Receiver*, and have left the Wood without Light.

Exp. IX. I took an old, but thin Glass, sealed at one End, whose Shape was pretty cylindrical, and whose Bore was about the Bigness of a Man's little Finger, and whose Length was about a Foot or more. Into this Pipe, near the sealed End, we put a Piece of *shining Wood*, wedged in with a Piece of Cork to keep it from falling; and having inverted the Nose of it into another slender Glass, but not cylindrical, wherein was pretty Store of Quicksilver, we put them both into a long *Receiver*, shaped almost like a Glass Churn; and having pumped a while, that the *Air* included in the Pipe expanding itself, might depress the Quicksilver, and so make Escapes into the *Receiver* as long as we thought fit; we then let in the outward Air, that the *stagnant* Quicksilver might be impelled into the Cavity of the Pipe now freed from much of the Air, to the Height requisite for our Purpose.

This done, we plied the Pump again, and observed, that as the Air in the Pipe did by its own Spring expand itself more and more, and grow thinner and thinner, the *shining Wood* grew dimmer and dimmer, till at length it ceased to shine, the internal Air being then got a good way lower than the Surface of the external Quicksilver; whereupon opening the Commerce between the Cavity of the *Receiver*, and the *Atmosphere*, the Quicksilver was driven up again, and consequently the Air above it was restored to its former Density; upon which the rotten Wood also recovered its Light. What the greatest Expansion of this Air was, we could not certainly determine, because the Expansion raised the external Quicksilver so high, as to hinder us to see and measure it: But we guessed, that the Air reached to about
a Foot

a Foot or more from the Top of the Pipe to the Surface of the Quicksilver near the Bottom of it. But when that rarified Air was impelled into its former Dimensions, we measured it, and found, that the upper Part of the Tube, unpossess'd by the Quicksilver, was about 3 Inches; and the Wood being about an Inch long, there remained two Inches or somewhat better for the Air. But this Experiment ought to be repeated, when exacter Instruments can be procured.

Exp. X. Thinking it fit to try, as well, whether stinking Fish that shines, be of the same Nature, as to *Luminousness*, with rotten Wood that shines too; as, whether the withdrawing of the Air will extinguish or eclipse the Light of a considerable Bulk of *luminous Matter*, as in the Experiments hitherto made, we found it would do to a small one; we took a Fish that we had kept, and caus'd to be watch'd till it was almost all over *luminous*, though much more in the Belly, and some Parts of the Head, than elsewhere: And having suspended him in a conveniently shaped *Receiver*, we found him to give so great a Light, that we suspected beforehand that the withdrawing of the Air would hardly have its full Operation upon a Body, whose Bulk was considerable as well as its Light very vivid, and which had many *luminous* Parts retir'd to a pretty Distance from the Air. Accordingly having exhausted the *Receiver* as much as we were wont, it appear'd indeed, especially towards the latter End of the Operation, that the Absence of the Air did considerably lessen, and in some Places eclipse the Light of those Parts that shone less strongly: But the Belly appear'd not much less *luminous* than before. Wherefore supposing, that upon the turning of the *Stopcock*, the Air coming in much more hastily than it could be drawn out, we should have the best Advantage to discern, what Interest it had in the *Luminousness* of the Fish, we re-admitted it: And upon its rushing in, perceiv'd the Light to be, as it were, revived and encreas'd; those Parts of the Fish that were scarce visible before, or shone but dimly, receiving presently their former Splendor.

And not to leave unprosecuted the remaining Part of the Experiment, which was to try, whether it was the Kind of the *luminous Body*, or only the Greatness of the *Bulk*, and the *Vividness* of *Light*, and, if I may so speak, the Tenacity of the Substance it resid'd in, that made the Difference between the *Fish* and *Wood*; we put Part of a Fish of another Kind, that shone much more faintly than that hitherto spoken of, and but in some Places; and by the withdrawing the Air, we made some of the luminous Parts disappear, and the others so dim, as scarce to be discern'd; and yet both the one and the other regain'd their former Light upon the Return of the Air.

And to pursue the Experiment a little farther, we put in such a Piece of the first Fish, as though it were bright, was yet but thin, and not considerably great; and upon pumping out the Air, we found it, according to our Expectation, quite eclips'd, though it recover'd its Light upon the Air's Re-entry.

'Tis probable that some will make use of this Discourse to countenance their Opinion, That notwithstanding the Coldness (at least as to Sense) of

Fishes and other Animals, there may be in the Heart and Blood a vital Kind of Fire which needs Air, as well as those Fires which are sensibly hot: Which may lessen the Wonder, that Animals should not be able to live when robb'd of Air.

Exp. XI. To examine the Conjecture mentioned in the last Experiment, That the Durableness of the Light in the shining Fish, in spite of the withdrawing the Air, might proceed in great Part from the *Vividness* of it, and the Beauty of the Matter it resided in, rather than from the Extent of the luminous Body, in Comparison of the small Pieces of shining Wood, I hitherto had made my Trials with; in *Dec. 1667.* I got a large Piece of Wood, whose luminous Superficies might be perhaps 10 or 12 times as great as that which the Eye saw at once of the Surface of such Fragments of shining Wood as I was wont to employ: And though some Parts of this large Superficies shined vividly enough (for rotten Wood, for the Light was usually inferior to that of our Fish) yet this great Piece being put into a convenient Receiver, was, upon the withdrawing of the Air, deprived of Light, as the smaller ones had been formerly; the returning Air restoring its Light to the one, as it had done to the other.

Exp. XII. I took some small Pieces of rotten Fish, that shone, some of them more faintly, and some of them more vividly, in reference to one another, but none as strongly as some that I could have employed; and having in a very small and clear Receiver so far drawn off the Air, as to make the included Body disappear, we so ordered the Matter, that we kept out the Air for about 24 Hours; and then allowing the Air to re-enter in a dark Place, and late at Night, upon its first Admittance the Fish regained its Light.

Exp. XIII. This compared with some of my former Observations about Putrefaction, put me upon a Trial, which, tho' it miscarried, I shall here make mention of, that in case you, who are better furnished with Glasses, think it worth while, you may get reiterated by the Society's Operator; considering how great an Interest *Putrefaction* hath in the *shining* of *Fishes*, and *Air* in the *Phænomena* of *Putrefaction*. I thought it might be somewhat to the Purpose, to take a *Fish*, that was, according to the common Course I had observed in Animals, not far from the State, at which it would begin to *shine*; and having cut out a Piece of it, I caused the rest to be hung up again in a Cellar, and the expected Piece to be put into a small and transparent Receiver, that we might observe, if a Day or two, or more, after the Fish in the Cellar should begin to shine, that in the exhausted Receiver would either also shine, or (because that seemed not likely) would, notwithstanding the Check which the Absence of the Air might be presumed to give the *Putrefaction*, be found to shine too, either immediately upon the Admission of the Air or not long after it.

But this *Experiment* was only designed and attempted, not compleated; the *Receiver* being so thin, that upon the *Exhaustion* of the internal Air, the Weight of the external broke it, and we could spare another of that Kind from Trials, we were more concerned to make: Notwithstanding which we made one Trial more, which succeeded no better than the former, but miscarried

carried upon a quite different Account, viz. Because neither the included Piece of Fish, nor the remaining, tho' it were of the same Sort with the Fishes I usually employed, would shine at all, tho' kept a pretty while beyond the usual Time, at which such Fishes were wont to grow luminous. But that this Paragraph may not be useless to you, I'll take this Occasion to give you a couple of Advertisements, that may relate not only to this Experiment, but also more generally to those whether precedent or subsequent, where *shining Fish* are employ'd.

Advertisement 1. In the first place then, I will not undertake, that all the Experiments you shall make with rotten Fish, shall have just the same Success with these I have related. For, as I elsewhere observed, that the Event of divers other Experiments is not always certain, so I have had Occasion to observe the like about *shining of Fishes*. And I remember, that having once designed to make Observations about the Light of rotten Fishes, and having, in order thereunto, caused a competent Number of them to be bought, not one of them all would shine; tho' they were bought by the same Person I was wont to employ, and hung up in the same Place where I use to have them put, and kept not only till they began to putrify, but beyond the Time that others used to continue to shine: Altho' a Parcel of the same Kind of Fishes, bought the Week before, and another of the same Kind, bought not many Days after, *shined* according to Expectation. What the Reason of this Disappointment was, I could not determine; only I remember, that at the Time it happened, the Weather was variable, and not without some Days of Frost and Snow.

Adver. II. Notice must also be taken in making Experiments with *shining Fish*, that their *Luminousness* is not wont to continue very many Days: Which Advertisement may be therefore useful, because, without it we may be apt sometimes to make Trials, that cannot be soon enough brought to an Issue, and so we may mistake the Loss of Light in the Fish to be a Deprivation of it, caused by the *Experiment*, which indeed is but a Cessation according to the usual Course of Nature.

Exp. XIV. We put a Piece of *shining Fish* into a wide-mouth'd Glass, about half fill'd with fair Water, and having plac'd this Glass in a *Receiver*, we exhausted the Air for a good while, to observe, whether when the *Pressure* of the Air was removed, and yet (by Reason of the Water that did before keep the Air from immediately touching the Fish) the Exhaustion of the Receiver did not deprive the Fish of that Contact of Air, which it had lost before; whether, I say, in this Case the Absence of the Air would have the same Influence on the shining Body, as in the former Experiments.

And here, as far as the numerous Bubbles excited in the Water would give us leave to discern it, we could not perceive, that either the Absence or Return of the Air had any great Operation upon the Light of the immersed Body.

I shall here inform you, that tho' when I formerly put together some Notes about luminous Bodies, I confined not my Observations to one or two Sorts of Fishes; yet these Experiments were all of them (except a collateral one or two) made with *Whitings*, which, among the Fishes I have had Occasion to

take

take Notice of, is (except one sort that I cannot procure) the fittest for such Trials.

Exp. XV. To prosecute the I. and IX. Experiments in one Trial, we took somewhat late at Night a Piece of rotten Fish, which we judged to shine too strongly to be quickly deprived of all its Light; and having put it into a small and clear *Receiver*, we found, as we had foreseen, that the *Light* was much impaired, but nothing near suppressed by the withdrawing of the Air. Wherefore having removed the *Receiver* into a convenient Place, I caused it to be brought to me about Midnight, and having made the Place pretty dark, I perceived the included Body to continue to shine more vividly than one would have expected (and, if I mistake not, I saw it shining in the Morning whilst it was dark;) but the Night after, coming to look upon it again, its *Light* appeared no more: Notwithstanding which, I made a Shift to keep out the Air about 24 Hours longer, and so after 48 Hours in all, we opened the *Receiver* in a dark Place, and presently upon the *Ingress* of the Air, were pleasingly saluted with so vivid an Apparition of Light, that the included Body continued to shine, when carried into a Room, where there was both Fire and Candle, if it were but by a *Hat* skreen'd from the Beams.

Being encouraged, as well as pleased with this Success, we forthwith exhausted the Air once more out of the same Receiver, and having kept it about 4 Hours longer, we look'd upon it again in a dark Place, and finding no Appearance of Light, let the Air in upon it, whereby it was made to shine again, and that vigorously enough.

The Suddenness, with which the included Body appeared to be, as 'twere, *rekindled* upon the first Contact of the *Air*, revived in me some Suspicions, I have had, about the possible Causes of these *short-lived Apparitions of Light* (for I speak not now of real Lamps found in Tombs, for a Reason to be told you another Time) which disclosing themselves upon Mens coming in, and consequently letting in fresh Air into Vaults, that had been very long close, did soon after vanish.

These Thoughts, as I was saying, occurred to me upon what I had been relating, by Reason of the *sudden Operation* of the fresh Air upon a Body, that but a Minute before disclosed no *Light*. For though the *Lights* reported to have been seen in Caves, quickly disappeared, which that of our Fish did not; yet that Difference might possibly proceed from the Tenacity, or some other Disposition of the Matter, wherein the *Luminousness* of the Fish resides: For I remembered that I had more than once observed a certain glimmering and small *Light* to be produced in a Sort of Bodies, upon putting them out of their former Rest, and taking them into the Air; which Sparks would vanish themselves, sometimes within one Minute, sometimes within a few Minutes. But as these Thoughts were but transient Conjectures; so I shall not entertain you any longer about them, but rather contenting myself with the Hint already given, take Notice of what may be more certainly deduced from our Experiment, which is, that the Air may have a much greater Interest in divers odd *Phænomena* of Nature, than we are hitherto aware of.

And

And for Confirmation of our Experiment, I shall add, that having in another *Receiver* eclipsed a Piece of Fish that shone when 'twas put in more languidly than divers others we had tried, I kept it about 3 Days and 3 Nights in a *Receiver*; after which I opened it in the Dark, and upon letting in the Air upon this Body, that shined but faintly at first, it immediately recovered its so long suppressed Light. And having included another Piece that was yet more faint than this, when it was put into the *Receiver*, and having kept this Piece also 3 Days and 3 Nights in the exhausted Glass, I let in the Air upon it; and notwithstanding the Darkness of the Place, nothing of Light was thereupon revived. But this being little other than I expected from a Body that shined so faintly, when 'twas put into the *Receiver*, and had been kept there so long, I resolved to try whether the Appulse and Contact of the Air would have that Operation after some Time that it had not at first; and accordingly, after having waited a while, I observed the Fish to disclose a Light, which tho' but dim, was yet manifest enough.

I shall only add, That having included in small *Receivers* 2 Pieces of rotten *Whittings*, whereof the one, before it was put in, scarce shone so vividly as did the other after the *Receiver* was exhausted; and having ordered the Matter so, that we were able to keep out the Air for some Days, at the End of about 48 Hours, we found, that the more strongly shining Body retained yet a deal of Light; but afterwards looking upon them both in a dark Place, we could not perceive in either any Shew of Light. Wherefore having let in the Air into that *Receiver*, whereinto the Body that at first shined the faintlier had been put, there did not ensue any glimmering of Light for a pretty while; nay, upon the rushing in of the Air into the other Glass, the Body that at first shone so strongly, and that continued to shine so long, shewed no glimmering of Light. But within less than a Quarter of an Hour we saw a manifest Light in the Body last named, and a while after the other also became visible, but by a Light very dim. The more luminous of these Bodies I observed to retain some Light 24 Hours after; and the hitherto recited Experiment had this peculiar Instance in it, that the 2 *Receivers* were uninterruptedly kept exhausted no less than 4 Days, and as many Nights.

LXXVII. I. 1. We put a full grown Duck into a *Receiver*, whereof she filled, by our Guess, a third Part, or somewhat more, but was not able to stand in any easy Posture in it; then pumping out the Air, within the short Space of one Minute, she appeared much discomposed, and between that and the second Minute, her struggling and convulsive Motions increased so much, that her Head also hanging carelessly down, she seemed to be just at the Point of Death: So that it did not appear, that, notwithstanding the peculiar Structure of some Vessels about the Heart, which enable these and other Water Birds to continue without Respiration for some Time under the Water, this Duck was able to hold out considerably longer than a Hen, or other Bird not aquatick might have done.

This Duck, being revived upon the Admission of fresh Air, and again shut up in the same *Receiver* with the Air in it, continued five Times as long as before without appearing any ways discomposed.

Pneumati-
cal Experi-
ments; By
Mr. Boyle,
n. 62. p.
2011. Upon
Ducks.

2. We conveyed a Duckling, that was not yet callow, into the same *Receiver*, and observed, that before the first Minute was quite ended, she gave manifest Tokens of being much disordered, and before a second Minute was expir'd, several convulsive Motions obliged us to let the Air in upon her, whereby she quickly recovered.

N. B. When the *Receiver* was pretty well exhausted, she appear'd manifestly bigger than before the Air was withdrawn, especially about the Crop, tho' that was very turgid before. We kept the same Duckling in the same *Receiver* very close, to keep out all external Air, and to keep in the *excrementitious* Steams of her Body for above 6 Minutes, without perceiving her to grow sick upon her Imprisonment.

Vipers.

II. 1. *Jan.* 166 $\frac{2}{3}$. We included a Viper in a small *Receiver*, and as we drew out the Air, she began to swell, and afforded us these *Phænomena*.

1. It was a good while after we had left pumping, e'er the Viper began to swell so much as to be forced to gape; which afterwards she did.

2. That she continued, by our Estimate, above 2 $\frac{1}{2}$ Hours in the exhausted *Receiver*, without giving clear Proof of her being killed.

3. That after she was once so swell'd, as to be compelled to open her Jaws, she appear'd slender and lank again, and yet very soon after appear'd swell'd again, and had her Jaws disjoined as before.

2. We took a Viper, and including her in the greatest Sort of small *Receivers*, we emptied the Glass very carefully, and the Viper moved up and down within, as it were to seek for Air, and after a while foamed a little at the Mouth, and left of that Foam sticking to the inside of the Glass. Her Body swelled not considerably, and her Neck less, till a pretty while after we had left pumping; but afterwards the Body and Neck grew prodigiously tumid, and a Blister appeared upon the Back. An Hour and an Half after the Exhaustion of the *Receiver* (which we then, by Trial, found to be pretty staunch) the distended Viper did give by Motion, manifest Signs of Life; but we observed none afterwards. The Tumour reached to the Neck, but did not seem much to swell the under Chap. Both the Neck and a great Part of the Throat being held betwixt the Eye and the Candle, were transparent enough, where the Scales did not darken them. The Jaws remained mightily opened, and somewhat distorted; the *Epiglottis* with the *Rimula Laryngis* (which remained gaping) was protruded almost to the farther End of the nether Chap. As it were, from beneath this *Epiglottis* came the black Tongue, and reached beyond it, but seemed by its Posture not to have any Life, and the Mouth also was grown blackish within: But the Air being re-admitted after 23 Hours in all, the Viper's Mouth was presently closed, though soon after it was opened again, and continued long so; and scorching or pinching the Tail made a Motion in the whole Body, that argued some Life.

3. *April* 25. We included an ordinary harmless Snake, together with a Gage, in a pretty portable *Receiver*, which, being exhausted and well secured against the *Ingress* of the Air, was laid aside in a quiet Place, where it continued from 10 or 11 a-Clock in the Forenoon, till about 9 the next Morning; and

and then, though he seemed to be dead, and gave no Signs of Life upon the shaking of the *Receiver*; yet upon holding the Glass at a convenient Distance from a moderate Fire, he did in a short Time manifest himself to be alive by several Tokens, and even by putting forth his forked Tongue. In that Condition I left him, till the next Day, early in the Afternoon; at which Time he was grown past Recovery, and his Jaws, which were formerly shut, gaped exceeding wide, as if they had been stretched open by some external Force.

III. 1. *Sept.* 9, 1662. We took a large lusty Frog, and having included her in a small *Receiver*, we drew out the Air, and left her not very much swell'd, and able to move her Throat from Time to Time, though not so fast as when she freely breathed before the Exsuction of the Air. She continued alive about 2 Hours that we took Notice of, sometimes removing from the one Side of the *Receiver* to the other; but she swelled more than before, and did not appear by any Motion of her Throat or Thorax to exercise Respiration; but her Head was not very much swell'd, nor her Mouth forced open. After she had remained there somewhat above 3 Hours (for it was not $3\frac{1}{2}$ Hours) perceiving no Sign of Life in her, we let in the *Air* upon her, with which the formerly tumid Body shrunk very much, but seemed not to have any other Change wrought in it; and though we took her out of the *Receiver*, yet in the *free Air* itself, she continued to appear stark dead. Nevertheless to see the utmost of the Experiment, having caused her to be laid upon the Grass in a Garden all Night, the next Morning we found her perfectly alive again.

2. *Jan.* 29, 1660. About 11 of the Clock in the Forenoon, we put a *Frog* into a small *Receiver*, containing about $15\frac{1}{4}$ Ounces Troy Weight of *Water*, out of which we had tolerably well drawn the *Air* (so that when we turned the Cock under *Water*, it sucked in about $13\frac{1}{4}$ Ounces of *Water*;) The *Frog* continued in it (the *Receiver* all the while under *Water*) lively enough till about 5 of the Clock in the Afternoon, when it expired. The *Frog* at the first seemed not to be much altered by the *Exsuction* of the *Air*, but continued *breathing* both with her Throat and Lungs.

3. *Sept.* 6th, 1662. We included into a large *Receiver* a couple of *Frogs* newly taken, the one not above an Inch long, and proportionally slender; the other very large and lusty. Whilst the *Air* was drawing out, the lesser *Frog* skipped up and down very lively, and somewhat to our Wonder, clambered up several Times to the Sides of the *Receiver*, insomuch that he sometimes rested himself against the Sides of the Glass, when his Body seemed to be perpendicular to the *Horizon*, if not in a *reclining Posture*. He continued to skip up and down a while after the *Exsuction* of the *Air*, but within a quarter of an Hour (measured by a *Minute-Watch*) we perceived him to lie stark dead, with his Belly upwards. The other *Frog* that was very large and strong, tho' he began to swell much upon the withdrawing of the *Air*, and seemed to be distressed, by his frequently leaping up, after the *Air* was drawn out, which he did not before, yet being as we said very lusty, he held out half an Hour; at which Time the Weight of the outward *Air* broke the *Receiver*, and thereby brought him a Reprieve.

4 Sept. 11. We took a small *Frog*, and having conveyed her into a very small portable *Receiver*, we began to pump out the Air. At first she was lively enough, but when the Air began to be considerably withdrawn, she appeared to be very much disquieted (leaping sometimes after an odd Manner, as it were to get out of the uneasy Prison) but yet not so, but that after the Operation was ended, and the *Receiver* taken off, the *Frog* was perfectly alive, and continued to appear so (if I am not mistaken) near an Hour, tho' the *Abdomen* was very much, and the *Throat* somewhat extended; this latter Part having also left that wonted panting Motion that is supposed to argue and accompany the *Respiration* of *Frogs*. At the end of about 3 $\frac{1}{4}$ th Hours, after the Removal of the *Receiver* from the *Pump*, the Air was let in; whereupon the *Abdomen*, which by that Time was strangely swelled, did not only subside, but seemed to have a great Cavity in it, as the *Throat* also proportionally had; which Cavities continued, the *Frog* being gone past all Recovery.

5. Apr. 14. A large *Frog* was conveyed into a plated *Receiver*, and the *Air* being withdrawn, her Body by Degrees was distended. The *Receiver* with the *Gage* were kept under Water near 7 Hours; at the End of which I found the *Receiver* staunch, but the *Frog* dead and exceedingly swelled; upon the letting in of the *Air*, she became more hollow and lank than ever.

Kitling.

IV. Being desirous to try whether *Animals* that had lately been accustomed to live either without any, or without a full *Respiration*, would not be more difficultly or slowly killed by the want of the *Air*, than others, which had been longer used to a free *Respiration*; we took a *Kitling* that had been kitten'd the Day before, and put it into a very small *Receiver* that we guessed to hold about a Pint or less, that it might be the sooner exhausted. Within one *Minute*, or a little more, after the *Air* first began to be withdrawn, the little Animal, who in the mean Time had gasped for Life, and had some violent *Convulsions*, lay as dead, with its Head downwards, and its Tongue out; but upon letting in of the *Air*, it did in a Trice shew Signs of Life, and being taken out of the *Receiver*, quickly recovered.

Another of the same Litter being put into the same *Receiver*, quickly began, like the other, to have *Convulsions*, after which it lay as dead. But tho' we continued pumping, and could not perceive that the *Engine* leaked more than in the former Experiments; the *Kitling* began to stir again, and after a while had stronger and more general *Convulsions* than before, till at the End of full 6 *Minutes* after the *Exsuction* of the *Air* was begun, the *Animal* seeming quite dead, was taken out of the Vessel, and lay with its Mouth open, and its Tongue lolling out, without any sensible Breathing and Pulsation; till having ordered it to be pinched, the Pain, or some internal Motion, produced by the external Violence done to it, made it immediately give manifest Signs of Life; tho' there was yet no sensible Motion of the *Heart* or the *Lungs*; but afterwards gaping and fetching its *Breath* in an odd Manner, and with much straining, as I have seen some *Fetus's* do when cut out of the *Womb*, it by little and little, within about a quarter of an Hour, recovered.

Inclosing

Inclosing another *Kitling* kitten'd at the same Time, in the same *Receiver*, we observed, that divers violent *Convulsions*, as it were gasping for Breath, into which it began to fall at the second or third Suck' ended in a seeming Death, within about a Minute and a half. A while after, notwithstanding our continuing to pump, the *Kitling* gave manifest Signs of Life, which was not till it had endured divers *Convulsions*, as great as those of the first Fit, if not greater. When 7 *Minutes* from the Beginning of the Exhaustion were completed, we let in the *Air*, upon which, the little Creature that seem'd stark dead before, made us expect that it might recover; but tho' we took it out of the *Receiver*, and put *Aqua-vitæ* into its Mouth, yet it irrecoverably died in our Hands.

By what has been related, it appears, that those Animals continued 3 Times longer in the exhausted *Receiver*, than other Animals of that Bigness would probably have done.

V. 1. We put some Water in an open *Tube*, and suffered the *Air latitant* in it to escape in an *exhausted Receiver*, without any Artifice to catch it; by which Trial, the Water did not part with any thing of its Bulk, that made a Diminution sensible to the Eye. The Air concealed in the Pores of Liquors.

2. A chymical Pipe, sealed at one End, and 36 *Inches* (or somewhat less) in Length, was filled with Water, and inverted into a Glass Vessel, not two *Inches* in Diameter, and but $\frac{1}{4}$ th of an *Inch* or little more in Depth. These Glasses being conveyed into a fit *Receiver*, and the *Air* being leisurely pump'd out, and somewhat slowly re-admitted, the numerous Bubbles that had ascended during the Operation, constituted at the Top an *Aereal Aggregate*, amounting to $\frac{1}{100}$ wanting about an 100 Part of an *Inch*.

3. Presently after, another *Tube* was filled again with the same Water, and inverted, and the Water being drawn down to the Surface of the vesselled Water, and the *Air* let in again, the Water was impelled up to the very Top, within a 10th and half a Tenth of an *Inch*.

4. The *Tube* for measuring the *Air latitant* in the Water, was $43\frac{1}{2}$ *Inches* above the Surface of the stagnant Water: The *Air* collected out of the Bubbles at the Top of the Water, was the first Time $\frac{1}{4}$ of an *Inch*, and somewhat better; the second Time we estimated it but $\frac{1}{5}$ and $\frac{1}{6}$. The first Time the Water in the *Pipe* was made to subside full as low as the Surface of the restagnant Water: The second Time, the lowest we made it subside seem'd to be 4 or 5 *Inches* above the Surface of the Water in the open Vessel.

I must here advertise, that the *Air* at the Top of the *Tube* did possess more Room than its Bulk did absolutely require, because it was somewhat defend- ed from the Pressure of the *Atmosphere* by the Weight of the subjacent *Cylinder* of Water, which might be about 3 or 4 Foot long.

5. We provided a clear round *Glass*, furnished with a *Pipe* or *Stem* of about 9 *Inches* in Length, the globulous Part of the *Glass* being on the outside about $3\frac{1}{2}$ *Inches* in Diameter; the *Pipe* of this *Glass* was within an *Inch* of the Top melted at the Flame of a Lamp, and drawn out for two or three *Inches* as slender as a *Crow's Quill*, that the Decrement of the *Water* upon the Recess of the *Air* harboured in its *Pores*, might, if any should happen, be the more easily

easily observed and estimated. Above this slender Part of the *Pipe*, the *Glass* was of the same Largeness (or near it) with the rest of the *Pipe*, that the *Aerial Bubbles*, ascending thro' the slender Part, might there find Room to break, and so prevent the overflowing, or Loss of any Part of the *Water*.

This Vessel being, not without Difficulty and some Industry, filled, till the *Liquor* reached to the Top of the slender Part, where not being uniformly enough drawn out, it was somewhat broader than elsewhere, we conveyed the *Glass*, together with a Pedestal for it to rest upon, into a tall *Receiver*, and pumping out the Air, there disclosed themselves numerous *Bubbles* ascending nimbly to the upper Part of the *Glass*, where they made a kind of Froth or Foam; but by Reason of the above-mentioned Figuration of the Vessel, they broke at the Top of the slender Part, and so never came to overflow. This done, the *Pump* was suffered to rest a while, to give the *Aereal Particles*, lodged in the *Water*, Time to separate themselves and emerge: which when they had done a pretty while, the *Pump* was ply'd again, for fear some *Air* should have stolen into so large a *Receiver*.

These Vicissitudes of *Pumping* and *Resting* lasted for a considerable Time, till at length the *Bubbles* began to be very rare, and we weary of waiting any longer; soon after which, the external Air was let into the *Receiver*, and it appear'd somewhat strange to the Spectators, that notwithstanding so great a Multitude of *Bubbles* as had escaped out of the *Water*, I could not by attentively comparing the Place where the Surface of the *Water* rested at first (to which a Mark had been affixed) with that where it now stood, I could not, I say, discern the Difference to amount to above, if so much as an Hair's breadth; and the chief Operator in the Experiment professed, that for his part, he could not perceive any Difference at all.

6. Filling a *Glass* of the same *Shape*, and much of the same Bigness, with *Claret-Wine*, and placing it upon a convenient Pedestal, in a tall *Receiver*, we caused some of the Air to be pumped out: Whereupon in a short Time there emerged thro' the slender *Pipe* so very great a Multitude of *Bubbles*, that were darted as it were upwards, as did not a little both please and surprize the Beholders: But it forced us to go warily to work, for fear the *Glass* should break, or the *Wine* overflow. Wherefore we seasonably left off pumping, before the *Receiver* was any thing near exhausted, and suffered the *Bubbles* to get away as they could, till the present Danger was over-passed, and then from Time to Time we pumped a little more *Air* out of the *Receiver*, till we were weary; the withdrawing of a moderate Quantity of Air at a Time sufficing, even at the latter End, to make the *Bubbles* not only copiously, but very swiftly ascend, (by a *Minute-Watch*) for above a quarter of an Hour together.

Shell-Fishes.

VI. 1. An *Oyster* being put into a very small *Receiver*, and kept in long enough to have successively killed three or four Birds or Beasts, &c. was not thereby killed, nor, for ought we could perceive, considerably disturbed, only at each Suck we perceived, that the Air contained between the 2 *Shells* broke out at their Commissure; as we concluded from the Foam which at those Times came forth all round that Commissure. About 24 Hours after, I found that both this and another that had been put into the *Receiver* at the same Time were alive.

2. We

2. We put a pretty large *Craw-fish* into a pretty large *Receiver*, and found that tho' he had been injur'd by a Fall before he was brought thither, yet he seemed not to be much incommoded by being included, till the Air was in great measure pumped out, and then its former Motion presently ceas'd, and he lay as dead; till upon the letting in a little Air into the *Receiver*, he began forthwith to move afresh; and upon the withdrawing the *Air* again, or presently, as before, became moveless. Having repeated this Trial 2 or 3 Times, we took him out of the *Receiver*, where he appeared not to have suffered any Harm.

3. Having put an *Oyster* into a Vial full of *Water*, before we included it in the *Receiver*, it proved so strong, as to keep itself close shut, and repressed the *Eruption* of the *Bubbles* that in the other did force open the Shells from Time to Time, and kept in its own Air as long as we had occasion to continue the Trials.

4. Moreover, a *Craw-fish*, that was thought more vigorous, being substituted in the Place of the former *Craw-fish*, tho' once he seemed to lose his Motion together with the Air, yet afterwards he continued moving in the *Receiver*, in spite of our Pumping.

VII. We took a *Receiver* shaped almost like a *Bolt-head*, containing by Estimation near a *Pint*, and the *globulous* Part of it being almost half full of *Water*, we put into it, at the *Orifice* (which was pretty large) a small *Gudgeon*, about 3 *Inches* long, which when it was in the *Water*, swam nimbly up and down therein. Then having drawn out the *Air* so well, that we guessed by a *Gage*, that about 19 Parts of 20 or more might be exhausted, we secured ourselves that the Regress of the *Air* should not injure our Experiment; about which we observed that,

1. The Neck of the Glass being very long, though there appeared great Store of Bubbles all about the Fish; yet the rest of the *Water*, notwithstanding the withdrawing of so much *Air* as had been mentioned, emitted no Froth, and but few Bubbles.

2. The Fish both at his Mouth and Gills did, for a great while, discharge such a Quantity of Bubbles as appear'd strange, and for about half an Hour or more, (for much longer I had not Opportunity to watch it) whenever he rested a while, new Bubbles would adhere to many Parts of his Body (as if they were generated there) especially his Fins and Tail: So that he would appear almost beset with *Bubbles*; and if, being excited to swim, he was made to shake them off, he would quickly, upon a little Rest, be beset with new ones as before.

3. Almost all the while he would gape and move his Gills, as before he was included; though towards the End of the Time that I watch'd, it often happened, that he neither took in, nor emitted any *Aereal* Particles that I could perceive.

4. After a while, he lay almost constantly with his Belly upwards, and yet would in that Posture swim briskly as before.

5. Nay, after a while, he seemed to be more lively than at first putting in; whether by Reason, that by Discharge of so many Bubbles, which by their Dis-

sension,

sension, perhaps, put him to Pain, he found himself relieved, or for some other Cause, I examine not.

6. About an Hour and an half after he had been sealed up, I found him almost free from Bubbles, and with his Belly upwards, and seeming somewhat tumid, but yet lively as before. But an Hour and a quarter after that, he seemed to be moveless and somewhat still; yet upon shaking the Glass, observing some faint Signs of Life in him by some languid Motions he attempted to make when excited to them, I opened the *Receiver* under *Water*, to try if that Liquor and Air would recover him; and the external *Water* rushing in, till it had filled the vacant Part of the Ball, and the greatest Part of the Stem too, the Fish sunk at the Bottom of it, with a greater Appearance than ever of being alive; in which State after he had continued a pretty while, I made a shift, by the Help of the *Water* he swam in, to get him through the Pipe into a Basin of *Water*, where he gave more manifest Signs of Life; but yet for some *Hours* lay on one Side or other, without being able to swim or lie on his *Belly*, which appeared very much shrunk in, as if something, during the Time of its being sealed up, had been broken in his *Body*, or his *Belly* had been exceedingly distended, beyond Restitution of its former Tone.

All the while he continued in the Basin of *Water*, though he moved his Gills as before he had been sealed up; yet I could not perceive, that he did, even in his new *Water*, emit, as formerly, any *Bubbles*, though two or three Times I held him by the Tail in the *Air*, and put him into the *Water* again, where at length he grew able to lie constantly upon his *Belly*, which yet retained much of its former Lankness. He lived in the Basin 8 or 10 Days, though divers other *Gudgeons* died there in much fewer Days.

Wounded
Animals.

VIII. 1. Sept. 12. A small *Bird*, having the *Abdomen* opened almost from Flank to Flank, without injuring the *Guts*, was put into a small *Receiver*, and the *Pump* being set a-work, continued for some Time without giving any Signs of Distress: But at the End of about a *Minute* and a *half* from the Beginning of the *Exhaustion*, she began to have convulsive Motions in the Wings; and though the *Convulsions* were not universal, nor did appear violent, as is usual in other *Birds* from whom the *Air* is withdrawn by the Engine, yet at the End of two full *Minutes*, letting in the *Air*, and then taking off the *Receiver*, we found the *Bird* irrecoverable; notwithstanding which, we did not find any notable Alteration in the *Lungs*, and found the *Heart* (or at least the *Auricles* of it) to be yet beating, and so it continued for a while after.

2. We took also a pretty large *Frog*, and having, without violating the *Lungs* or the *Guts*, made two such Incisions in the *Abdomen*, that the two curl'd *Bladders* or *Lobes* of *Lungs* came out almost totally at them, we suspended the *Frog* by the Legs in a small *Receiver*, and after we had pumped out a good Part of the *Air*, the Animal struggled very much, and seem'd to be much disorder'd, and when the *Receiver* was well exhausted, she lay still for a while as if she had been dead, the *Abdomen* and Thigh very much swell'd, as if some rarified *Air* or Vapour forcibly distended them. But as, when the *Frog* was put in, one of the *Lobes* was almost full, and the other almost shrunk up,

so they continued to appear after the *Receiver* had been exhausted; but upon letting in of the Air, not only the Body ceased to be tumid, but the plump Bladder appeared for a while shrunk up as the other, and the *Receiver* being removed, the *Frog* presently revived, and quickly began to fill the *Lobe* again with Air.

IX. 1. The *Heart* of an *Eel* being taken out and laid upon a Plate of Tin in a small *Receiver*, when we perceived it to beat there, as it had done in the open *Air*, we exhausted the Vessel, and saw, that though the *Heart* grew very tumid, and here and there sent forth little Bubbles, yet it continued to beat as manifestly as before, and seem'd to do so more swiftly, as we tried by numbering the *Pulsations* it made in a *Minute*, whilst it was in the exhausted *Receiver*, and when we had re-admitted the *Air*, and also when we took it out of the *Glass* and suffered it to continue its Motion in the open *Air*.

The separated
Hearts of
Cold Animals

2. The *Heart* of another *Eel*, after having been included in a *Receiver*, first exhausted, and then accurately secur'd from leaking, though it appear'd very tumid, continued to beat there an Hour; after which looking upon it, and finding its Motion very languid, and almost ceas'd, by breathing a little upon that Part of the *Glass* where the *Heart* was, it quickly regained Motion, which I observ'd a while, and an Hour after finding it to seem almost quite gone, I was able to renew it by the Application of a little more Warmth.

At the End of the 3d Hour I could no more excite it by *Warmth*; wherefore I suffered the outward *Air* to rush in, but could not discern, that thereby the *Heart* regained any sensible Motion, though assisted with the *Warmth* of my *Breath* and *Hands*.

X. A sufficient Number of Instances of *Animals* kill'd in the exhausted *Receiver*, is to be met with in our other Experiments: And therefore I shall now subjoin some Trials, about the Times wherein *Animals* may be kill'd by that want of Respiration, which, in those that are drowned, is caused by the *Water* that suffocates them.

Animals
drowned
and deprived
of Air.

1. Sept. 10. A *Green-Finch*, having his Legs and Wings tied to a Weight, was gently let down into a *Glass Body* fill'd with *Water*; and at the end of half a *Minute* he was found quite Dead.

2. A *Sparrow*, that was lusty and quarrelsome, was let down after the same Manner; but though he seem'd to be under *Water* more vigorous than the other Bird, and continued struggling almost to the very end of half a *Minute* from the Time of its being totally *Immersed* (during which stay under *Water* there ascended from Time to Time, pretty large *Bubbles* from his Mouth) yet notwithstanding that as soon as ever the half *Minute* was completed he was drawn up, we found him, to our Wonder, irrecoverably gone.

3. A small *Mouse*, being held under *Water* by the Tail, emitted from Time to Time divers *Aereal Bubbles* out of his Mouth, and at last, as one of the Spectators affirmed he saw, at one of his Eyes. Being taken out at the end of half a *Minute* and some few Seconds, he yet retained some Motions; but they proved but convulsive ones, which at last ended in *Death*.

4. We took the *Duck* mentioned above, and so tied a considerable Weight of Lead to her Body, as it did not hinder her Respiration, and yet

vid. Sup. 1.
Exp. 1.

would

would be sure to keep her down under Water. With this Clog she was put into a Tub full of clear *Water*, under whose Surface she continued about a Minute by my Watch quietly enough, but afterwards began to appear for a while much disturbed; which Fit being over, our not perceiving any Motion in her, made us, at the end of the *second Minute*, take her out of the *Water*, to see in what Condition she was, and finding her in a good one, after we had allowed her some breathing Time to recruit herself with *fresh Air*, we let her down again into the Tub, which in the mean Time had been filled with *fresh Water*. After a while, she began, and from Time to Time continued, to emit divers *Bubbles* at her Beak. There also came out at her Nostrils divers real *Bubbles* from Time to Time; and when the Animal had continued about *two Minutes* or better under *Water*, she began to struggle very much, and to endeavour either to emerge, or change Postures; the latter of which she had liberty to do, but not the former. After *four Minutes* the *Bubbles* came much more sparingly from her: Then also she began to gape from Time to Time, (which we had not observed her to do before) but without emitting *Bubbles*; and so she continued gaping till near the End of the *6th Minute*, at which Time all her Motions, some of which were judged *Convulsive*, and others that had been excited by our rousing her with a *Forceps*, appear'd to cease, and her Head to hang carelessly down as if she were quite dead. Notwithstanding which, we thought fit for greater Security to continue her under *Water* a full *Minute* longer, and then finding no Signs of Life, we took her out; and being hung by the Heels, and gently pressed in convenient Places, she was made to void a pretty Quantity of Water. But all the Means that were used to recover the Bird to Life, proving ineffectual, we concluded, she had been dead a full *Minute* before we removed her out of the *Water*: So that to sum up the Event of our *Experiment*, even this *Water-Bird* was not able to *live* in *cold Water*, without taking in *Fresh-Air*, above *6 Minutes*.

Vid. Sup. 1.
Exp. 2.

5. The *Duckling* (mentioned above) having a competent Weight ty'd to her Legs, was let down into a *Tub* of *Water*. There came out Store of *Bubbles* at her Nostrils, but there seem'd to come out more and greater from a certain Place in her Head almost equi-distant from her Eyes, but somewhat less remote from her Neck than they. After much struggling and frequent gaping, she had divers *convulsive* Motions, and then let her Head fall down backward with her Throat upwards. To which moveless Posture she was reduced at the End of the *third Minute*, if not a little sooner; but a while after there appeared a manifest but tremulous Motion in the two Parts of her Bill, which continued for some Time, but afforded no Circumstances, whereby we could be sure, that they were not *convulsive* Motions; but these also ceasing upon the End of the *fourth Minute*, the Bird was taken out and found irrecoverable.

From these two Experiments it appears, that tho' *Water-Fowl* (at least *Ducks*) could not in our *Receivers* endure the want of *Air* much longer than other *Birds*; yet by that Contrivance of Nature mentioned about the *Heart*, they are enabled to continue much longer under *Water*.

6. A *Viper* that was kept so many Hours in an *exhausted Receiver* till it was concluded to be stark *dead*, and to have been so for a good while, was kept all Night in a *Glaſs-Body* upon a warm digestive *Furnace*. Whereupon the *Viper* was found, the next Morning, to be very *lively*. We then put her into a tall *Glaſs-Body* fitted with a *Cork* to the *Orifice* of it, and depressed with *Weight*, so that she could come at no *Air*. And after she had been *duck'd* a while, she lay with a very little *Motion* for a considerable *Space* of *Time*. At an *Hour* and a *quarter* she often put out her black *Tongue*; at near 4 *Hours* she appear'd much *alive*, and, as I remember, about that *Time* also put out her *Tongue*, *swimming* all this while, as far as we observed, above the *Water*. At the end of about 7 *Hours* or more, she seem'd yet to have some *Life* in her, her *Posture* being manifestly changed in the *Glaſs* from what it was a while before, unless that might proceed from some *Difference* made in her *Body* as to *Gravity* and *Levity*. Not long after she appeared quite *dead*; her *Head* and *Tail* hanging down *movelessly*, and directly towards the *Bottom* of the *Vessel*, whilst the middle of the *Body* floated as much as the above-mentioned *Cork* would permit it.

I must here take notice, that though some of the above-mentioned *Animals* seem by the *Relations* we have given of them, to have been a little sooner destroyed by *Drowning*, than any we have mentioned were by our *Engine*, yet that is no sure *Proof*, that *Suffocation* does kill *Animals* faster than the *Deprivation* of *Air*, they are exposed to in our *Engine*. For in *Drowning*, that which destroys is applied to its full *Vigour* at the very first, and all at once; whereas our *Receivers*, being made for several *Purposes*, the *Deprivation* of the *Air*, that they make, cannot be made all at once, but the *Air* must be *pump'd* out by *Degrees*; so that till the last the *Receiver* will be but partly emptied. For *Confirmation* of which I have this to alledge, that, having in the *Presence* of some *Virtuosi*, provided for the nonce a very small *Receiver*, wherein yet a *Mouse* could live some *Time* if the *Air* were left in it, we were able to evacuate it at *one Suck*, and by that *Advantage* we were enabled, to the *Wonder* of the *Beholders*, to kill the *Animal* in less than *half a Minute*.

XI. 1. *Aug.* 16. A *Linnet* being put into a *Receiver*, capable to hold about four *Pints* and a half of *Water*, the *Glaſs* was well closed with *Cement* and a *Cover*; but none of the *Air* was drawn out with the *Engine*, or otherwise. And though no new *Air* was let in, nor any change made in the imprisoned *Air*, yet the *Bird* continued there 3 *Hours* without any apparent *Approach* to *Death*; and though it seem'd somewhat *Sick*, yet being afterwards taken out it recovered, and lived several *Hours*.

2. *Aug.* 18. From the above-mentioned *Receiver* about *half* the *Air* was drawn out, a *Linnet* being then in the *Glaſs*, and in the *rarified Air* (which appear'd by a *Gage* to continue in that *State*) the *Bird* lived an *Hour* and near a *quarter* before it seem'd in *Danger* of *Death*; after which the *Air* being let in without taking off the *Receiver*, she manifestly recovered, and leap'd against the *Side* of the *Glaſs*; being taken out into the *open Air*, she flew out of my *Hand* to a pretty *Distance*.

3. *Sept.*

Animals in rarified Air,
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3. *Sept. 9.* We conveyed into a *Receiver*, capable to hold about $4\frac{1}{2}$ *Pints* of Water, a *Lark*, together with the *Gage*, by the Help whereof we pump'd out of the *Receiver* $\frac{3}{4}$ of the *Air* that was in it before; then heedfully observing the *Bird*, we perceived it to pant very much, so that a learned Physician (from whom I yet dissented) judged these Beatings to be *Convulsive*: Having continued thus for a little above a *Minute* and a half, the *Bird* fell into a true *convulsive* Motion, that cast it upon the Back. And although we made great haste to let in the *Air*, yet before the Expiration of the *second Minute*, and consequently in less than *half* a *Minute* from the Time immediately preceding the *Convulsion*, the *Lark* was gone past all Recovery.

4. Presently after we put into the same *Receiver* a *Green-finch*, and having withdrawn the *Air*, till it appeared by the *Gage* there remained but *half*, we took notice, that, within a *Minute* after, she appeared to be very *sick*, and shaking her Head, threw against the inside of the Glass a certain Substance, which I took to be *Vomit*, and which afterwards appeared so; upon this *Evacuation* the *Bird* seemed to recover, and continue pretty well (but not without panting) till about the end of the 4th *Minute*, at which growing very *sick*, she vomited again (shaking her Head as at first,) but much more unquestionably than before, and soon after, eat up again a little of her *Vomit*: At which Time (whether that contributed to her Recovery or no) she very much recovered. And though she had, in all, three Fits of Vomiting, yet for the last 7 or 8 *Minutes* that we kept her in the *Receiver* she seemed to be much more *lively* than was expected: Which may in Part be attributed to a little *Air* that by an Accident got in, tho' it were immediately *pump'd* out again. At the end of a full *quarter* of an *Hour* from the first Exhaustion of the *Receiver*, the *Bird* appearing little likely to die in a while, we took her out.

5. *April 12.* A *Viper* was included, together with a *Gage*, in a portable *Receiver*, capable to hold $3\frac{1}{2}$ *Pints* of Water. The Vessel being exhausted, and secured against the Regress of the *Air*, the imprisoned Animal was observ'd not only to be alive, but nimbly to put out and to draw back its Tongue, about 36 *Hours* after it was first shut up. At the end of 60 *Hours*, as I was going to Bed, she appear'd very dull and faint, and not likely to live much longer; the next Day after *Dinner*, I found her stark *dead*, with her Mouth open'd to a strange Wideness: Wherefore suffering *Water* to be impelled by the outward *Air* into the Cavity of the *Receiver*, we found that 4 Parts of 5, or rather 5 of 6 of the vesselled *Air* had been pumped out.

Difficult Respiration at the Tops of Mountains.

6. I shall here add, that, an ecclesiastical Person, who had visited those *high Mountains* of *Armenia* (on one of which, because of their Height, the Tradition of the Natives will needs have the *Ark* to have rested;) told me, that those *Mountains* were really exceeding *high*, and that he could not come to the *Top*, (because of the unpassable *Snows*) And that whilst he was in the upper Part of the *Mountain*, he plainly perceived that he was reduced to fetch his Breath much oftner than he was wont, and than he did before he ascended the Hill, and after he came down from it; and that having exprest some Wonder to find himself so short-winded, the People told him, that it was no more than happened

happened to them when they were so high above the Plain ; it being a common Observation among them. He also told me, that he made the like Observation upon the *Top* of a Mountain in the Country of *Sevennes*, in or near the Province of *Languedoc*.

A learned Traveller, who was a Person very Curious and Intelligent, told me, that being invited, about the beginning of *September*, to visit a neighbouring Mountain that is at least one of the *biggest* of the *Pyreneans*, which is commonly call'd *Pic de Midi*, they found the *Air* there not so fit for *Respiration* as common *Air*, and were fain to breath *shorter* and *oftner* than usual ; and because I suspected, that might come from their Motion, I asked whether they observed it to cease when they came down to the *Bottom* of the *Hill*, which he told me they plainly did ; besides that, they staid many *Hours* at the *Top*, too long to continue out of *Breath*.

It is worth farther Inquiry, whether the Sickness, if not also the Difficulty of Breathing that some have been obnoxious to in the uppermost Parts of *Pariachaca*, and perhaps some other *high Mountains*, may not be imputed, not so precisely to the *Thinness* and *Rarity* of the *Air*, in Places so remote from the lowermost Part of the *Atmosphere*, as to exclude certain *Steams* of a peculiar Nature, which in some Places the *Air* may be imbued with. For an intelligent Person informed me, that he had attempted to go up to the *Top* of the *Pic* of *Teneriffe* : But that, though some of the Company were able to do so, he and some others, before they had reached near so *high*, grew so *sick* upon the Operation they felt of the sharp *Air*, and *sulphurous Exhalations* which infected it, that they were fain to stay behind their Companions, he having already found this Effect of those *piercing Steams* upon his Face, that the *Skin* began to be of a *Pale-yellow*, and even his *Hair* to be discoloured.

XII. We included a *Mouse* in a fine limber and clear *Bladder*, made more transparent by being anointed with *Oyl* on the outside, that the Smell of it might less offend him.

Animals in the same Air varied as to Density.

Then, to make up so large an Orifice without Wrinkles, (at which the *rarefied Air* may escape) we provided a round Stick, somewhat less than the Orifice, which we laid over with a close and yielding Cement, (for Pitch, or the like uncommon Stuff, will not always serve the Turn) and ty'd the *Bladder* fast and close enough upon it, leaving in the *Bladder* as much *Air* as we thought might suffice him for as long Time as the *Experiment* was to last. Then putting this limber or *extensible Receiver*, if I may so call it, into an ordinary one of *Glass*, and placing this *Engine* near a Window, that we might see through both of them ; the *Air* was by Degrees pump'd out of the *external Receiver*, (as for Distinction sake I shall call it,) and thereupon the *Air* included in the *Bladder* did proportionally expand itself, and so distend the *internal Receiver*, till being arrived at a Degree of *Rarefaction*, which rendred it unfit for the included *Mouse's Respiration*, I perceived, though with some Difficulty, in this Animal, the Signs of his being in great Danger of *sudden Death*. Whereupon the outward *Air*, being hastily let into the *external Receiver*, compressed the swelled *Bladder* to its former Dimensions, and thereby the included *Air* to its former *Density*, by which means the *fainting Mouse* was quickly

quickly *revived*. Having given him some convenient Time of Respite, the *Experiment* was reiterated with the like Success; and we doubted not but the *third Trial* we made, would have ended as the two former did: But whilst we were considering of the Sickness of the *Mouse*, which, by Reason of some Opacity that would scarce be avoided in the wrinkled Bladder, was not, as to its Degree, so easily taken notice of, it grew *irrecoverable* by the subsequent *Condensation* of the *Air*.

The Production and Growth of Animals in an exhausted Receiver.

XIII. 1. We took a good Company of *Tadpoles*, and put them with a convenient Quantity of *Water* into a portable *Receiver* of a round Figure, and observ'd, that at the first *Exsuction* of the *Air*, they did rise to the Top of the *Water*, though most of them subsided again, till the next *Exsuction* raised them. They seem'd by their active and wrigling Motion to be very discomposed. The *Receiver* being *exhausted*, they continued restless, moving all of them on the Top of the *Water*; and tho' some of them seemed to endeavour to go to the Bottom, and dived some Part of the Way, especially with their Heads, yet they were immediately buoyed up again. Within an *Hour* or a little more they were all moveless, and lay floating on the *Water*; wherefore I opened the *Receiver*, upon which the *Air* rushed in, and almost all of them (which were many) presently sunk to the Bottom, but none of them recovered to *Life*.

2. A little after these, we included a lesser Number of *Tadpoles* in a smaller *Glass*, which was also *exhausted* with the like Circumstances with the former. And when I found the other *Tadpoles* to be *dead*, I halted to these, which did not, except perhaps one, give any Sign of *Life*; but upon letting in the *Air*, these having not been long kept from it, some few of them did recover, and swam up and down lively enough for some Time; though after a while they also *dy'd*.

3. Some Years after, I repeated the same *Experiment*: And though after the *Exhaustion* was perfected, the *Tadpoles* did for a while move briskly enough on the Top of the *Water*, (none of them appearing able to Dive or Swim under *Water*) yet coming to look on them after the End of an *Hour*, they seem'd to be all of them quite dead, yet continued floating. And though within *half an Hour* after that, I let in the *Air* upon them, yet all the Effect of it was, that most of them immediately sunk to the Bottom, as the rest of them did a very little while after; none of them, that I could observe, recovering any *vital Motion*.

4. Having after much watching and with much ado got 4 or 5 of those odd *Aquatick Insects* whereof *Gnats* are generated, about the End of *August*, after a Shower of *Rain* which dropt from a House into a Vessel laid on Purpose for it, we included them, with some of their *Water*, into a small *Glass Receiver*, which being very exactly closed, we kept in a South-Window, where those little Creatures continued to swim up and down for some few *Days*, without seeming to be much incommoded by so unusual an Habitation; and at the End of that Time, and much about the same Day, they divested the Habit they had whilst they lived as *Fishes*, and appear'd with their *Exuvia*, or cast Coats, under their Feet, shewing themselves to be perfect

fect *Gnats*, that stood without sinking upon the Surface of the *Water*, and discovered themselves to be *alive* by their Motion, when they were excited to it: But I could not perceive them to *fly* in that *thin Medium*; to which Inability, whether the *Viscosity* of the *Water* might contribute, I know not, though they lived a pretty while, till Hunger or Cold destroy'd them.

1. The warm *Blood* of a *Lamb*, or a *Sheep*, being taken as it were hastily brought from the Butchers, where the *Fibres* had been broken to hinder the *Congulation*, was in a wide-mouth'd *Glass* put into a *Receiver*, made ready for it, and the *Pump* being early set on Work, the *Air* was diligently drawn out. After a long Expectation, the more subtile Parts of the *Blood* would begin to force their Way through the more clammy ones, and seem to boil in large Clusters, some as big as great Beans or Nutmegs; and sometimes to the Wonder of the by-standing Physicians, the *Blood* was so volatile, and the Expansion so vehement, that it boiled over the containing *Glass*; of which, when it was put in, it did not, by our Estimate, fill above a Quarter.

The Expansion of Blood and other Animal Juices, and of the Soft Parts of the Body.

Having also included some *Milk*, warm from the *Cow*, in a cylindrical Vessel of about 4 or 5 Inches high, when the *external Air* was fully withdrawn, the white Liquor began to boil in a way that was not so easy to describe, as pleasant to behold: And this it did for a pretty while, with so much Impetuosity, that it threw up several Parts of itself out of the wide-mouthed *Glass* that contained it (and could have contained as much more) though there were not above two or three *Ounces* of the Liquor.

A yet greater Disposition to the *Intumescence* we thought we observ'd in the *Gall*, which was but suitable to the *Viscosity* of the Texture.

Note, That the two foregoing Experiments were made with an Eye cast upon the Inquiry, that I thought might be made, Whether, and how far the destructive Operation of our *Engine* upon the included Animal, might be imputed to this, that upon the withdrawing of the *Air*, besides the Removal of what the *Air's* Presence contributes to Life, the little *Bubbles* generated upon the Absence of the *Air* in the *Blood*, *Juices*, and soft Parts of the *Body*, may by their vast Number and their conspiring Distensions, variously streighten in some Places, and stretch in others, the *Vessels*, especially the smaller ones, that convey the *Blood* and *Nourishment*; and so by choaking up some Passages, and vitiating the Figure of others, disturb, or hinder the due Circulation of the *Blood*: not to mention the Pains that such Distensions may cause in some Nerves and membranous Parts, which by irritating some of them into *Convulsions*, may hasten the Death of Animals, and destroy them sooner by occasion of that Irritation, than they would be destroyed by the bare Absence, or Loss of what the *Air* is necessary to supply them with. And to shew, how this Production of *Bubbles* reaches even to very minute Parts of the *Body*, I shall add on this occasion (hoping that I have not prevented myself on any other) what may seem somewhat strange, what I once observed in a *Viper*, furiously tortured in our exhausted *Receiver*, namely, that it had manifestly a conspicuous *Bubble* moving to and fro in the waterish Humour of one of its *Eyes*.

2. And

2. And to shew, that not only the Blood and Liquors, but also the other soft Parts, even in cold *Animals*, have aerial Particles latent in them, we took the *Liver* and *Heart* of an *Eel*, as also the *Head* and *Body* of another *Fish* of the same Kind, cut asunder cross-ways somewhat beneath the *Heart*, and putting them into a *Receiver*, upon the withdrawing of the *Air*, we perceived that the *Liver* did manifestly swell every way, and that both the upper and lower Parts did so likewise; and at the place where the Division had been made there came out, in each Portion of the *Fish*, diverse *Bubbles*, several of which seem'd to come from the *Medulla Spinalis*, or the Cavity of the *Back-bone*, or the adjoining Parts, and the external *Air* being let in, both the Portions of the *Eel* presently shrunk, some of the Skin seeming to be grown empty or flaccid in each of them.

Assuefaction
to rarified
Air.

XIV. 1. We included in a round Vial with a wide Neck, (the whole *Glass* being capable of containing about 8 Ounces of *Water*) a young and small *Mouse*, and then tied strongly upon the upper Part of the *Glass*'s Neck a fine thin *Bladder*, out of which the *Air* had been carefully express'd, and then conveyed this phantastical Vessel into a middle-sized *Receiver*, in which we also placed a *mercurial Gage*. The *Air* was by Degrees pumped out, till it appeared by the *Gage* that there remained but a 4th Part in the *external Receiver*, (as for Distinction sake I call it;) whereupon the *Air* in the *external Receiver* expanding itself, appeared for to have blown the *Bladder* almost half full, and the *Mouse* seem'd very ill at Ease by his leaping, and otherwise endeavouring to pass out at the Neck of his uneasy Prison; we did, for fear the over-thin *Air* would dispatch him, let the *Air* flow into the *external Receiver*, whereby the *Bladder* being compress'd, and the *Air* in the Vial reduced to its former *Density*, the little *Animal* quickly recovered.

2. A while after, without removing the *Bladder*, the *Experiment* was repeated, and the *Air*, by the help of the *Gage*, was reduced to its former Degree of *Rarefaction*; and the *Mouse* was kept in that thin *Air* for full 4 *Minutes*; at the End of which he appeared so sick, that to prevent his dying immediately, we removed the *external*, and took out the *internal Receiver*. Whereupon, tho' he recovered, yet 'twas not without much Difficulty; being unable to stand any longer upon his Feet, and for a great while after continued manifestly trembling.

3. But having suffered him to rest a seasonable Space of Time, presuming that *Assuefaction* had accustomed him to greater Hardships, we conveyed him again into the *external Receiver*, and having brought the *Air* to the former Degree of *Expansion*, we were able to keep him there for a full quarter of an Hour. And 'tis worth noting, That till near the latter End of the quarter of an Hour, not only the *Animal* did scarce at all appear distressed, remaining still very quiet; but which is more, whereas when he was put in, the Tremblings formerly mention'd were yet upon him, and continued so for some Time, yet afterwards, in spite of the *Expansion* of the *Air* he was then in, they left him early enough. And when the *internal Receiver* was taken out, he did not only recover from his fainting Fit sooner than before, but escaped those subsequent Tremblings.

4. After

4. After we had allow'd him some Time to recollect his Strength, we convey'd him into the *Receiver*, and pump'd out the *Air*, till the *Mercury* in the *Gage* was not only drawn down as low as formerly, but near half an Inch lower. And tho' this did at first seem to discompose our little Beast, yet after a-while he grew very quiet, and continued so for a full quarter of an Hour, when we caused 3 *Exsuctions* more to be made by the Pump, before we discovered him to be in manifest Danger (at which Time the *Bladder* appear'd much fuller than before :) But then we were oblig'd to let the *Air* into the outward *Receiver*, whereupon the *Mouse* was more speedily revived than one would have suspected.

And these *Trials* of the Power of *Assuesation* seem'd the more considerable, because the *Air* in which the *Mouse* had all this while lived, had been clogged and infected with the *excrementitious Effluvioms* of his Body; for 'twas the same all along, we having purposely forbore to take off the *Bladder*.

XV. 1. We took a *Mouse* of an ordinary Size, and having, not without some Difficulty, conveyed him into an oval Glass fitted with a somewhat long and considerably broad Neck, we conveyed in after him a *Mercurial Gage*, in which we had diligently observed and marked the Station of the *Mercury*, and which was so fastned to a *Wire* reaching to the Bottom of the *Oval Glass*, that the *Gage* remaining in the *Neck*, was not in Danger to be broken by the Motions of the *Mouse* in the oval Part: The upper Part of the long Neck of the Glass was, notwithstanding the Wideness of it, *hermetically seal'd*: And tho' by Reason of the Largeness of the Vessel in Comparison of so small an Animal, he seem'd to me rather drooping than very near Death at the End of the *second Hour*; yet coming to look upon him about *half an Hour* after, he was judg'd by the Spectators quite dead, notwithstanding our shaking of the Vessel to rouse him up. This made me cast my Eyes upon the *Gage*, wherein I could not perceive any sensible Change of the *Mercury's* Station. But having caused the seal'd Part of the Glass to be broken off, and fresh *Air* to be blown in by a pair of Bellows, the gasping Animal revived, tho' but slowly.

Unfit for Respiration, yet retaining its Density.

2. Such an Experiment as the former we made with like Success upon a small Bird, included with a *Gage* in a *Receiver*, holding about a Quart of Water. The *Bird* in about half an Hour appeared to be sick and drooping, and the Faintness and Difficulty of *Breathing* increased for about 2 Hours and an half after that, at which Time the Animal died, the *Gage* being not sensibly altered.

3. In a *Glass Vial*, capacious enough to hold about 3 Quarts of *Water*, we *hermetically* sealed up a small Bird, and found, that in a few *Minutes* he began to be sick and pant; which *Symptoms* I suffered to continue and increase against the Mind of a learned *By-stander*, who thought the Animal would not hold out so long, till they had lasted just half an Hour; at which Time having provided a Vessel of *Water*, made exceeding cold with *Sal-Armoniack*, newly put into it, the *Vial* with the sick *Bird* was immersed in it, and kept there in that Condition for 6 Minutes; and yet it did not appear, that this great *Refrigeration* did sensibly refresh the drooping Animal. So that this Remedy proving ineffectual, the *Vial* was removed out of the *Water*, and the *Bird* some

some time after did, as I foretold, make many Strains to vomit, (tho' she brought up little) followed by *Evacuations* downward, before she quite expired, which she did within a Minute or two of a just Hour after the Beginning of her Imprisonment.

The use of
Air in Re-
spiration.

XVI. We made by *Distillation* a Blood-red Liquor, which I have with very little variation communicated in the *History of Colours*, and which chiefly consists of such *saline* and *spirituous* Particles as may be obtained from the *Mass* of *Blood* in human Bodies. This *Liquor* is of such a Nature, that if a *Glass-Vial*, about half fill'd with it, be kept well stopp'd, the red Liquor will rest as quietly as any ordinary one, without sending up any Smoke or visible Exhalation; but if the *Vial* be unstopp'd, so that the *external Air* be permitted to come in and touch the Surface of the Liquor, within a quarter of a Minute or less, there will upon this Contact be elevated a copious white Smoke, which will not only fill the upper Part of the *Glass*, but plentifully pass out into the open Air, till the *Vial* be again stopp'd. This *Experiment* may serve to illustrate the Office of the *Air* to carry off in *Expiration* the *fuliginous Steams* of the *Lungs*. For, in our *Experiment* we manifestly see, that the very *Contact* of the *Air* may give the *Corpuscles* of moist Bodies a peculiar Volatility, or Facility to emerge in the Form of *Steams*. It may here suffice to take notice of these two Things: The one is, that when the *Vial* has lain stopp'd and quiet a competent Time, the upper Half of it will appear destitute of *Fumes*, of which the *Air*, it seems, will imbibe, and constantly retain but a certain moderate Quantity; which may give some Light towards the Reason, why the same *Air*, which will be quite clogg'd with *Steams*, will not long serve for *Respiration*, which requires frequent Supplies of fresh *Air*: The other is, That if the *unstopp'd Vial* were placed in our *Vacuum*, it would not emit any visible *Steams* at all, nor so much as to appear in the upper Part of the *Glass* itself that held the Liquor; whereas, when the *Air* was by degrees restored at the *Stopcock* without moving the *Receiver* itself, to avoid injuring its Closeness, the returning *Air* would presently raise the *Fumes*, first into the vacant Part of the *Vial*, whence they would ascend into the Capacity of the *Receiver*; and likewise, when the *Air* that was requisite to support them was pumped out, they also accompanied it, as their unpleasant Smell evinced, and the red Spirit, tho' it remain'd unstopp'd, emitted no more *Fumes* till the *Air* was let in.

Snails, Efts,
and Lecches.

XVII. 1. Two *white Snails without Shells*, of differing Sizes, (the biggest about an Inch and a half, and the other about an Inch in Length) were included in a small portable *Receiver*, which was carefully *exhausted*, and secured against the Return of the *Air*. Presently after 'twas remov'd from the *Engine*, it was easy to discern that both the *Snails* thrust out and retracted their Horns (as they are commonly call'd) at pleasure, tho' their Bodies had in the softer Places pretty Store of newly generated *Bubbles* sticking to them: But tho' they did not lose their Motion near so soon, as other *Animals* were in our *Vacuum* wont to do, yet coming to look on them after some Hours, they appeared moveless and very tumid, and at the End of 12 *Hours*, the inward Parts of their Bodies seem'd to be almost vanished, and they seem'd to be
but

but a couple of small full-blown Bladders; and on the letting in of the Air, they immediately so shrunk, as if the Bladders having been pricked, the residing Air had left behind it nothing but Skins; nor did either of the *Snails* afterwards, tho' kept many Hours, give any Signs of Life.

2. We included in a *Receiver*, whose globular Part was about the Bigness of a large *Orange*, one of that Sort of *Animals* that they vulgarly call *Efts*: Having withdrawn, but not solicitously, the Air, we kept him there about 48 Hours: During all which Time he continued alive, but appeared somewhat *swelled* in his Belly; his under-chap moving the very first Night, but not the Day and Night following. By opening the *Receiver* at length under Water, we perceived, that about half the Air had been drawn out. As soon as the Water was impelled into the Glass, the *Animal* that was before dull and torpid, seem'd, by very nimble and extravagant Motions, to be strangely revived.

3. We took a *Leech*, that was of a moderate Bigness, or somewhat short of it, and having included it together with some *Water* in a portable *Receiver*, that was guess'd to be capable of holding about ten or 12 *Ounces* of that Liquor, the *Air* was pump'd out after the usual Manner, and the *Receiver* being remov'd to a lightsome Place, we observed, as we expected, that the *Leech* keeping herself under Water, there emerged from diverse Parts of her Body store of *Bubbles*, some of them in a dispersed Way, but others in *Rows* or *Files*, if I may so speak, that seem'd to come from determinate Points. Though this Production of *Bubbles* lasted a pretty while, yet the *Leech* did not seem to be very much *discomposed* by her present Condition: For after 5 Days (tho' the *Receiver* continued well exhausted) we found her very lively.

XVIII. 1. We took 5 or 6 *Caterpillars* of the same Sort; and had the *Air* ^{Creeping In-} drawn from them, and carefully kept from returning. About an Hour after, ^{sects.} I found them moving to and fro in the *Receiver*, and even above two Hours after that, I could by shaking the Vessel, excite in them some Motions, that I did not suspect to be convulsive. But about 10 Hours after they were first included, they seem'd to be quite dead; yet the *Air* being forthwith restored to them, I found the next *Day*, that 3 or 4 of them were perfectly alive.

2. We took from a Hedge a Branch that had a large *Cobweb* of *Caterpillars* in it, and having divided it into two Parts, we put them into like *Receivers*; and in one of them shut up the *Caterpillars* together with the *Air*, which from the other was exhausted. The Event was, that in that which had the *Air*, the little and difficultly visible *Insects*, after a small Time appeared to move up and down as before, and so continued to do for a Day or *two*; whereas that Glass whence the *Air* had been drawn out, and continued kept out, shewed, after a very little while, no Motion that we could perceive.

XIX. 1. *Nov.* 12. 8 *at Night*. There were taken 4 middle-siz'd *Flesh-flies*, ^{Winged In-} which having their Heads cut off, were inclosed in a portable *Receiver*, furnished with a pretty large Pipe and a Bubble at the End. As soon as the *Receiver* was exhausted, those *Flies* lost their Motion (which was not brisk before.) An Hour or *two* after, I approached them to the Fire, which restored not their Motion to them (but as to one of them I suspected it had a languid Motion for a while) wherefore I let in the Air upon them, after which in a

very short Time, tho' not immediately, they began one after another to move their Legs, and *one or two* of them to walk.

2. *Sept. 11. About Noon.* We closed up divers ordinary *Flies*, and a *Bee* or *Wasp*; all which, when the *Air* was fully *withdrawn*, lay as dead, save that for a very few *Minutes* some of them had convulsive Motions in their Legs; they continued in this State 48 Hours, after which, the *Air* was let in upon them, but none of them recovered.

3. *Decem. 11.* at Night, we put a great *Flesh-Fly* into a very small portable *Receiver*, where at first it appear'd to be very brisk and lively, but as soon as the *Air* was *drawn* out, fell on her Back, and seem'd to have convulsive Motions in her Feet and *Proboscis*, from whence she presently recover'd, upon the letting in of the *Air*; which being *drawn* out again, she lay as dead; but a while after, (within a quarter or half an Hour) I perceived, that upon shaking the *Receiver*, she stirred up and down, but faintly. The next Night, by Warmth, and letting in the *Air*, the *Fly* recovered: But being next Morning *seal'd up* again in that *Glass*, and kept 48 Hours, tho' over the Chimney, she died for good and all.

4. We took a large *Grasshopper*, whose Body, besides the Horns and Limbs, was about an Inch in Length, and of a great Thickness in Proportion to that Length: This we convey'd into a portable *Receiver* of an oval Form, and capable of holding, by our Guess, about a Pint of *Water*. When the *Air* began to be considerably rarified, he appear'd to be very ill at Ease, and seem'd to sweat out of the *Abdomen* many little Drops of Liquor, which being united, trickled down the *Glass* like a little Stream, which made at the Bottom a small Pool of clear Liquor, amounting to near a *Quarter* of a *Spoonful*; and by that time the *Receiver* was ready to be taken off, the *Grasshopper*, was fallen upon his Back, and lay as dead, and continued so for 3 Hours; after which, the *Air* being let in upon him, he continued without any Signs of Life for a *Quarter* or *Half an Hour*: But being carried into a Sun-shiny Place, the Beams of a declining Sun presently began to make him stir his *Limbs*, and in a short time brought him perfectly to Life again.

5. *Apr. 15.* We took one of those *shining Beetles* they call *Rose-Flies*, and included it in a very small round *Receiver*, which we *exhausted*; and tho' it struggled much whilst the *Air* was withdrawing, yet presently after, I could perceive but little Motion (and part of that seem'd almost convulsive.) About six Hours after, it seem'd quite dead, and upon the Return of the *Air*, no Sign of Life ensued for a pretty while; but 3 or 4 Hours after, I found him lively enough.

6. Having observed *Butterflies* not only to *live*, but to *move* longer than was expected, I included divers of them in somewhat large *Receivers*, and tho' whilst the *Air* continued in the *Glasses*, they *flew* actively as well as freely up and down; and tho' after the *Exhaustion* of the *Air* they continued to live, and were not moveless; nay, tho' at the Bottom of the *Receiver*, they would even move their Wings, and a little flutter: Yet I could not perceive any of them to fly, by which I mean, perform any progressive Motion supported by the Medium only. And by frequently inverting the
Receiver

Receiver (which I took Care should be pretty long, to let them fall from one Extream to the other) they would fall like dead Animals, without displaying their Wings; tho' just as they came to touch the Bottom, some of them would sometimes seem to make some Use of them, but not enough to sustain themselves, or to keep their Falls from being rude enough.

XX. 1. A pretty Number of *Ants* were included in a small portable *Receiver*, exhausted yesterday about Noon. They grew almost moveless as soon as the Air was exhausted: And between 6 and 7 in the Afternoon, they seem'd to be all quite dead. Whereupon I opened the Glass, and tho' no Sign of Life appear'd for a great while, yet this Morning I found many of them alive, and moving to and fro.

*Ants and
Mites.*

2. We conveyed a pretty Number of *Mites*, which are reputed but living Points, together with the mouldy Cheese they were bred in, to nourish them, into 3 or 4 very small *Receivers*. One of them with the Air in it was seal'd up at a Lamp Furnace, and from all the rest we *withdrew* the Air. This done, we observ'd the following *Phænomena*, viz.

1. Those *Mites* that were inclosed in the small Glass that never came near the Engine, continued alive, and able to walk up and down for above a full Week, after they had been put in; and possibly would have continued much longer, if the Glass had not been broken.

2. Though just before the *withdrawing* of the *Air*, the *Mites* were seen to move up and down in it; yet within a few *Minutes* after the *Receiver* was applied to the Engine, I could discern in them no Life at all, tho' my Eye was assisted with a double convex Glass. Above an Hour after, I could not perceive any of them to stir: 2 or 3 Hours after that, I let in the Air, and left the *Receiver* unstopped in a *Window*.

3. About 2 or 3 Days after, I found a Number of my little Animals revived, as an attentive Eye might easily perceive by the Motion of certain little white Specks; and they continued to appear alive for 2 or 3 Days after that, if not longer.

4. One of the *Receivers* was kept exhausted from *Monday* to *Tuesday*; after all which time, our attentive Eyes being unable to discover any Signs of Life among the included *Mites*, the Air was let in upon them, and after a long time, we could plainly see them creep up and down in the Glasses again.

LXXVIII. 1. We took Filings of crude *Copper*, and put them into a crystal-line Glass of a conical Shape, into which we poured some strong Spirit of *Salt*, (that was fitted for our peculiar Purpose) to the Height of about a Finger's breadth above the *Filings*, and then closing the Vessel with a Glass-stopple, exquisitely fitted to it, we suffered it to continue unmoved in a *Window* for some Days, till the Liquor had both obtained a high and darkish brown Colour, by the Solution of some of the *Copper*, and lost that Colour again, growing clear like common Water (which is itself a somewhat odd *Phænomenon*;) and then taking out the Stopple, without shaking the Liquor, and thereby giving Access to the *outward Air*, we perceived, as we had conjectured, that the upper Surface of the Liquor did in a few *Minutes* re-acquire a darkish brown Colour, which penetrating deeper and deeper, at the End of

*Experiment
about the
Weakned
Spring, and
some unob-
served Ef-
fects of the
Air, by Mr.
Rob. Boyle,
n. 120. p.
467.*

about a Quarter of an Hour, the whole Body of the Liquor appeared to be likewise tinged. The conical Glass being again well stopp'd, the *Menstruum* did again in very few Days let fall, or otherwise lose its *Tincture*, which, the Stopple being taken out, it regained as before. Nor were these 2 the only Trials I made with the like Success for the main; but afterwards being desirous by a farther Trial to resolve a Doubt I had, I kept the Glass yet longer in the same Place with the same *Filings* and *Menstruum* in it, for, if I misremember not, a *Month* or *two* together; but observed not that the Liquor would any more grow clear.

2. Having taken another conical Glass, wherein the Liquor was grown clearer than is usual, and had probably been so a good while before, for the Vessel having been hid by others which stood before it, had been for some Weeks forgotten; we took out the Stopple, and left it out for about half an Hour, but did not perceive the Liquor to have acquired any Colour, so much as at the Top. But putting in the little Stopple, I left the Vessel closed for 2 or 3 Hours, and at my Return to visit it, I perceived, that it had acquired a faint Colour tending to a Green: Wherefore, taking out the Stopple again, I opened its Commerce with the *outward Air*, leaving the *Glass* unstopt for 20 or 24 Hours, but found that in all that time it had not regained its wonted dark Colour, but was only arrived at a Green, deep enough, but not true nor very transparent.

This Observation being made in the same Vessel that had been formerly employed, suggested to us an Enquiry, whether the advanced Time of the Year, which was the middle of *October*, might not have an Interest in the *slow* and *imperfect* Success of this Trial.

3. Some strong *Spirit* of *Salt* having been kept upon *Filings* of *Copper* till the Solution was come to be of a dark *brown* Colour, about three Spoonfuls of it, by guess, was put into a *Receiver* that might hold 8 or 10 Times as much: Being kept *in Vacuo*, if the Time be rightly remember'd, about half a Year, it retain'd its Colour; but the Vessel being opened, and the external *Air* permitted a free Access to it, the Solution in about an Hour was turned into a fine transparent Green, tho' no Precipitation of any muddy Substance appear'd by any Sediment to be made.

4. In one of that Sort of *Conical Glasses* that has been already described, we had put upon some *Filings* of *Copper* a convenient Quantity of our *Spirit* of *Salt*; and tho' we observed, that for a great while it would not part with its *deep* and somewhat *muddy Tincture*; yet we left it in the *Window* for many *Weeks* longer, and at length, towards the latter End of *December*, we found it to have lost its *Tincture* so much, that the Liquor appeared like common *Water*. Upon which Observation, tho' the Time of the Year was unpromising, I thought fit to try whether the *Air* in that Season would not have some, tho' perhaps but a slow Operation on the *saline Spirit*; and accordingly taking out the Glass Stopple to give free Access to the *outward Air*, we observ'd, that in some Hours its Operation on the Liquor was scarce sensible; but within about 24 Hours, the *Menstruum* had acquired not just its former Colour, but a somewhat faint and moderately transparent Green: So that this tinted

Menstruum,

Menstruum, as it had been very slow in losing its Colour, so it did but slowly and imperfectly re-acquire it.

5. We took some *Filings* of *Copper*, and putting them together with a *Mercurial Gage*, in a *Conical Glass* fitted with an exactly ground Stopple of the same Matter (which was *Crystalline*) we poured on the *Filings* as much rectified *Spirit* of *fermented Urine* made *per se*, as sufficed to swim an Inch or better above them; then carefully stopping the *Glass*, coming to look on it many Hours after, we perceived that the *Mercury* in the seal'd Leg was considerably deprest; and gently drawing out the Stopple, to let in the *outward Air*, we perceived that Access to have a manifest Effect upon the *Mercury*.

6. We took a *Crystal Glass* of an almost *Conical Shape*, and capable of containing between 5 or 6 Ounces of *Water*, and furnished with a Stopple of the same Matter, that by grinding was exactly fitted to it. Into this we put a considerable Quantity of clean *Filings* of good *Copper*, on which we poured as much strong *Spirit* of *Fermented*, or rather *putrify'd Urine*, as served to swim about an Inch above the *Copper*, and having let down a *Mercurial Gage*, so that it leaned upon the Bottom and Side of the *Glass*, we clos'd it very well with a Stopple, and set it in a quiet and well enlightned Place, having taken good notice at what Mark the *Quicksilver* rested in the *open Leg* of the *Gage*. This done, we let in the *Menstruum* alone to work upon the *Filings*; which it did, as we foresaw, somewhat slowly and very calmly, without producing any *Noise* or sensible *Bubbles*, acquiring by Degrees a very pleasant *blue* Colour, and the *Glass* being kept quiet in the same Place for 2 or 3 *Days* longer, the *Liquor*, as I conjectured would happen, began to lose of the *Intenseness* of its Colour, which by Degrees grew fainter and fainter, till at the End of 3 or 4 *Days*, the *Liquor* was grown very *pale*, and left me little doubt but that, if I would have stay'd some *Days* longer, it would have lost the remaining Eye of *Blue*, and have look'd almost like common *Water*. But being unwilling to tarry so long, I took out the Stopple, that the *Air* without the *Glass* might have Access to that within; and leaving the *Vial* in the same Place and Posture, my Expectation was somewhat answered by finding, that within 4 or 5 *Minutes*, if not less, the upper Part of the *Liquor* that was *contiguous* to the *Air*, had acquired a fine *blue Colour*, which descending deeper and deeper, before the End of the 10th *Minute* had diffused itself, but somewhat weakned, through the *Liquor*, whose Colour was suffered to deepen for a while longer; so that in less than a *quarter* of an *Hour* from the first unstopping of the *Vial* the *Liquor* was grown to be throughout of a rich *ceruleous* Colour, which grew almost too opacous within a few *Minutes* longer: When carefully closing the *Vial* again with the same Stopple as before, we set it aside in the same Place, where the *included Air* being denied all Commerce with the *external*, the *Liquor* began again within 2 or 3 *Days* to lose of its Colour; and, to be short, afforded me the Opportunity of making a 2d Experiment much like the former. And the like Success I had, for the main, in a Trial or two made in another *Glass* with another Portion of the same *Spirit* of *Urine*, put upon the *Filings* of *Copper*; so that the Experiment was, in all, made diverse Times, as well when I was not, as when I was alone: And particularly,

cularly, once to be sure that the diurnal Air, as such, had not any great Interest in the *Phænomenon*, I made the Trial successively about Nine a-Clock at Night.

In most of these Experiments I forbore to shake the Glafs, lest it should be suspected, that the Agitation of the Liquor might have raised some little fine Powder that might have been supposed to have been *precipitated* out of the Tincture, and, being thus mingled with the Liquor again, restore it to its former Colour; but in Truth I did not perceive any such Powder to be *precipitated*. And though to obviate the Objection, I forbore to shake the Vial, yet I justly supposed, that if, by the Agitation of the Liquor, more Parts of it should be quickly exposed to the Action of the Air, the Coloration would be hastned, which upon Trial appear'd to be true.

7. We took such a conical Glafs, as has been lately described, and covering the Bottom of it with a convenient Quantity of *Filings* of good Copper, we poured on them as much strong *Spirit* of *Sal-Armoniack* as served to swim about a Finger's breadth above them; and, having let down such a *Mercurial Gage* as is formerly mentioned, so that it leaned upon the Bottom and Side of the Glafs, we closed it very well with a Stopple, and set it in a quiet and well enlighten'd Place, having taken good notice at what Mark the *Quicksilver* rested in the open Leg of the *Gage*: This done, we let alone the *Menstruum* to work upon the *Filings*, which it did, as we foresaw, somewhat slowly and very calmly, without producing any *Noise* or sensible *Bubbles*, acquiring by Degrees a very pleasant *blue* Colour, and afforded us also the *Phænomenon* we chiefly looked after; which was, that repairing from time to time to the Window to see what past, we perceived, that for 2 or 3 *Days* together the *Mercury* in the *seal'd Leg* of the *Gage* did, tho' very slowly, *descend* till it appeared to be near a *Quarter* of an *Inch* lower than at first; and probably the Depression might have been greater, if the Experiment had not been disturb'd; whose Event yet seem'd sufficiently to argue, that the *Spring* of the *Air* contain'd in the Cavity of the Glafs, and communicating with that in the *open Leg* of the *Gage* or *Syphon*, was *weakened* in Comparison of that in the *closed Leg*, which by the *Hermetick Seal* on one Side, and the *Quicksilver* on the other, was kept from such Communication. And I was farther careful to observe, whether the *Depression* did not continue at differing times of the *Day*, and found it to do so, as well at *Night* as at *Noon*, though at this last named time the *Sun* shined hot upon the Place and *Vessels* too.

This Experiment was made, in all, 4 or 5 times, though not always with equal, yet still with some Success, the *Mercury* in the *seal'd Leg* of the *Gage* being sometimes more, and sometimes less, but always manifestly *depress'd*; which *Phænomenon* was confirmed by the Observation we more than once made of the sudden Return of the *Quicksilver* to its former Station, upon the unstopping of the Glafs, to give free Admission to the *outward Air*.

8. A *Mercurial Gage* having been put into a Conical Glafs, whose Bottom was covered with beaten *Coral*, some *Spirit* of *Vinegar* was poured in, and then the Glafs Stopple, which was very well ground, closing the Neck exactly, we observed, tha upon the working of the *Menstruum* on the *Coral*,
Store

Store of *Bubbles* were for a good while produced, which successively broke in the Cavity of the Vessel; and their Accession so constipated the *Air*, that they *compress* the *Air* imprisoned in the closed Leg of the *Gage* three Marks or Divisions, which I guessed to amount to about the *third part* of the Extent it had before: But some *Hours* after the *Corrosion* had ceased, the *Compression* made by this new generated *Air* grew manifestly fainter, and the imprisoned *Gage Air* drove down the *Mercury* again till 'twas *depress* within one Division of its first Station; and thereabouts, or a little lower, continued 5 or 6 *Days*; so that in this Operation there seemed to have been a double *Compressive* Power exercised; the one transient, by the brisk Agitation of *Vapours* or *Exhalations*; and the other durable, from the *Aereal* and *Springy* Particles either produced or extricated by the Action of the *Spirit* of *Vinegar* upon the *Coral*.

But a pretty Quantity of *Spirit* of *Vinegar* being put upon *Minium*, it continued divers *Days* without any sensible *Depression* of the *Mercury* in either Leg, nor did any Change appear in the *Gage*, upon the Removal of the Stopple, though 'twas evident by the great Sweetness acquired, that it had made a *Solution* of a great Portion of the *Minium*.

9. We took some *Filings* of *Copper*, and in a Vial capable of holding some 2 or 3 *Ounces* of *Water*, we poured on them strong *Spirit* of *Sal-Armoniack* made without *Quick-lime*, till the *Liquor* reached near an *Inch* above them. This was done about the 20th of *August* on the *Friday* before Noon, and the following *Monday*, presently after *Dinner*, it had acquired a deep *Blue Tincture*, and lost again so much of it, that it was pale almost like common *Water*: Then to satisfy a *Virtuoso*, I unstopt the Vial, desiring him to place his *Eye* level with the Surface of the *Liquor*, which in a *Minute* of an *Hour* or less appeared to his *Surprise* and *Wonder* to have acquired a deep *Blue Tincture*, that reached *downwards* to the Thickness of the Back of a *Knife*, the whole *Liquor* becoming of the like Colour in 4 or 5 *Minutes* more, and the *Glass* being presently stopt again, and left where 'twas before, appeared not at the End of 9 *Days* to have lost its *Tincture*; tho' now and then within that Time it seemed manifestly *paler* than when the Vial was stopt.

10. We took a round Vial, holding about 8 *Ounces* of *Water*, and having put into it *Filings* of *Copper* and a *Mercurial Gage*, we poured on the Metal strong *Spirit* of *Sal-Armoniack*, till it reached to a good Height in the Vial, which then being *Hermetically sealed* up, was set by in a *South Window*, where it quickly acquired a deep *Blue Tincture*: There it stood about 12 *Days*, before that *Tincture*, which decayed but slowly, did little by little grow so diluted that the *Liquor* was pale and almost like *Water*; during this Stay of the *Glass* in the *Window*, the *Mercury* in the *open Leg* appeared to be *impelled* up; and when after 9 a-Clock at *Night* (which Time I chose to try whether the *nocturnal Air* would have any thing to do with the *Phanomenon*) the *hermetick Seal* was broken off; immediately upon which there was produced a *Noise*, and the *Mercury* in the shorter and closed Leg was briskly *impelled* up, by our Guess, near $\frac{1}{2}$ of an *Inch*; and tho' the Orifice at which the *Air* had Access was scarce *wide* enough to admit a middle-siz'd *Pea*, yet
within

within a *Minute and half* the Surface of the Liquor being held between the Eye and the Candle, appeared to have acquired a very lovely and fair *Colour*, which reached downwards a quarter of an Inch; so that the Vial seemed to contain two very differing Liquors swimming one on another; and the Coloration piercing deeper and deeper, within 5 Minutes in all, the whole Liquor had attained a rich *Blue Colour*.

Pneumatical
Experiments
by M. Papin:
Directed by
M. Hugen's,
n. 119. p.
443.

LXXIX. 1. To mingle divers Liquors together by Means of the Air Pump, there were employed two small Glasses, whereof the one could enter into the other, and the least of the *two* was fastened to the Hook of an *Iron Wire*, and the greater put under it, and the said *Wire* was so ordered, that these *two* Glasses were a little distant one from another. The *Recipient* was of a Cylindrical Figure, of which one End is all open, to be fastned to the Cement of the *Pump*; the other is all closed, except a small Hole, having a little Edge or Brim; thro' which Hole you pass the hook'd *Iron Wire*, and tye an *Eel-Skin* close about the same; and three or four Inches higher, the same *Skin* is also to be tyed about the *Iron-Wire*, to keep the *external Air* from entering into the *Recipient*, and yet without taking away the Liberty to stir therein what you will by means of the *Iron-Wire*, that hath a Communication *inwards* and *outwards*. For this Purpose you must chuse that Part of the *Eel-Skin* that is next to the Head, the other Part being pierced with many *Holes* with *Valves* that do not always shut well.

To be the more sure that no Air enters by the Ligatures of the *Eel-Skin*, you may apply a Tube on the *Recipient* with Cement, and pour Water into this Tube until the *Eel-Skin* be quite cover'd therewith. Care also must be had, that the Hole be exactly filled up by the *Iron-Wire*; for, if it were too big, the *Eel-Skin* would be thrust into it with great Violence, and so hinder the Liberty of raising and sinking it.

When the *Recipient* was evacuated of Air, the lesser Glass was by the *Iron-Wire* let down into the greater, until the Liquors they contain did mingle themselves. Thus some *Aqua-fortis* was poured into the upper Glass, and *Spirit of Wine* into the lower, and the *Recipient* was so well exhausted of Air, that the *Spirit of Wine* boiled up with great Bubbles (as usually it doth) and the *Aqua-fortis* cast some small Bubbles. After that both these Liquors were well purged of Air, the upper Glass was sunk into the lower, so as that the *Spirit of Wine* was mingled with the *Aqua-fortis*, at which Instant there was yet seen a very considerable *Ebullition*.

Now to know whether the *Aqua-fortis* gave to the *Spirit of Wine* some new Vigour or Force to make it bubble, we mixed without the *Recipient* some *Aqua-fortis* with *Spirit of Wine*; the Quantity of the former being somewhat more than that of the latter. This Mixture being put *in Vacuo*, instead of boiling up more strongly than the *Spirit of Wine*, (as 'twas thought it would have done) it only cast up some few Bubbles: Which shewed that the *Ebullition*, which was seen when they were mixed within the *Vacuum*, is of the same Nature with all those that are made of *Acids* and *Alcalies*. For, in the very instant that they are mixed they make great *Ebullitions*, but soon after they mortify one another, and lose the Properties they had before.

'Tis also probable, that the *Aqua-fortis* and the *Spirit of Wine* would boil always when they are mingled, but that the Pressure of the Air keeps this *Ebullition* from being sensible, and appears only when that Pressure is taken off.

When you employ *rectified Spirit of Wine* instead of *Aqua-vitæ*, there is required a greater Quantity of *Aqua-fortis* to mortify it.

It was also experimented, that the *Solution of common Salt* boils also with *Spirit of Wine*, being mixed *in Vacuo*; and the *Solution of Salt Peter* yet more. The same Experiment was also made with common Water, and its *Ebullition* with *Aqua-vitæ*, purged of Air, was also found to be very great, when mixed *in Vacuo*.

Farther, it is somewhat remarkable, that *common Water* doth not mortify *Spirit of Water*, as *Aqua-fortis* doth, though they make *Ebullitions* with it almost of the same Degree. The Experiment of it is easy: For, making without the *Recipient*, a Mixture of *common Water* and *Aqua-vitæ*, this being put within the *Vacuum*, bubbles up very well, though the *common Water* be there in greater Quantity than the *Aqua-vitæ*; whereas a Mixture of *Aqua-fortis* and *Aqua-vitæ* did not there bubble up at all.

After this, the Experimenter being desirous to see whether these *Ebullitions* did make *new Air*, he put in the *Recipient* a Gage (that is a Glass Tube fill'd either with Water freed of Air, or with *Mercury* serving to measure the Quantity of the Air in the *Recipient*) which was 4 Inches long, and observed, that, at the Instant when the Liquors were mingled together, the *Water* in the *Gage* rose very nimbly to the Top of the *Gage*; and then drawing out this *new Air* that was made, he made the *Gage-Water* subside again by Degrees, in like manner as when the *common Air* is drawn out: And by this means it was seen, that all these kinds of *Ebullition* made an Air which expands itself like *common Air*. Yet it is very remarkable, that the Air which is made by these *Ebullitions* is not of the same Nature: For it hath been found experimentally, that the Air formed by the Mixture of *Aqua-fortis* and *Copper* remains always Air, and always keeps up the *Water* in the *Glass* at that Height to which it raised it; but, on the contrary, that *Air*, which hath been produced by the Mixture of *Oyl of Tartar* and *Oyl of Vitriol*, is almost all destroyed of itself in the Space of 24 Hours; insomuch that in the *Recipient*, 24 Hours after the *Ebullition* had been there made, there was not found much more *Air* than there was before the same was made.

2. Mr. Boyle (as 'tis recorded in the *Journal Book of the Royal Society*, April 30. 1668.) gave an Account to the said *Society* of the Experiments he had then made about *generating new Air*, or *extricating* that *Air* which was lurking before in several Bodies: At which Time he mentioned also some ways of *examining*, whether the Substance thus produced be *true Air* or not.

And long before that Time, *viz. An. 1664. March* the 15th (witness the same *Journal*) Mr. Boyle mentioned to the *R. Society*, that *Corals* or *Oyster-Shells* pounded, and put into *distill'd Vinegar*, might prove fit Substances to produce *Air*, wholesom for *Inspiration*. At which Time he also *proposed*, that some fit Animal might be put into a *Receiver* of his exhausting Engine, and the *Air* pump'd out till the Creature grew sickish, and that then

Some *new Air* might be produced in the *Receiver* by a Contrivance of making *distill'd Vinegar* work upon the Substances before-mentioned, to see whether by this means the Animal would recover.

About which time Sir *Chr. Wren* also suggested, to put a *fermenting Liquor* in a Glass Ball, and to fit a *Stop-Cock* to it, and tye a Bladder about the Top of the *Stop-Cock*; by which means the *Air*, to be generated by the *fermenting Liquor*, would pass into the Bladder, and upon the turning of the *Stop-Cock* be kept there in the form of *Air*. Mr. *Hook* also mentioned several Liquors, which by their working upon one another would produce an *Air*; as *Oyl of Tartar* and *Vitriol*; *Spirit of Wine* and *Turpentine*. And the same made before the *R. Society* the following Experiment: He took a common Glass Vial with two Pipes, and some pounded *Oyster-Shells* and *Aqua-fortis*; and as soon as the latter was by one of those Pipes poured upon the former, and the Hole stopt with good Cement, the *Ebullition*, caused by the *Shells* being corroded by the *Aqua-fortis*, did in a very little Time blow up the Bladder, tyed on the other Pipe, so as to swell it very plump with *Air*; which Expansion remained till the *Society* rose. They afterwards order'd the said Vessel to be carefully lock'd up till their next Meeting, which being the Week after, the Bladder was then found somewhat shrunk. The like Experiment was made with Bottled Ale, supposed to yield more wholesom Air for Respiration.

3. One Day we mingled equal Parts of *Aqua-fortis* and *Aqua-vitæ*; and having put two equal Quantities of this Mixture in two small Glasses with two equal Bits of *Iron*, one into each; one of the Glasses was included *in Vacuo*. Then there was seen a very great *Ebullition*, and the Liquor became black, whilst that which was left without the *Recipient* wrought almost nothing, but remained always transparent, and rather white than black. After these two Glasses had stood thus 12 Hours, that which was *in Vacuo* was taken out, and we found that the *Iron* was almost all dissolved, whereas the other was very little diminished. This Experiment succeeds quite contrary when 'tis made with *Aqua-fortis* alone and *Copper*; for then the *Dissolution* is less within the *Vacuum*, than without it.

We made some other Mixtures of diverse Liquors, which make no *Ebullition* at all *in Vacuo*, no more than they do in open Air. *Oyl of Olives* makes none neither with *Vinegar*, nor with *Spirit of Wine*, at the instant that they mingled; neither doth the said *Oyl* mortify the *Spirit of Wine*. Only this we observed one Day, that having mingled together, without the *Recipient*, some of that *Oyl* and *Vinegar* and *Spirit of Wine*, and put this Mixture *in Vacuo*, it did not boil up so soon as when there was no *Oyl*; but then the Bubbles which it made afterwards were bigger, and they began to appear again from Time to Time, so that some of them were seen a Quarter of an Hour after the *Recipient* had been evacuated. Possibly this may come to pass, because that the *Oyl*, swimming on the Top, retains the more volatile Parts of the *Spirit of Wine*, which else would fly away as soon as the Air is begun to be pump'd out, and at the same Time it hinders the Surface of the Liquor below from easily rising up into Bubbles, because, to make them do so, the Parts of the *Oyl*, that sticks close to one another, must be separated. When
therefore

therefore the volatile Parts are gathered together in a sufficient Quantity, able to surmount the Resistance which the Oyl makes to it, they issue out with much more Violence, than if nothing had retained them.

All these *Ebullitions*, hitherto spoken of, are greater *in Vacuo* than in the *open Air*: But with *Lime* it is not so. For, taking two equal Glasses with two equal Quantities of *Water*, and putting the one of them *in Vacuo*, the other in the free Air, there was let fall into both at the same Time two equal Parcels of *Lime*, one into each, and it appeared, that that which was *in Vacuo* did indeed throw up some big *Bubbles*, but yet fewer of them than that which was in the Air; and having taken it an Hour after out of the *Recipient*, and stirred the *Lime*, it was found to have only the Consistence of *Dirt*, whereas the other had the Consistence of *slaked Lime*. The Reason of which may perhaps be, that the *volatile Salts* of the *Lime* do exhale whilst the *Recipient* is emptying.

There was also some *Plaster of Paris* slaked *in Vacuo*, and the *Ebullition* of it did there appear much more than it doth in the open Air. When it is not touched, the *Bubbles* that issue out leave great Holes in it, and then it settles very uneven; but taking care to stir it until the *Bubbles* be come forth, and pressing it when it begins to settle, it becomes very smooth, and hath not so many little *Holes* as the *common Plaster*.

I took one Day a small *Recipient*, and instead of the *Iron Wire* I passed into the little *Hole* a Sprig of a known Plant, which was *Balm*, so as that the *Top* of the Plant was within the *Recipient*, and the *Roots* without. Then I closed the rest of the *Hole* with *Cement*, and when I had taken away my little *emptied Receiver*, with the Plant half shut up therein, I put the whole into a great Glass fill'd with *Water*, the Root being downwards; and I saw that there were formed little *Water Drops* upon the Leaves that were *in Vacuo*. I left it ten Days in this Condition, and during that Time there were entred about two Spoonfuls of *Water* into the *Receiver*, and in all Appearance this *Water* had pressed through the Plant, Yet there appeared no more any Drops upon the Leaves; but that might very well come from the grosser *excrementitious Matter* that is in the *Water*, which had stopp'd the *Conduits*.

After this, to know whether any Air had been form'd there, I replaced the *Receiver* upon the Engine, and having whelmed a bigger upon it, I saw there was but very little Air formed in the small one, because the great *Recipient* was almost all empty before the Air included in the little one could lift it up. Yet at last it did raise it, and I inclined the Engine, to the End that the little *Receiver* might not be applied to its *Cover*, when I should let the Air re-enter; and after this Manner both the *Recipients* were filled in the same Time. Then I looked upon the Leaves of the Plant; they were not withered, though they were not grown; only the Leaves had in the Middle a little changed their Colour, and had a Smell somewhat fowrish; but the next Morning the Plant was quite spoiled. We may believe that the Pressure of the Air had made the *Water* enter into this Plant with so great a Violence, that thereby it had, as it were, mortified the Parts, especially in the Middle where the Leaves were most tender; but this *Water* still kept the Leaves, ex-

tended, and so they withered not ; but, when the Air came to act upon them, the Parts of the Plant which had so much suffered were soon corrupted by it. For 'tis very probable, as well by this Experiment, as by others hereafter to be mentioned, that the Air is a Dissolvent which corrupteth Bodies.

This being done, I made the Experiment the other Way, that is, with the Leaves in the Air, and the *Roots* in a *Bottle of Water* that was in *Vacuo* ; and immediately I saw Air-Bubbles issuing out at the End of the Tail in *Vacuo*. After this I put Water upon the Leaves, to see whether this Air came from thence, and I saw indeed soon after that these Bubbles began to cease ; and having taken away the Water wherein the Leaves were, I saw that the Bubbles began to issue out at the Tail as before : And I saw them still come out 24 *Hours* after, but in *little Quantity* ; and at length it quite ceased. During these 24 *Hours* the *Roots* did lengthen about four Lines, that is, one Third of an *Inch*, which is little less than they ordinarily do in the *Air*.

I kept the Plant in this Condition for *four Days* upon the *Engine*, and took care from Time to Time to draw out the Air that entered into it by the Leaves ; and then it began to *wither*, and the *Roots* shot no more.

Another Time I put *two Twigs* of *Balm*, each into a Vial full of *Water*, and at the End of 5 *Days*, when I saw manifestly that they both shot *Roots*, I included in the *Vacuum* that of the *Two* which had the *longest Roots*, without taking it out of its Vial. At the end of *three Days*, observing that it was *wither'd in Vacuo*, I took it out, and changed the Vials of the *Twigs*, to see, whether that which remained in the Air, and did thrive very well in *common Water*, would also thrive in *Water freed of Air* ; and whether that which was *wither'd in Vacuo* would revive in the *common Water* and in Air. *Four Days* after I found the *Twig* that had been in *Vacuo* quite spoiled, and the other still verdant, but not thriving ; and I observed, that it did not begin to shoot in the *Water freed of Air* till *ten Days* after it had been put in.

This Experiment drew another after it, to know whether the Water purged of Air were less fit than common Water to make Plants *vegetate*. For this End I took *two Vials* full, the one of Water purged, the other of common Water, and having put a *Twig* of *Balm* in each, I left them both in the Air. I found, that the *Twig* in the common Water shot at the end of Six *Days*, and in Water purged shot this Time neither but *ten Days* after it had been put in.

I repeated this Experiment once more, and I was much surprized to see, that the *Twig* in the Water freed of Air began this Time to shoot the 3d *Day*, and the other in the common Water still the 6th *Day*. But this was remarkable herein, that the *Twig* in the Water purged shot no more but one *Root*, which grew very long, and on the 9th *Day* only it began a little to shoot another, which lengthened but one Line in *two Days*, whereas the *Twig* in the common Water had then 9 or 10 *Roots*, which were all very long, having always lengthened *five Lines* or more in a *Day*.

Although this Experiment appear'd at first contrary to the precedent, yet it still confirmed the first Thought, to wit, that the Air which is mixed in common Water serves for *Vegetation*, considering the little *Root* which the *Twig* shot in the Water cleansed of Air.

After

After this, I made some Experiments upon harder Plants. One Day I put a green Piece of *Sallow-Wood*, part in the Air and part *in Vacuo*, after the Manner above describ'd. I put into Water that Part which was in the Air, and the Water presently began to mount and to pass through the Middle of the Wood, and incessantly formed *Bubbles* in the *Receiver*. These *Bubbles* continued thus for the Space of 24 Hours; and certainly it was the *Water*, which passing through the *Wood* was in part changed into *Air*. For I made the same Experiment with a Piece of *Buffe*, and the Water mounted also and passed through it, but it formed no *Bubbles*. Mean time, if there be *Valves* in *Wood*, they must needs be unable to resist the *Pressure* of the *Air*; for I have noted in *Sallow*, as well as in *Elm*, that the *Water* passes thro' them with the same Facility what End soever you put *in Vacuo*.

One Day also I put the upper End of a little *Elm Branch* in the *Vacuum*, and the lower End in the *Air*. This lower End I trenched in Water, as I had done the Roots of *Balm* before: But it was a whole Hour before there appeared any Drop of *Water* upon the *Elm-Leaves in Vacuo*, whereas upon the *Balm-Leaves* the Drops appeared presently. The Cause of which may be the Hardness of the *Elm-Wood*. But I know not why *Water* passing thro' *Wood* forms *Bubbles*, and in passing thro' *Leaves* forms nothing but Drops.

I made also the Experiment the other Way, that is, the *Leaves* in the *Water* without the *Recipient*, and the lower End of the Branch *in Vacuo*, and I saw, that there passed nothing for two Hours time; insomuch that I cut a little of the upper End of the Branch which was very tender, and then indeed I saw a little Moisture appear at the End that was *in Vacuo*, but that enough only to form one Drop, and there appeared no *Bubbles* of *Air*. Then I cut the Branch yet a little lower, and then there was formed one Drop of *Water* at the End that was *in Vacuo*, but it fell not. And having cut the Branch yet a little more, the Drop of *Water* fell down *in Vacuo*. This shews, that they were not the *Valves* of the *Plant* that hindered the *Water* from passing whilst the Branch was entire; but rather that it was the great Tenderness of the *Leaves*, suffering themselves to be compressed by the *Pressure* of the *Air*, and that so the *Water* could not insinuate itself between their Parts.

Apr. 3. 1673. * I included an *Apple*, which had a little Speck of *Rottenness*, and some *Water* in the same *Recipient*, thereby to promote the *Corruption*, in case any should come to pass: But I have not found that any *Change* happen'd to it since that Time.

Jun. 7. I included in a *Receiver* two *Nosegays* of *Roses*, one suspended at the Top, the other having its Tail in a little Vessel full of *Water*. I also put in the same *Receiver* a Gage 4 Inches long, to know whether any *Air* would be there produced. Two Days after I found my *Roses* a little wither'd, and the *Water* already risen to 8 or 10 Lines near the Top of my Gage; and after that the Changes of these *Flowers* became less still, so that at this present time they are not much more wither'd, and the *Water* of the Gage is by 3 or 4 Lines nearer the Top. The *Roses* which lie dipt in the *Water* are as much withered as the others, and as soon. Other *Roses* which I had included at the same Time, but with *Air*, grew mouldy in less than eight Days.

n. 121. p. 422. * These Experiments were printed at Paris, in the Year 1674.

At another time I included one single *Rose-Button* in a very little Glass, to learn whether it would keep its Scent. At the End of 15 Days it looked a little less fresh, but was not at all wither'd; and having taken it out, I found it had still its good *Smell*; but after that it lost both *Colour* and *Smell*, in less than two Hours. I must also add, that its Leaves did not appear moist in the *Vacuum*, but they look'd all moist as soon as they were in the *Air*: Which shews, that the Parts of the Leaves had acted as Springs, like as *Spunges* do, and that the Weight of the *Air* coming to press upon them, did express the Humidity, which had insinuated itself between the Parts thus expanded.

I did also include some *Gilly-Flowers*, which changed but very little; only they looked as if they had been dipped in Water.

Having included some *Strawberries*, at the End of two Days they look'd less fresh; but after that, seeing they changed no more, I took them out of the *Vacuum* after they had been there 15 Days. They had still the *Smell* and Taste of *Strawberries*; but they had also contracted a very ungrateful Taste of the Cement which I then employed to close them up with.

Phil. Sup.
§. LXXIV.

At another time I put some *Strawberries* without Cement, making use of a Skin, after the Manner described formerly, and I then observed nothing new, except that their Taste kept good, but was a little sourish, and that they yielded a little Water.

Jun. 24. I included some *Cherries*, to the Number of 25 or 30, in a *Receiver* which was almost fill'd with them. They all burst but two. Two Days after they had a little changed their *Colour*, and those two, that before remained whole, were not burst like the rest. After that, I observed no more change in them.

Jul. 20. I included in the *Vacuum* one *Cherry*, with eleven great *Currants*. The *Cherry* burst presently, and after that I found it not changed, only it appeared turned, as the *Currants* also did: This is a Beginning of Putrefaction, which may be imputed to the *Air* that remains in the *Receivers*.

Jul. 27, I included in the *Vacuum* four *Rasberries* and three *Currants*. The latter appeared also to be turned, and the *Rasberries* looked less fresh than they were. But 'tis now more than five Months that I perceive no Change in them.

Hitherto I had employed none but *small Receivers*, which did just hold that little Fruit I put in them, and the *red Currants* seem'd to keep well enough; so that one Day I filled a great Glass, of the Figure of *cupping Glasses*, with them, hoping to keep that as well as the *small Receivers*. But I was surpriz'd five Days after, to see that *Bubbles* were formed in the *Turpentine* which I had put about the said *great Glass* in the Place where 'twas fasten'd to its *Cover*, and that these *Bubbles* were burst outwards; and afterwards having seen that the *Cover* held fast to the *Bolt-head* no longer, I made no doubt of the *Currants* having produced Air enough to lift up the said *great Glass*, and to form in the *Turpentine* the *Bubbles* I had seen. I was confirmed in this Thought, when I found by the *Smell* that they had fermented. They were yet good, except some that had lost almost all their Taste, and all their Acidity.

The

The same thing happen'd to me with a very *small Receiver*, that could hold no more but one *Cherry*, of that Kind we call *Bigarreaux*, and one *red Currant*. These Fruits yielded also Air enough to lift up their *Receiver* 7 Days after they had been included therein: And having reiterated this *Experiment*, I found the same Success; only this second Time the *Receiver* was not lifted up till the 11th Day. This Effect is rather to be ascribed to the *Cherry* than the *Currant*, because I have kept *Currants* to the Number of 11, in a small *Glass*, and they did not raise it up. Whence it follows, that the *Bigarreaux* yield much more *Air* than acid Fruit.

Another time I included some of the same Kind of *Cherries*, a whole great *Glass* full, and found, that from the second Day they had yielded *Air* enough to lift up the *Cover*. I took away Part of the *Cherries*, and included the rest again.

This second time they did not raise the *Glass* till the 8th Day. The *Cherries* looked fair, but they had lost much of their Taste, and afterwards they were spoiled in less than an Hour.

I did also one Day include three *Pears*, of that Sort we call *Rouffeletes*, in a like figur'd *Glass*, which could hold no more. They lifted up the *Glass* at the end of five Days, and they were not changed, only one of them was a little softer.

Another time I put a *Peach* in such a *Glass* emptied of *Air* with a *Gage* to it; and I found, that the first 6 Hours the *Quicksilver* in the *Gage* was risen about an *Inch*. Yet it was not till the 13th Day that the *Glass* was lifted up; and the *Peach* appeared to have kept very well till then; but after that, it rotted in a very little Time.

I did once put some *Bread* with a *Gage*, but I found not that for the Space of a whole Month it had yielded any *Air*, so that I took it out, and found it yet good; only it had a little taste of *Mustiness*, which yet appeared not at all to the Eye, and whereof the Cause may be ascribed to that little *Air* that might rest in the *Receiver*.

One Day I included a Piece of roasted Mutton with a *Gage*, and found, that in 4 Days it had yielded no *Air*, but after my Absence of 6 Weeks, I saw the *Mercury* was risen to the Middle of the *Gage*, and having taken out the Meat, I found it of a very ill Smell.

Two Days after, I included a Piece of *raw Beef*, and a *Gage* with it, and I saw, that in 2 Days the *Quicksilver* was risen an *Inch* in the *Gage*; and after 6 Weeks Absence, I found the *Mercury* was got almost to the Top of the *Gage*, and that this Meat had contracted a much worse Smell than that which had been roasted.

I also kept for 15 Days a Piece of *fresh Butter in Vacuo*, and I found, that it smelt more strong than when I first put it in: But yet it could be still eaten upon Bread, whereas another Piece of *Butter*, which at the same Time I had kept in the Air, was altogether unfit to be eaten.

One Day I covered a *Receiver*, whose 4th Part was fill'd with Water, and the rest all empty. I put it over the Flame of a *Candle*, and saw that the Water boiled very quickly, yet the *Glass* not much heated; so that the Wa-

ter boiled near a quarter of an Hour, with a great *Ebullition*, and the Glass was no more than tepid. I then took it away from the Flame, and saw that the *Water* continued a very great while boiling, and that it began again from Time to Time. I then believed that the Vapors which had been raised into the Air were recondensed by the Cold, and that that made the *hot Water* bubble up, as *Water* usually doth when 'tis put into the *Engine*, and the *Air* that presses it exhausted. Mean Time, I have since made the Experiment with a Gage, and I did not perceive, that all the *Bubbles* that issued out of the *Water* made the *Mercury* rise to Sense.

After this, I left my *Receiver* exposed to the Frost, and I found that the *Ice* which was made therein was not yet quite free from *Bubbles*, though the *Water* thereof had boiled in the *Vacuum*, which one would think should have driven out all the *Air*; yet the *Bubbles* were there far less numerous than in *Ice* made of ordinary *Water*. I perceived not that the *Quicksilver* was much risen in the *Gage*. Afterwards I melted this *Ice*, and put the *Water* abroad to freeze again, still without taking it out of the *Vacuum*, and I found that this second Time it was very much freer from *Bubbles*. The Glass did not break; but because it was somewhat conical, we could not know, whether it remained whole upon the Account of its Figure, or because that the *Water* which was frozen within was freed of *Air*.

After this, I made *Spirit of Wine* boil *in Vacuo* in the same Manner I did the *Water*, and I saw that it boil'd much sooner. It made the *Mercury* rise about an *Inch* in the *Gage*. Then I took it from the Fire, and saw it continue in its Boiling; and even sinking the *Receiver* into cold *Water*, it thereupon boiled much more strongly. One would think this proceeded from an *Antiperistasis*; but we have more ground to say it came from hence, that the Vapors of the *Spirit* were condensed, and so made the *Receiver* more empty; which is sufficient to make the *Spirit of Wine* boil, even tho' it were not hot. The *Quicksilver* did in *two Hours* subside again, to near half a Line as low as it had been. Then I put the *Receiver* over the Flame again, and made the *Mercury* rise more than *two Inches*; but then the *Receiver* cracked.

One Day I took a *Tube* of *Plaster of Paris*, open at one End, and close at the other. I applied the open End to the Cement as I was wont to do *Receivers*; and I saw it was not possible thus to exhaust it, because the *Air* did easily pass thro' the *Plaster*. I put therefore a *Tube* of *Iron* on the *Engine*, so as having filled it with *Water*, the *Tube* of *Plaster* was covered therewith, and then having caused the *Pump* to be plied, I found, that the *Water* did pass as easily thro' the said *Plaster*. I therefore covered it with *Venice-Turpentine* instead of *Water*, and then I saw that it evacuated very well, and that nothing passed thro' it for the Space of *two Hours*. Then I took some *Oyl* very hot, and poured it over the *Turpentine*, which did melt by this Heat, and passed thro' the *Plaster*. Then I took off this *Tube*, which was so pervaded by the *Turpentine*, and I saw, that that had made it *transparent*: Which effect is pretty like, and is to be explicated in the same Manner as that of the little Stone called *Oculus Mundi*. Thus we may be assisted by the Weight of the *Air* to make diverse Sorts of *Glues* penetrate *Plaster*, *baked Earth*,
Wood,

Wood, &c. And possibly those, who shall make a good Number of such Trials, will find their Labour and Pains recompensed, by giving to those Materials such Properties as they never had before.

I did also put some *Eggs* in the *Vacuum*, and one Day I saw one of them break, which I had put in a small *Receiver*. It burst upon the very first *Suction*: But since that Time I could never make any *break*, tho' I exhausted as much as I could those *Receivers* wherein I had put some. You must therefore begin to crack them a little before you put them in the *Vacuum*, and then they do easily break quite, and what is in the Egg riseth all into a very thick *Froth*: I also put some of these thus ordered over the Fire, where they boiled very easily, not being pressed by the Air; but they boiled there very long, before it began to appear that they were so boiled as to be ready to eat.

All the little Bubbles, that appear in *Mustard*, do swell and break *in vacuo*; and after that the *Mustard* is seen to be without Bubbles.

One Day I included a *black Ribbon* in the *Vacuum*, and then burnt it with a *Burning-Glass*. Abundance of Smoke issued out of it, which fell by little and little, and so permitted us to see the *Ribbon* plainly; which appeared not at all changed. But after I had returned the Air into it, and touched it, I found it turned to Ashes.

Another time I caused some *Gunpowder* to be burnt after the same Manner; and I was much surprized to see that it burnt Grain by Grain, none of the kindled Grains firing those which touched. Another time, when the Sun had less Force, I could not at all kindle the Powder, but I made it only boil and emit Store of Smoke. I had put a Gage in the same *Recipient*, by means whereof I observed, that that Smoke produced no Air; for the *Quicksilver* did not rise in the Tube. I noted also, that this Smoke falling upon the Past-board, on which I had put the Powder, appeared yellow, of the Colour of *Brimstone*. After that, I took out the Powder that remained, being like a black Mass, and having put it upon burning Coals, I saw it burned as doth *Salt-Petre*; and so it appeared, that the Sulphur was almost all exhaled. I was willing to reiterate this Experiment, and then I saw that the Powder after *boiling, fuming*, and being kindled Grain by Grain, (as in the first Experiment) at last flashes out all at once, when one hath the Patience to hold the Fire to it with a *Burning-glass*. And when the Fumes are grown clearer, you may see Needles of *Salt-Petre* sticking to the Sides of the *Receiver*.

Another time, I put the Weight of 12 or 15 Grains of *Powder* in a Glass, shap'd like a *Cupping-Glass*, capable to hold 14 Ounces of Water, and having put Fire to it, I made the Powder boil and smoke as usually. Afterwards, seeing that the Corns began to crack very near one after another; I then took away the burning Concave, for fear all should be kindled together: But it was already too late; for the Corns did continue to crack longer than a second of Time, and at last all kindled, tho' there was then nothing left to heat them but the Fire which they had kept within themselves. The *Receiver* was lifted up above a Foot high without breaking.

Another time I put the Weight of 18 Grains of *Powder*, together with a *Gage*, into a *Receiver* holding 7 Pound of Water; and I saw, that the *Powder*

was more difficult to be kindled than in small *Receivers*. Yet at length it was kindled altogether, and made the *Quicksilver* rise to the height of an *Inch* and a half in the Gage; and I am very well assured, that all that Air was not come from without; for that Part of the *Receiver*, to which the Cover is applied, had always been under Water.

From what I have been relating it may be concluded, that there is a fifth Part of *Air* in *Gunpowder*, supposing, as other *Experiments* do shew, that Air is about a Thousand times lighter than Water. For, in this *Experiment*, the *Mercury* did rise to the 18th Part of the Height where the Air commonly sustains it; and consequently the Weight of 18 Grains of Powder did yield Air enough to fill the 18th Part of a *Receiver* that contains 7 Pound of Water. Now this 18th Part contains 49 Drachms of Water: Wherefore the Air, that takes up an equal Space, being 1000 times lighter, weighs $\frac{1}{1000}$ of 49 Drachms, which is more than $3\frac{1}{2}$ Grains. It follows therefore, that the Weight of 18 Grains of Powder, which I employed in my Experiment, contained more than $3\frac{1}{2}$ of Air, which is about the fifth Part of 18 Grains.

It may also be calculated, how many times this Air hath been compressed in the Powder: But this Calculation is more uncertain than the former, because we know not, whether this Air took up more or less than the fifth Part of the Space which the Powder possessed. But yet 'tis certain, that tho' it had even taken up three Fourths of the whole room of the Powder, and that the 14 Grains of the other Matter had taken up no more than the one remaining fourth Part, still this Air would have been compressed about three hundred times. To calculate this, I suppose, that the Space of a *Cubick Foot* can hold only 72 Pounds of *Gunpowder*, which do contain more than 14 Pounds of Air, by the foregoing *Calculus*; which Quantity of Air is therefore found inclosed in the three Fourths of a *Cubick Foot*. Now this Space doth usually contain but about 6 Drachms of Air: Wherefore, to make it hold 14 Pounds of Air, which is near 300 times six Drachms, it must needs be, that the Air be compressed near 300 times.

There is Reason to believe, that this Compression is much greater, because a *Cubick Foot* can hold much more than 72 Pounds of Powder, and because also that the fifth Part of the Weight must not in Appearance possess alone the three Fourths, and all the rest take up no more than one Fourth of the Space possessed by all the Powder.

I should therefore make no Difficulty to believe, that all the Effect of *Gunpowder* comes from the Air which is compressed therein, and especially in the *Salt-Petre*; for I have not yet observed that *Brimstone* yields Air. Possibly also we may find in time, that all other *Fulminations*, *Ebullitions*, and *Fermentations*, that make such surprizing Motions, are nothing else but Air compressed expanding itself.

n. 122. p.
542.

One Day I included in the *Vacuum* an Insect which resembles a *Beetle*, but is a little bigger; and when I perceived it to appear dead, I gave it Air again, and it soon after recovered. Then I put it in the *Vacuum* again, and having left it there for an Hour, I re-admitted the Air, and found, that then the Insect needed much more Time to recover. I included it there the third Time, and

and having left it there two Days, I gave it Air again, and saw it needed about ten Hours before it began to stir again; yet it recovered well enough this Time: But having put it in again the fourth Time, and left it there 8 Days, it would never stir again.

Intending to try the like upon a *Butterfly*, I saw, when I re-admitted Air to it, that the top of its Back, which before was much swelled, did fall in more than it should, and the *Insect* would not recover.

I also killed in the *Vacuum* many Animals that breath, as *Birds*, *Mice*, *Rats*, *Rabbets*, *Cats*; and some of them I recovered by quickly giving them Air again before the *Engine* was quite exhausted; but I never saw any of them *Revive*, that had been in a perfect *Vacuum*.

M. Guide did make frequent *Dissections* of such Animals as we had thus kill'd, and observed, amongst other Things, that their *Lungs* fell to the Bottom in *Water*. He saith, that the *Solidity* or *Clofeness* of the *Lungs* of Animals, that have died in *Vacuo*, comes from hence; that the *Blood* which is propelled into the *Lungs* by the *Vena Arteriosa* doth so strongly press the *Bronchi* of the *arteria aspera*, that it expresses the *Air* out of them, and glues as 'twere their Sides to one another. But for my part I do not believe, that the *Blood* of the *Vena Arteriosa* can thus compress those *Bronchi*, because that the said *Blood* is inclosed in its Vessels, that keep and hinder it from compressing others. Yet I am not ignorant, that the Things that are included in the *Oesophagus* do indeed compress the *asperia Arteria*, and that the *asperia Arteria* by being filled compresses also the *Oesophagus*, upon the account of the Situation of these two *Conduits*. But it appears not at all, that the smallest *Ramifications* of those *Bronchi*, and of the *Vena Arteriosa*, are situate in the same Manner; for the *Bronchi* being harder than the *arterial Vein*, they will compress it more easily, than be compressed by it; and so if you should blow them up with Bellows, they will glue the Sides of that Vein together, and hinder the Circulation: Which is directly contrary to the Experiment, as M. Guide himself observeth.

It is therefore far more probable, that if the *Lungs* be compressed, that Compression is made by the *Pleura*, which may be swelled within the *Breast*, as the *Skin* is swell'd without. But it is not necessary that the *Lungs* be compressed in *Vacuo* to make them subside in *Water*; for I have diverse times put Pieces of *Lungs*, and whole *Lungs* in the *Vacuum*, and they remained there extremely swell'd; but, as soon as the *Air* was again intromitted, they became very flat and red, and sunk to the Bottom in *Water*. Which shews, 'tis sufficient for getting the *Air* out of the *Lungs* to render them close and red; and I have not been able to produce this Effect but by means of the exhausting Engine. For I have left *Lungs* a whole Night between two Plates with a great Weight upon them, to endeavour to press the *Air* out of them, but it would not succeed, and those *Lungs* did still float upon the *Water*. I have also tried to make the *Air* re-enter into the *Lungs*, after I had render'd them solid in the Engine, and that I found very easy; for drawing them out from the Bottom of the *Water*, I did blow into the *asperia Arteria*; and the *Lungs* swelled again, and resumed their ordinary Colour, and floated on the *Water*. And this is that which befalls the *Lungs* of *Infants* new born.

A Pneumati-
cal Experi-
ment, b. M.
Joh. Chr.
Sturmius,
P. Coll.
n. 2. p. 8.

LXXX. I seal'd up a round Glass hermetically, and covered it with a double Bladder vary carefully, and including it in a large Receiver, I found, according to my Expectation, that, after about 200 *Exhaustions* had been made, it broke all in Pieces with a very great noise.

LXXXI. Papers, Of less general Use, omitted.

- n. 251. p. 144 1. A List of the *French Academicians* at their new Regulation in the Year 1699. by *M. Geoffry*.
- n. 99. p. 61; 8 2. An Account of some of the *natural Things*, with which the intelligent and inquisitive Signior *Paulo Boccone*, of *Sicily*, hath lately presented the *R. S.* and enriched their Repository.
- n. 246 p. 393 3. Remarks by Mr. *Ja. Petiver*, on some *Animals, Plants, &c.* sent to him from *Maryland*, by the Reverend Mr. *Hugh Jones*.
- n. 255 p. 295 4. A Catalogue of *Shells, &c.* gathered at the *Island of Ascension*, by Mr. *Ja. Cunningham* Surgeon, with what Plants he there observed; communicated to Mr. *Ja. Petiver*.
- n. 246. p. 390
n. 247. p. 461
n. 249. p. 44.
n. 250. p. 70. 5. An Account of a *China Cabinet*, filled with several Instruments, and some *natural Curiosities* of that Country, sent to the *R. Society*, by Mr. *Buckley*, chief Surgeon at *Fort St. George*; by *Hans Sloane*, M. D.
- n. 10. p. 167. 6. A *Thermoscope* and a *Baroscope*, invented by Mr. *R. Boyle*, described by *Dr. Wallis*.
- n. 13. p. 218. 7. *Dr. Hook's Wheel Barometer*, describ'd in his *Micrography*, is here something improv'd; by himself.
- n. 91. p. 5168 8. *Experiments* proposed, to explicate the Reason of the *Suspension* of *Mercury* in the *Torricellian Tubes* at an unusual Height; by *Dr. Wallis*.
- n. 206. p. 993 9. Some *Queries* concerning the Nature of *Light* and *Diaphaneus Bodies*; by Mr. *Edm. Halley*.
- n. 79. p. 3060 10. *Queries* concerning the different Effects of the *Sun's Heat* collected by a burning Concave, and that of *Fire*, upon *Gold, &c.* by *P. Fr. Luna*.
- n. 66. p. 2020 11. An *Experiment* concerning the Progress of *artificial Conglaciation*, and the remarkable Accidents therein observed; by the *Florentine Philosophers*, and published in their *Saggi di Naturali Esperienze*.
- n. 23. p. 424. 12. Proposals to try the Effects of the *Pneumatical Engine*, exhausted in *Plants, Seeds, Eggs of Silk-worms, &c.* by Mr. *R. Boyle*, and *Dr. Beale*.

LXXXII. Accounts and Emendations of Books, omitted.

- n. 27. p. 501. 1. THE History of the *Royal Society of London*, for the Advancement of *Experimental Philosophy*; by *Tho. Sprat*.
- n. 36. p. 715. 2. The Progress and Advancement of *Knowledge* since the Days of *Aristotle*, in an Account of some of the most remarkable late *Improvements* of useful Learning; by *Jos. Glanvill*, Lond. 1668. in 8vo.
- n. 8. p. 145. 3. A Narration of the Establishment of the *Lyncei*, an *Italian Academy*, and of their *Design* and *Statutes*.
- n. 203. p. 886 4. *Diogenes Laertius, Græce & Latine*, cum commentariis integris *Doctorum Virorum*. *Amstel.* 1692.

5. C. Plinii Historia Naturalis. Notwithstanding the great Care of R. P. Har-
 duine, in this curious Edition, yet he hath past over several Faults, three of which
 Mr. Halley hath here corrected, viz. n.194.p.535

(1.) Lib. 2. Cap. 13. Defectus [Solis & Lunæ] Ducentis Viginti Duobus Men-
 sibus redire in suos Orbes certum est: Whereas it ought to be CCXXIII; at
 which Time that Period is compleated; and the Moon returns to the Sun and
 of the same Node accurately enough, to her Apogæum very near, and within a
 few Degrees to the same Place of the Heavens.

(2.) Lib. 11. Cap. 37. Jecur maxime vetustatis patiens centenis durare An-
 nis Obsidionum exempla prodidere; which Mr. Halley conjectures should either
 be Hoc Seniorum exempla, or Hoc Syrorum exempla prodidere.

(3.) Lib. 20. Cap. 14. Instead of Syriation & vomicas vulvæ curavit illa, Mr.
 Halley reads Satyriasin & Vomicas vulvæ curavit.

6. Pinax rerum Naturalium Britannicarum, continens Vegetabilia, Animalia,
 & Fossilia, in hac Insula reperta. Auth. Chr. Merret, M. D. n.20.p.364.
 n.21.p.448.

7. Museo Cospiano annesso a quello del famoso Ulisse Aldrovandi, & donato
 alla sua Patria dell' Illustrissimo Signore Ferdinando Cospi Patricio di Bologna
 & Senatore, &c. Descrizione di Lorenzo Legati Cremonese. In Bologna
 1678. in Folio. n.140.p.
 1011.

8. Musæi Petivcriani Centuria Prima; Rariora Naturæ continens: viz. n.224.p.393
 Animalia, Fossilia, Plantas, ex variis Mundi plagis advecta; ordine digesta;
 Nominibus propriis signata; & Iconibus Æneis eleganter illustrata. Lond.
 1696. in 8vo.

9. (1.) Saggi di Naturali Esperienze, fatte nell' *Accademia del Cimento*, in
 Firenze, An. 1667. in Folio. n.33.p.640.

(2.) Essays of natural Experiments made in the *Academy del Cimento* under
 the Protection of the most serene Prince Leopold of Tuscany. Established by
 the ingenious Rich. Waller, Esq; 1684. in 4to. n.164.p.757

10. (1.) *Miscellanea Curiosa Medico-Physica, Academiæ naturæ curiosorum*, n.68.p.2070
 Annus Primus, Lipsiæ 1670. in 4to.

(2.) Annus Secundus; Anni Scil. 1671. Jenæ, 1671. in 4to. n.85.p.5024

(3.) *Ephemèridum Medico-Physicarum Germaniæ Annus Tertius, &c. Lipsiæ* n.101.p.15.
 & *Francofurti*. 1673. in 4to.

(4.) Annus IV. & V. Anni 1673 & 1675, &c. Cum Appendice. *Franco-* n.129.p.742
furti & Lipsiæ. 1676. in 4to.

11. (1.) *Thomæ Bartholini Acta Medica & Philosophica Hafniensia, An. 1671* n.97.p.6135
 & 1672. *Hafniæ*. 1673. in 4to.

(2.) *An. 1673. Hafniæ*. 1675. n.114.p.315

12. *Georgii Hieronymi Velschii Hecatostæ 2. Observationum Physico-Medi-* n.127.p.673
carum Augustæ Vindelicorum. 1675.

13. *Stephani Chauvini Lexicon Rationale, sive Thesaurus Philosophicus, &c.* n.199.p.737
Roterodami. 1692. in Folio. A

14. (1.) *Collegium Experimentale sive Curiosum, in quo Primaria hujus Se-* n.121.p.509
culi inventa & Experimenta Physico-Mathematica, A. 1672. quibusdam Na-
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(2.) Pars Secunda. *Altorfi*. 1685. in 4to.

15. EX- 1184

- n.92.p.6002 15. *Experienze intorno a diverse Cose Naturali, & particolar mente à quelle che ci son portate dall' Indie; fatte da Francesco Redi in Firenzi. 1671. in 4to.*
- n.207.p.33. 16. *Observationi Naturali, ove si contengono materie Medico Fisiche, &c. Natural Observations, containing several Medico-Physical and Botanical Matters; with diverse natural Productions; several Sorts of Phosphori, subterraneous Fires in Italy, and other curious Subjects; in familiar Letters, by Signior Paul Boccone, M. D. Bononia, 1684. in 12mo.*
- n.207.p.37.
n.249.p.53. 17. *Museo di Fisica, & di Esperienze, arricchito di Figure di Piante Nove Osservazione, Note Medicinali e Ragionamenti, secondo i Principii di Neoterici, disposto in Decade VIII. by S. Paolo Boccone. Upon this Book Mr. Ray adds here some Remarks of his own.*
- n.73.p.2214 18. *Philosophus Autodidactus, exhibitus in Epistola, ex Arabica in Latinam Linguam versa, ab Edvardo Pocockio, Oxon. 1671. in 4to.*
- n.69.p.2114 19. *Prodromo Overo Saggio di alcune Inventioni nuove premesse all' Arte Maestra, di P. Francisco Lana S. I. in Breſcia, 1670. in 4to.*
- n.72.p.2179 20. *Of the Usefulness of experimental natural Philosophy, the second Tome; by the honourable Robert Boyle, Esq. Oxon. 1671. in 4to.*
- n.103.p.53. 21. *About the Excellency and Grounds of the Mechanical Hypothesis, some Considerations occasionally proposed to a Friend. by R. B. E. Lond. 1674. in 4to.*
- n.131.p.116 22. *A free Enquiry into the vulgarly receiv'd Notion of Nature; by the Hon. R. Boyle, Esq; Lond. 1686. in 8vo.*
- n.40.p.810. 23. *Ren des Cartes Epistolæ; Pars Prima & Secunda. Lond. 1668 in 4to.*
- n.22.p.392. 2. *Le Tome Troisieme & Dernier des Lettres de M. des Cartes.*
- n.54.p.1094 24. *Le System General de la Philosophie; per Francois Bayle. M.D. A Tholouze, 1696. in Fol.*
- n.62.p.2034 25. *A Discourse in Vindication of Des Cartes's System; by Mr. Des Fourneillis: To which is annexed, the System General of the same Cartesian Philosophy, by Francis Bayle, M. D. Lond. 1670.*
- n.70.p.2137 26. *Philosophia Veterum, è Mente Renati des Cartes breviter digesta; ab Antonio le Grand. Lond. 1670. in 12mo.*
- n.80.p.3094
n.108.p.192 27. *Antonii le Grand institutio Philosophiæ, secundum Principia Renati de Cartes, nova Methodo adornata, & explicata. Lond. 1672. in 8vo.*
- n.54.p.6046 28. *Antonii le Grand Historia Naturæ. Lond. 1673. in 8vo.*
- n.123.p.570 29. *De consensu Vet. & Novæ Philosophiæ, Lib. 4. seu Promotæ per Experimenta Philosophiæ pars prima: Auth. J. B. du Hamel. P. S. L. in 12mo.*
- n.65.p.2105 30. (1.) *De Corporum Affectionibus cum manifestis tum occultis, Libri 2 seu Promotæ per Experimenta Philosophiæ Specimen, Auth. J. B. du Hamel. Paris, 1670. in 12mo. Mr. Boyle's Discourse (in his Origin of Forms and Qualities,) concerning the Necessity of the Creator's Concourse in the Preservation of all Things, being misunderstood by Mr. Du Hamel, is here explained.*
- n.98.p.6151 (2.) *De Corpore Animato, Libri 4. seu Promotæ per Experimenta Philosophiæ Specimen alterum: Auth. Job. Baptista du Hamel. P.S.L. Parisiis, 1673. 12mo.*
- n.131.p.790 31. *Clavis Philosophiæ Naturalis, Aristotelica Cartesiana; Editio secunda, aucta Opusculis Philosophicis varii Argumenti; quibus Errores Scholarum passim deteguntur, ac veritas Philosophiæ, quam Cartesianam vocant, confirmatur, Auth. Jo. de Raei. Amst. 1677. in 4to.*

32. *Elementa Physica, sive nova Philosophiæ Principia*; ubi *Cartesianorum* Principiorum Falsitas ostenditur, ipsiusque Errores ac Paralogismi ad Oculum demonstrantur, ac refutantur; a *Fran. Willhelmo* Libero Barone de *Nuland*, &c. *Hagæ Comitum*, 1669. in 12mo. n.65.p.2007
33. *Placita Philosophica Guarini*. n.20.p.365.
34. *Physica in Decem Tractatus Distributa*; Auth. *Honorato Fabri*. S. J. *Lugd. Gal.* 1669. in 4to. n.68.p.2082
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37. *Propositiones Hydrostaticæ ad Illustrand. Aristarchi Samii Systema destinatae, & quædam Phenomena Naturæ generalia*. Auth. *Francisco Jessop* Arm. *Lond.* 1687. in 4to. n.191.p.440
38. *Casp. Bartholini* Thom. F. *Specimen Philosophiæ Naturalis*. Accedit, de *Fontium Fluviorumque Origine*, *Dissertatio Physica*. *Amstelodam.* 1697. in 12mo. n.237.p.62.
39. *Themæ Cornelii Consentini Progymnasinata Physica*. n.30.p.579.
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41. *Erasmi Bartholini de Naturæ Mirabilibus Quæstiones Academicæ*. *Hafniæ*, 1674. in 4to. n.30.p.579.
42. *Decameron Physiologicum*: Or ten Dialogues of *natural Philosophy*. To which is added the Proportion of a strait Line, equal to half the Arch of a *Quadrant*. By *Mr. Hobbs*. n.107.p.159
n.138.p.965
43. *Cosmopœia Divina, seu Fabrica Mundi explicata*, per *Ludov. de Beaufert*. M. D. *Lugd. Batar.* 1656. in 4to. n.59.p.1052
44. *Cartesius Mosaizans*; Auth. *Joh. Amerpoel Leowardicæ*. 1669. in 12mo. Ibid. p.1052
45. *The Divine History of the Genesis of the World explicated and illustrated* *Lond.* 1670. in 4to. n.60.p.1082
46. *A Treatise of the Bulk and Selvage of the World, &c.* by *Nath. Fairfax*, M. D. *Lond.* 1673. n.99.p.6172
47. *Telluris Theoria sacra*. Authore *T. Burnetio*. *Lond.* 1681. in 4to. PbCol3.p.75
48. *Archeologiæ Philosophicæ, sive Doctrina Antiqua de Rerum Originibus*; Libro duo. Auth. *Tho. Burnet*. *Lond.* 1692. n.201.p.769
49. *Considerations on a Book, entituled, The Theory of the Earth*: Published some Years since by the Learned Doctor *Tho. Burnet*. Written by *Jo. Burnet*, Jun. *Gent.* n.203.p.888.
50. *The Wisdom of God manifested in the Works of the Creation*, in 2 Parts. By *Mr. J. Ray*. *Lond.* 1692. in 8vo. n.196.p.612
51. *Three Physico Theological Discourses, concerning, 1. The Primitive Chaos, and Creation of the World. 2. The General Deluge, its Causes and Effects. 3. The Dissolution of the World*, by *Mr. J. Ray*. *Lond.* 1692. in 8vo. Ibid. p.625.
52. *The Prodromus of a Dissertation concerning a Solid contained in a Solid*, by *Nicholaus Steno*. *English'd out of Latin*. *Lond.* 1671. in 8vo. n.72.p.2186
53. *An Essay toward a natural History of the Earth, and terrestrial Bodies, especially Minerals: As also of the Sea, Rivers, and Springs. With an Account of the universal Deluge, and of the Effects it had upon the Earth*. By *J. Woodward*, M. D. *Lond.* 1695. in 8vo. n.217.p.215

- n. 219. p. 181
199. 54. *La vana speculatione disingannata dal senso: Lettera responsiva circa i Corpi Marini, che Petrificati si trovano in varii Luoghi Terrestri. Di Agostino Scilla Pittore Academico della Fucina, in Napoli, 1670. in 4to. This Book is here abridg'd, some short Notes added, and some of the Author's Figures annexed and explained by two of the Fellows of the Royal Society.*
- n. 8. p. 145
n. 11. p. 191. 55. (1.) *The Origin of Forms and Qualities illustrated by Considerations and Experiments; by the Hon. Robert Boyle, Esq;*
n. 66. p. 2044 (2) *The same in Latin. Oxon. 1669. in 12mo.*
- n. 28. p. 532. 56. *Free Considerations about subordinate Forms; by the Hon. Robert Boyle.*
- n. 63. p. 2057 57. *Tracts written by the Hon. Rob. Boyle, about the cosmical Qualities of Things; the Temperature of the subterranean and submarine Regions; and the Bottom of the Sea; together with an Introduction to the History of particular Qualities. Oxon. 1670. in 8vo.*
- n. 127. p. 669 58. *Experiments, Notes, &c. about the Mechanical Origin of diverse particular Qualities: Among which is inserted a Discourse of the Imperfection of the Chymists Doctrine of Qualities; together with some Reflections upon the Hypothesis of Alkali and Acidum. By the Hon. Robert Boyle, Esq; Lond. 1675. in 8vo.*
- n. 130. p. 766 59. *Roberti Boyle Nobilissimi Angli & Soc. Regiæ dignissimi Socii, Opera varia. Geneva, 1677. in 4to. This Edition and Translation is here complained of for several Reasons.*
- n. 53. p. 1069 60. *Certain Philosophical Essays, and other Tracts by the Hon. Rob. Boyle.*
- n. 162. p. 702 61. *Experiments and Considerations about the Porosity of Bodies, in two Essays; by the Hon. Robert Boyle, Esq; Lond. 1684. in 8vo.*
- n. 96. p. 6101 62. *Several Tracts written by the Hon. Rob. Boyle, of the strange Subtlety, Efficacy, and determinate Nature of Effluvioms; of new Experiments to make the Parts of Fire and Flame stable and ponderable; together with some additional Experiments about Arresting and Weighing of igneous Corpuscles; as also a Discovery of the Perviousness of Glass to ponderable Parts of Flame, with some Reflections on it by way of Corollary.*
- n. 150. p. 982 63. *An Essay of the great Effects of even languid and unheeded Motions. Lond. 1685.*
- n. 1. p. 8.
n. 3. p. 46. 64. *New Observations and Experiments, in order to an experimental History of Cold, by the Hon. Robert Boyle, Esq;*
- n. 78. p. 3043 65. *Dissertations sur la Nature du Froid & du Chaud, par le Sieur Petit. Avec un Discours sur la Construction & l'Usage d'un Cylindre Arithmetique invente par le mesme Auteur. A Paris, 1671.*
- n. 267. p. 724 66. *Thaumantiadis Thaumasia, sub Præsidio Dom. Chr. Sturnii. Noribergæ, 1699.*
- n. 42. p. 845. 67. *A Continuation of new Experiments Physico-Mechanical, touching the Spring and Weight of the Air, and their Effects; the I. Part, &c. by the Hon. Rob. Boyle, F. R. S. Oxon. 1668. in 4to.*
- n. 50. p. 1017 68. *Georgii Sinclarii Ars Nova & Magna Gravitatis & Levitatis. Roterodami. 1669. in 4to.*
- n. 92. p. 5199 *Some Complaints and Suggestions by that Author, (in his Preface) are here answer'd.*

69. Dimostrazione Fisico-Matematica Delle sette Propositioni, che promesse n. 63. p. 213.
Donato Rosetti, in *Firenze* 1668. in 4to.
70. Observations touching the *Torricellian Experiment*, and the various So- n. 104. p. 739
 lutions of the same, especially touching the *Weight* and *Elasticity* of the *Air*.
London. 1674. in 8vo.
71. Tracts written by the Hon. *Rob. Boyle*, of a Discovery of the admi- n. 67. p. 203
 rable *Rarefaction* of the *Air* (even without *Heat*;) New Observations about
 the *Duration* of the *Spring* of the *Air*; New Experiments touching the *Con-*
densation of the *Air* by mere *Cold*; and its *Compression* without *Mechanical*
Engines: And the admirably differing *Extension* of the same Quantity of *Air*
rarified and *compressed*. *London*. 1670. in 4to.
72. Tracts, written by the Hon. *Rob. Boyle*, containing new Experiments n. 92. p. 5197
 touching the Relation betwixt *Flame* and *Air*, and about two *Explosions*: An
Hydrostatical Discourse, occasioned by some *Objections* of *Dr. Hen. More*,
 &c. To which is annexed an *Hydrostatical Letter*, about a way of weighing
Water in *Water*: New Experiments of the *Positive* or *Relative Levity* of
Bodies under *Water*; of the *Air's Spring* on *Bodies* under *Water*; and about
 the differing *Pressure* of heavy *Solids* and *Fluids*. *London*. 1672. in 8vo.
73. Tracts, consisting of Observations about the *Saltness* of the *Sea*: An n. 97. p. 6117
 Account of a *Statistical Hygroscope* and its *Uses*; together with an *Appendix*
 about the *Force* of the *Air's Moisture*: and a *Fragment* about the *Natural*
 and *Præternatural State* of *Bodies*, by the Hon. *Rob. Boyle*. To all which
 is premised a *sceptical Dialogue* about the *positive* or *privative Nature* of *Cold*:
 By a Member of the *R. Society*. *London*. 1673. in 8vo.
74. Tracts, containing, (1.) *Suspicious* about some hidden *Qualities* of the n. 110. p. 226
Air, with an *Appendix* touching *celestial Magnets* and some other *Particu-*
lars. (2.) *Animadversions* upon *Mr. Hobbs's Problemata de Vacuo*. (3.) A *Dis-*
course of the *Cause* of *Attraction* by *Suction*: By the Hon. *Rob. Boyle*, Esq;
London. 1674. in 8vo.
75. A *Discourse* concerning the *Origin* and *Properties* of *Wind*, &c. by n. 90. p. 514
R. Bobun. *Oxon*. 1671. in 8vo.
76. *Aero-Chalinos*, or a *Register* for the *Air*, &c. by *Nath. Henshaw*, M. D. n. 133. p. 834
London. 1677. in 12mo.

C H A P. II.

Hydrology.

I. TAKE a Globe of Fir or Maple, or other light Wood, as *A*; let it
 be well secured by Varnish, Pitch, or otherwise, from imbibing Water;
 then take a Piece of Lead, or Stone, *D*, considerably heavier than will sink
 the Globe: Let there be a long Wire Staple *B* in the Ball *A*, and a spring-
 ing Wire *C* with a bended End *F*, and into the said Staple press in with your
 Fingers the springing Wire on the bended End; and on it hang the Weight

To find the
 Depth of the
 Sea without
 a Line; by
 Dr. Hook.
 n. 3. p. 147.
 n. 24. p. 439.

Fig. 45. *D* by its Hook *E*, and so let Globe and all sink gently into the Water, in the Posture represented in the *Figure*, to the Bottom, where the Weight *D* touching first is thereby stopt; but the Ball, being by the Impetus it acquired in descending carried downwards a little after the Weight is stopt, suffers the springing Wire to fly back, and thereby sets itself at Liberty to re-ascend. And by observing the Time of the Ball's Stay under Water, which may be done by a Watch having Minutes and *2ds*, or by a good Minute-Glass, or best of all by a Pendulum vibrating seconds; the which must be three Foot, three Inches, and one fifth of an Inch long, *viz.* between the Middle of the Bullet and the upper End of the Thread, where it is fastened or held when it vibrates, you may, with the help of some Tables, come to know any *Depth* of the *Sea*.

Note, That Care must be had of proportioning the Weight and Shape of the Lead to the Bulk, Weight, and Figure of the Globe, after such a Manner, as upon Experience shall be most convenient.

In some of the Tryals already made with this *Instrument*, the Globe being of Maple-wood, well covered with Pitch to hinder soaking in, was $5\frac{1}{2}$ Inches in Diameter, and weighed $2\frac{1}{2}$ Pounds; the Lead, of $4\frac{1}{2}$ Pounds Weight, was of a *Conical* (but is now used of a *Globose*) Figure 11 Inches long, with the sharper End downwards, $1\frac{1}{8}$ at the Bottom in Diameter. And in those Experiments made in the *Thames*, in the Depth of 19 Foot Water, there passed between the Immersion and Emerision of the Globe 6 Seconds of an Hour; and in the Depth of 10 Foot Water there passed $3\frac{1}{2}$ Seconds or thereabouts.

In the same Tryal it was also found, that there was no Difference in Time between the Submersions of the Ball at the greatest Depth, when it rose two Wherry's Length from the Place where it was let fall, being carried by the Current of the Tide, and when it rose only a Yard, or so, from the same place where it was let down: And that it must be so, in great Depths and stronger Currents, is as certain, as easy to be demonstrated.

And if it be alledged, that it must be known, when a light Body ascends from the Bottom of the Water to the Top, in what Proportion of Time it rises; it may be considered, that in this Experiment the Times of the Descent and Ascent are both taken and computed together; so that, for this Purpose, there needs not the Nicety which is alledged.

Of other Experiments of this way of *founding* without a *Line*, made by the Noble Lord Viscount *Brouncker*, Sir *Robert Moray*, Knight, and Mr. *Hook*, in the Channel at *Sbeerness*, the following Account was given; *viz.*

	Ounces,	Grains.
A wooden Ball <i>A</i> weighed—	$52\frac{2}{6}$	00
Another wooden Ball <i>B</i> —	30	22
A Lead <i>A</i> —————	30	00
Another Lead <i>B</i> —————	$30\frac{1}{2}$	00

The Ball *B*, and the Lead *B*, were let down at 16 Fathom; and the Ball returned in 48 single Strokes of a *Pendulum*, held in the Hand, vibrating 58 single Strokes in a Minute.

A second Time repeated with the same Success; therefore the Motion was 4 Foot every second.

Again, the Ball *A*, and the Lead *B*, whose Nail was bended into a sharper Angle; the Ball returned in 39 Strokes. A second Time repeated with the same Success at the same Depth.

Ball *B*, Lead *B*, in which Tryal the Line not being clear, stopped a little the Motion; the Ball returned in 47 at the same Depth.

Ball *A*, Lead *A*, at 8 Fathom and 1 Foot, returned at 20; repeated at 8 Fathom, returned at 19.

Tried the *third* Time at 10 Fathom and 4 Foot, returned at 28.

A *fourth* Tryal at the same Depth, just the same.

At a *fifth*, at 10 Fathom 5 Foot, returned at 27.

A *sixth* Tryal just the same.

A *seventh* at 12 Fathom 5 Foot, returned in 37.

An *eighth* Tryal just the same.

Another Day near the same Place.

Note, That the *Pendulum* was this Day adjusted, and made a little shorter, there having been but 58 *Vibrations* in a Minute the other Day.

Ball *A*, Lead *B*, at 14 Fathom, returned in $32\frac{1}{2}$.

A second Tryal a little after, in the same Place, returned in 33. In the making of which Tryal the *Vibrations* were told aloud, and the Lead having been let down by a Line, was found to touch the Bottom in just half the Time the Ball staid under Water. By a second Tryal, the ascending and descending was found to be in equal Times. And by a third Tryal, with another Lead, the very same found, *viz.* $16\frac{1}{2}$ descending, and $16\frac{1}{2}$ ascending. This Lead and Ball let down without a Line, the Ball returned in 13 *Vibrations*; a Sign it went not to the Bottom.

A Tryal made with a Lead, whose Iron Crook was fasten'd at the Top of it, succeeded very well, and the Ball returned in $34\frac{1}{2}$: But, by reason of the Current, the Experimenters could not perceive when the Lead touched the Bottom. This Lead being let down without a Line, the Ball returned in $32\frac{1}{2}$. The Depth of Water was now found by the Ship's Lead, to be 14 Fathom.

Another Tryal was made with a Line, bowing the Point of the Lead, and the Ball returned in 34. The same let down without a Line, the Ball returned in 6 or 7 *Vibrations*; a Sign again it went not to the Bottom. In a Tryal with another Lead, the Ball returned in 34. Repeated again with the same Success.

In a Tryal with a Lead, whose Nail was set awry, the Ball returned in 34. After which Tryal the Depth was found to be just 14 Fathom. The last Lead and Ball being let down without a Line, the Ball returned at 35. In another Tryal, with a Lead that never failed, the Ball returned in 34, and the Lead touched the Bottom at 17.

By a Tryal with another Lead, the same Time was found exactly.

By a 3d Tryal with this last, the very same.

These Tryals were made near about high Water, at the Depth of 14 *Fathoms* just by Measure; and in them the Motions seem to be 5 *Foot* every *Second*.

In all these Tryals the greatest Difficulty was, in the Use of Conical Figures with Iron Crooks, to bend the Iron that it might be sure to carry down the Ball with it to the Bottom, and when come thither to let it go: For almost every one of these Leads failed in one of these Requisites, 'till by several Tryals they had been adjusted.

It is not to be omitted, that the last Tryals being made near High-water, the Ball was found to rise (by the Boat being permitted to drive) far off upon one Side, out of the Way, just as any light Thing, suffered to swim on the Water, would be carried; which seemed to argue a Motion of the Underparts of the Water, differing from that of the Upper (a thing which is said to be at certain Times of the Tides, both at the Mouth of the *Sound*, and of the *Streights*; which deserves to be farther inquired into.) The Angle, made by these different Motions, seemed to be about 40 *gr*.

To fetch up
Water from
any Depth;
By Dr. Hook
n. 9. p. 149.
n. 24. p. 447.
Fig. 49.

II. Let there be made a square wooden Bucket *C*, whose Bottoms *EE* are so contrived, that as the Weight *A* sinks the Iron *B*, to which the Bucket *C* is fastened by two Handles *DD*, on the End of which are the moveable Bottoms, or Valves *EE*, and thereby draws down the Bucket; the Resistance of the Water keeps up the Bucket in the Posture *C*, whereby the Water hath, all the while it is descending, a clear Passage through; whereas, as soon as the Bucket is pulled upwards by the Line *F*, the Resistance of the Water to that Motion beats the Bucket downward, and keeps it in the Posture *G*, whereby the included Water is kept from getting out, and the ambient Water kept from getting in.

By the Advantage of this Vessel you may come to know the Constitution of the Sea-water in several Depths; and whether it be saltier at and towards the *Bottom*.

Directions
for observing
Tides; By
Sir Rob.
Moray.
n. 17. p. 198.

III. 1. To observe in what Proportion the Increases of the Tides from the Neap to the Spring Tides, and their Decreases, and the Risings and Fallings of the Ebbs, happen to be in regard to one another; it is supposed upon some Observations, made by Sir *Rob. Moray* (though not thoroughly and exactly performed,) that these Increases are in the Proportion of Sines; the first Increase exceeding to the lowest in a small Proportion; the next in a greater; the 3d greater than that; and so on to the Midmost, whereof the Excess is greatest, diminishing again from that to the highest Spring Tide; so as the Proportions before and after the Middle do greatly answer to one another, or seem to do so.

2. To observe the Increase and Decrease of the *Velocity* of the *Current*; which is also supposed to be according to the Proportion of Sines.

3. The

3. The exact Measures of the Heights of every utmost High-Water and Low-Water from one Spring-Tide to another.

4. The exact Heights of Spring-Tides and Spring-Ebbs.

In order to all which this following *Apparatus* is proposed to be made use of. In some convenient Place upon a Wall, Rock, or Bridge, &c. let there be an *Observatory* standing as near as can be to the Brink of the Sea, or upon some Wall; and if it cannot be well placed just where the Low-Water is, there may be a Channel cut from the *Low-Water* to the *Bottom* of the *Wall*, *Rock*, &c. The *Observatory* is to be raised above the *High-Water* 18 or 20 *Foot*, and a Pump of any reasonable Dimension placed perpendicularly by the Wall, reaching above the *High-Water* as high as conveniently may be. Upon the top of the Pump a Pulley is to be fastened, for letting down into the Pump a Piece of floating Wood, which, as the Water comes in, may rise and fall with it. And because the rising and falling of the *Water* amounts to 60 or 70 *Foot*, the *Counterpoise* of the *Weight*, that goes into the Pump, is to hang upon as many Pulleys as may serve to make it rise and fall within the Space by which the *Height* of the Pump exceeds the *Height* of the *Water*. And because by this Means the *Counterpoise* will rise and fall slower, and consequently by less Proportions than the *Weight* itself, the first Pulley may have upon it a Wheel or two, to turn the *Indexes* at any Proportions required, so as to give the *minute Parts* of the *Motion*, and Degrees of Risings and Fallings. And because if the Hole, by which the *Water* is let into the *Pump*, be as large as the Bore of the *Pump* itself, the *Weight* that is raised by the *Water* will rise and fall with an *Undulation* according to the *Inequality* of the *Sea's* Surface, 'twill therefore be fit that the Hole, by which the *Water* enters, be less than half as big as the Bore of the *Pump*; any Inconvenience that may fall thereupon, as to the *Periods* and *Stations* of the *Flood* and *Ebb*, not being considerable.

5. To observe the Position and Strength of the Wind, the State of the *Weather*; the *Heights* of the *Barometer*, *Thermometer*, *Hygroscope*, and the *Moon's* Age and Place in all Respects.

IV. 1. The true time of the Tides at all times of the *Moon* is very rudely and slightly reckoned up by most *Seamen* and *Astronomers*; most of them reckoning, as if the *Moon* being upon such a *set Point* of the *Compass* (as the *Seaman* calls it) or so many Hours past the *Meridian* (as the *Almanack-makers* reckon) it were *High-Tide* in such and such a *Port* at all times of the *Moon*. And thus they reckon the *Tides* every Day to differ constantly 48 *Minutes*. As for Instance, a *South-West-Moon* makes a full Tide at *London*, that must be understood that it is *High-Tide* at *London*, when the *Moon* is 3 Hours past the *Meridian*. Now this is true indeed at *new* and *full Moon*, but not at other times of the *Moon*, which few take any notice of: Only *Mr. Booker* indeed used to give this *Caveat*, that about the first and last *Quarters* of the *Moon* the *Neap-Tides* did not flow so long as the *Spring-Tides* by one *Point* of the *Compass*; but he gives no Rule to proportion the Difference.

Tides observed at London, by Mr. Hen. Phillips, n. 34. p. 696.

But.



But, observing this more narrowly, I find, that at *London* the Tides fall out at the least *Two Points*, that is an Hour and a half, sooner in the *Quarters*, than in the *new* and *full Moon*. I have also found by many Tryals, that the true Time of the Tides might be found to be somewhat shorter and shorter, from the *new* and *full Moon* unto the *Quarters*, yet not in an equal manner, neither gradually decreasing from the *new* and *full Moon* until the *Quarters*; but rather, that there was some little Difference of Alteration both at the *new* and *full Moons*, and also at the *Quarters*, and that the greatest Difference fell out in the midst between them, agreeing very well to a *circular Proportion* after this Manner.

Fig. 50.

1. Divide a Circle into 12 equal Parts or Hours, according to the Moon's Motion, or Distance from the Sun from the *new Moon* to the *full*.

2. Let the *Diameter* of the Circle be divided into 90 Parts or Min. that is, according to the Time of the Difference of Tides between the *new* or *full Moon*, and the *Quarters*, which is one Hour and an half.

3. Make perpendicular Lines cross the *Diameter* of the Circle from Hour to Hour.

4. Reckon the Time of the Moon's coming to the South in the Circumference of the Circle, and observe the perpendicular Line that falls from that Point upon the *Diameter*; and the proportional Min. cut thereby, will shew how many Hours or Min. are to be subtracted from the time of high Tides at the *new* and *full Moon*, that so you may have the true time of the Tides that present Day.

For *Example*; At *London*, on the Day of *new* and *full Moon*, it is high Tide at 3 of the Clock, that is, when the Moon is 3 Hours past the Meridian, and so by the common Rule, the Moon being about 4 Days old, it will be S. about 3 of the Clock, and it will be high Tide 3 Hours afterwards, that is, at 6 of the Clock. But now, by this Rule, if you count this Time of the Moon's coming to the South in the Circumference, the perpendicular Line, which comes from 3 to 9, cuts the *Diameter* at 45 Min. which shews, that so much is to be abated from the time of high Tide in the *new* and *full Moons*; so that it is high Tide 45 Min. before 6 of the Clock; that is, at 5 Hours 15 Min. and not at 6 of the Clock, according to the common Rule.

The like you may do for any other *Port* or *Place*, knowing the time of *high Water* at the *new* and *full Moon* in that *Place*: And you may do it the more readily, if you set down the time of *high Water* at the *new* and *full Moon* under the *Diameter*, as I have done for *London*, where it is high Tide at 3 of the Clock: So that, when the Moon is South at 3 of the Clock, the Perpendicular cuts the *Diameter* at 2 Hours 15 M. and so when the Moon is South at 9 of the Clock, by adding 2 Hours 15 Min. you may have the Time of *high Water*, which is 11 of the Clock and 15 Min.

And thus you may easily make a Table, which by the Southing of the Moon shall readily tell you the time of high Tide at any time of the Moon, as I have done here for *London*: To which all other *Places* may be reduced to correspond.

On the Quarter Days.

High-Water on the Bar, at 5 a Clock.

At Rings-end, at a Quarter past 5.

At the Custom-house, half an Hour past 5.

A Southerly Wind between S. S. E. and S. S. W. blowing fresh, makes it flow near half an Hour longer than its usual Course.

N. B. That this Observation makes the Tides, upon the *Quarter-Moons*, come in later, in respect of the *Moon's Southing*, than upon *new* and *full Moons* by half an Hour; whereas in the River of *Thames*, as high as *London*, the *Quarter-Moons* make *High-Water* above an Hour and Quarter sooner in that respect, than the *new* and *full*; as may be seen in the accurate *Tide-Tables* of *Mr. Flamstead*; but it is from hence evident, that the same *Tables* are not applicable to the *Sea-Ports*, where there is not the same Reason for the Anticipation of the *Neap-Tides* upon the *Quarter-Moons*.

The Cause of this *Phænomenon* seems to be, that the *Impulse* of the Ocean in the *Quarter-Moons* is not so vigorous as in the *new* and *full*, nor the Motion of the Waters so quick, (as is evident by daily Experience:) Whence it comes to pass, that in the open Sea, and in Ports upon the Sea-Coast, as this of *Dublin*, the *High-Water* time falls out later than when the Motion is more rapid in the *new* and *full*; but, on the contrary, in Rivers, at any considerable Distance from the Sea, the Resistance of the Weight of the fresh Water, which is kept suspended during the time of the Flood, is longer overcome by the more potent *Impetus* in the *new* and *full*, than by the weaker in the *Quadratures*; and from hence this Difference should be still more and more considerable, as the Port is farther remov'd from the Sea.

Nigh Pli-
mouth, by
Mr. Sam.
Coleprests, n.
33. P. 632

4. Our *diurnal Tides* from about the latter End of *March* till the latter End of *September* are about a Foot higher (perpendicular, which is always to be understood) in the Evening than in the Morning, that is, in every Tide that happens after 12 in the Day, before 12 at Night. On the contrary, the Morning Tides from *Michaelmas* till our *Lady-Day* in *March* again are constantly higher by about a Foot, than those that happen in the Evening. And this Proportion holds in both after the gradual Increase of the Tides Rising from the *Neap* to the highest *Spring*; and the like Decrease of its Height till *Neap* again is deducted.

The highest *menstrual Spring-Tide* is always the *third Tide* after the *new* or *full Moon*, if a cross Wind do not keep the Water out, as the *N. E.* or *N. W.* usually doth; whose contrary Wind, if strong, commonly makes those to be *High-Tides* upon our Southern Coasts which otherwise would be but low.

The highest *Springs* make the lowest *Ebbs*. (Tho' I am informed by an expert *Waterman*, that it sometimes happens, that there may be a very low *Ebb*, tho' no high *Spring*, which they term an *Out-let*, or *Gurges* of the Sea; as when a great Storm chances off at Sea, and not on the Land.)

The Water neither flows nor ebbs alike in respect of equal Degrees; but its *Velocity* increaseth with the *Tide* till just at *Mid-Water*, that is, *half flown*, or at half Flood, at which time the *Velocity* is strongest, and so decreaseth
pro-

proportionably 'till high Water, or full Sea. As may be guessed at by the following Scheme collected by Observations made at several Times and Places. And although it be restrained to *Plymouth Haven*, or the like, where the Water riseth about 16 Foot (I say usually, because it may vary in this Port from the *lowest Neap* to the *highest Annual Spring* above 7 or 8 Foot) yet it may indifferently serve for other Places, where it may rise as many Fathom, or not so high, by a proportional Addition or Subtraction.

	Time.		Height.	
	<i>h.</i>	'	<i>f. inch.</i>	
<i>Flowing</i>	1	0	1	6
	2	0	2	6
	3	0	4	0
	4	0	4	0
	5	0	2	6
	6	0	1	6

	Time.		Height.	
	<i>h.</i>	'	<i>f. inch.</i>	
<i>Ebbing</i>	1	0	1	6
	2	0	2	6
	3	0	4	0
	4	0	4	0
	5	0	2	6
	6	0	1	6

The usual Number of Tides, or Times of high Water from new Moon to new Moon, or from full Moon to full Moon, is 59.

5. (1.) I have observed, that our Annual Spring Tides do happen in *March* and *September*, either at the Tide next before the *Sun's* Ingress into the *æquinoctial* Points of *Aries* and *Libra*, or the next Tide after, according as the Moon is near her Full or Change, when the Sun thus enters into the said Signs; and when it flows in Height about 45 Foot; the lowest Neap Tides flowing in Height 25 Foot.

(2.) That the lowest Neap makes the highest Spring, if the *N. E.* Winds hinder not, by blowing hard, and so keep back the Tides; as usually they do when they blow: Whose contrary Winds, *S. W.* if they blow hard, make here the highest Tides.

(3.) That from about the latter End of *September* they are about 1 Foot and 3 Inches higher, perpendicularly, in the Evening than in the Morning; that is, if high Water happen after the Sun is past the *Meridian*, or in the Tides betwixt Noon and Midnight. But from *Michaelmas* to our *Lady-Day* we find the contrary, the Day-Tides being, in that Season, higher by 15 Inches than the Night-Tides, or the Tides between Mid-night and Noon. And this Proportion holds in both, after the gradual Increase of the Tides rising from the Neap to the highest Spring, and the like Decrease of their Height till Neap again.

(4.) That the highest menstrual Spring-Tide is always the Third after the full Moon or Change-Day, if it be not kept back by *N. E.* Winds.

(5.) That it flows here on the Change-Day, when the Moon is *E. S. E.* the Tide flowing in for the Space of 5 Hours, and ebbing 7 Hours. But in Neap-Tides it does not flow here by two Points of the Compass so long.

*In Hong-
road, 4 Miles
from Bristol,
by Capt. Sath.
Sturmy,
n. 14. p. 813.
Signs.*

(6.) That the Water flows nor ebbs equal Spaces in equal Times, but its Velocity is stronger at the first, both the Flood and Ebb, and so gradually decreaseth untill full Sea, or low Water. This is observed in the Spring-Tides only, as you may see by the following Table, which I have made for my Observations of our Tides here. And I have farther observed, that it hath flowed and ebbed at the first of the Tide one Foot in 6 Minutes, or that then the Tide ran out a Foot in 6 Minutes, or did rise so much in Height.

	Time.		Height.	
	b	'	f.	inch.
	0	15	2	7 $\frac{1}{2}$
	0	30	2	6
	0	45	2	6
	1	00	2	6
	0	15	2	6
	0	30	2	5 $\frac{1}{2}$
	0	45	2	5
	2	00	2	5
	0	15	2	3
Flowing	0	30	2	3
	0	45	2	3
	3	00	2	3
	0	15	2	2
	0	30	2	1
	0	45	2	1
	4	00	2	1
	0	15	1	9
	0	30	1	8
	0	45	1	8
	5	00	1	8
	5	0	44	1

	Time.		Height.	
	b	'	f.	inch.
	0	15	2	7 $\frac{1}{2}$
	0	30	2	6
	0	45	2	6
	1	00	2	6
Ebbing	2	00	9	0
	3	00	8	0
	4	00	6	0
	5	00	5	0
	6	00	4	0
	7	00	3	0
	7	0	44	10 $\frac{1}{2}$

(7.) The usual Number of Tides from New Moon to New Moon, or from Full to Full, is 59.

(8.) In the River of *Severn*, 20 Miles above *Bristol* near *Newnham*, 160 Miles from the River's Mouth (*Lundy*) the *Head* of the Flood at its coming in in Spring-Tides ariseth in Height, like a Wall, 9 Foot high, and so runs for many Miles together, covering at once all the Shoals which were dry before; at which time all *Vessels*, that lie in the Way of the said *Head-Tides*, or (as it is vulgarly called) *Boar*, are commonly overset, or carried upon the *Banks*; and the *Head* of the *Tide* being past, such *Vessels* are left dry again. It flows there but two *Hours* and 18 *Foot* in Height, and it ebbs ten *Hours*. The Reason of the said *Boar* is doubtless the straitning and shoaling of the River

in that Place, it being there but half a Mile broad ; as it is but 20 Pearches over, three Miles higher ; running tapering to Gloucester.

(6.) We have been informed by a curious Gentleman, that the *Annual highest Tides* about *Chepstow* Bridge were at *St. David's* and *Michaelmas* Stream ; that is, the one a little before the *Vernal*, and the other somewhat after the *Autumnal Æquinox* ; which agrees also with the Conjecture of a very intelligent *Mathematician*, who is withal of Opinion, that because both are not far from the *Æquinoxes*, tho' the one before, the other after, it might well give occasion to think it was depending on the *Æquinox*.

At Chepstow, by * * *
ibid. p. 816.

(7.) Our great Bay *Mr. Camden* calls *Washes*, whereas they are only two small Arms of the Sea, running into it, viz. *Fosdike* and *Cross-Keys* ; 'tis full of Sands, making two Channels to *Lynn*, and as many to *Boston*. It may be useful to Travellers to have a Table when to pass over the said *Washes*, tho' without a Guide I would not advise them, especially after great Freshes, which make the Sands shift, and consequently quick, and Horses many times stick fast : The way to get them out is by several Peoples trampling round them at a Distance, which by Degrees raiseth them.

A Table of the Washes in Lincolnshire, by Mr. Chr. Merrit.
n. 223 p. 352
n. 224 p. 392

Moon's Age.	Fosdike begins.		Ends.		Full Sea.		Moon's Age.	Fosdike begins.		Ends.		Full Sea.			
	b.	'	b.	'	b.	'		b.	'	b.	'	b.	'		
1	16	10	0	4	45	7	0	9	24	4	24	11	9	1	24
2	17	10	48	5	33	7	48	10	25	5	12	11	57	2	12
3	18	11	36	6	21	8	36	11	26	6	0	12	45	3	00
4	19	12	24	7	9	9	24	12	27	6	48	1	33	3	48
5	20	1	12	7	57	10	12	13	28	7	36	2	21	4	36
6	21	2	0	8	45	11	0	14	29	8	24	3	9	5	24
7	22	2	48	9	33	11	48	15	30	9	12	3	57	6	12
8	23	3	36	13	21	12	36								

Cross-Keys begins to be fordable fifteen Minutes after *Fosdike*, and ends an Hour sooner.

(8.) It is high Water upon the Day of the *New* and *Full Moon*.

The Tides in France, by * * *
n. 185 p. 220

On the Coast of *Gascony* and *Guienne*.

At 3 b. at the Mouth of *Garonne*, and the *Isle of Rhee*.

At 3 1/2 b. at *St. John de Luz*, *Bayonne*, and *Memiffan*.

At 3 1/4 b. at *Rohan*, *Brouage*, and *Rochelle*.

At 3 b. on the Coast of *Poitou*.

At 3 1/4 at *Ollonne* and *Beauvoir*.

On the Coast of *Britany*.

At 1 1/2 b. at *Bell-Isle*.

At 3 b. at the Mouth of the *Loyre*, at *Garande*, *Morbihan*, *Blavet*, and *Cancarneau*.



At $\frac{1}{4}$ b. at *Apenars, Vannes, and Auray.*

At $2\frac{1}{4}$ b. at *Apenmark, Audierne, the Race of Fontenay, and Le Conquet.*

At $2\frac{1}{4}$ b. at *Brest, and at Cape de Four.*

At 4 b. at *St. Paul de Leon.*

At $4\frac{1}{2}$ b. at *Pert Blanc.*

At 6 b. at *St. Malo and Cancale.*

On the Coast of *Normandy.*

At 7 b. at *Granville, and Barneville.*

At 8 b. at *Cberbourg and Barfleur.*

At 9 b. at *Caen and Honfleur, at the Mouth of the Seine, and at Havre de Grace.*

At $9\frac{1}{4}$ b. at *Fescan, and St. Valeri.*

At $10\frac{1}{2}$ b. at *Rouen, Dieppe, and Treport.*

On the Coast of *Picardie.*

At 11 b. at the Mouth of the *Somme, at Estaple, Bologne, and Ambletense.*

At 11 b. at *Calais.*

At 12 b. at *Dunkirk, Newport and Ostend.*

*At Bermu-
das, by Mr.
Rich. Nor-
wood,
n. 30. p. 565.*

9. (1.) I have only taken a general notice of the *Tides*, as that it is high Wa-
ter about 7 of the Clock on the *Change-Day* (in some *Creeks* an Hour or two
later.) The *Water* riseth but little, as about 4 Foot at *high Water*, but at
Spring-Tides it may be a Foot more. The *Tides* without are very various in
Setting: Sometimes the Tide of Flood sets to the Eastward, sometimes to the
Westward; but in fair, calm, and settled Weather, the said Tide sets from
the South-East toward the North-West, as they say.

*By Mr.
Rich. Staf-
ford, n. 40.
p. 792.*

(2.) The Water about our Island (*Bermudas*) does not flow, by any Man's Ob-
servation, above 5 Foot; and that but at one Season of the Year, between
Michaelmas and *Christmas*; at other times not above 3 Foot. It is high Wa-
ter when the Moon is about an Hour high, and the like after her going down.
It flows in from the *North-West*, and runs to the *South-East* nearest; and in
that Part of the Land, which lies most to the *North-West*, there it is high Wa-
ter soonest. But the Tide does not always ebb and flow directly that Course
round about our Coast; but, I suppose, the Reason is, that some Points of Land
or Shoals may turn its *North-West* and *South-East* Course.

*At Cabo
Cors Castle
on the Coast
of Guinea,
by Mr.
Heathcot.
n. 158. p. 78
An Hypo-
thesis about
the Flux and
Reflux of
Sea by Dr.
Wallace.
n. 16. p. 235.*

10. The Sea runs here along the Shore continually to the *Eastward*, at a
very great Rate, except at Full and Change; for then it runs to *Westward*, or
at least makes a great Abate. Nov. 24. 1683. I took the time of the high
Water at the *Castle* (as near as I could) at 3 b. 30. p. m. it flowed about 6
Foot.

V. (1.) The *Sea's ebbing* and *flowing* hath so great a Connection with the
Moon's Motion, that in a manner all *Philosophers* (whatever other Causes they
have

have joined with it) have attributed much of its Cause to the *Moon*; which either by some *occult Quality*, or particular Influence which it hath on moist Bodies, or by some *magnetick Virtue*, drawing the Water towards it (which should therefore make the Water there highest, where the *Moon* is vertical) or by its Gravity and Pressure downwards upon the terraqueous Globe (which should make it lowest where the *Moon* is vertical) or by whatever other Means (according to the several Conjectures of inquisitive Persons) hath so great an Influence on, or at least a Connection with the *Sea's Flux and Reflux*, that it would seem very unreasonable to seclude the Consideration of the *Moon's Motion* from that of the *Sea*: The *Periods of Tides* (to say nothing of the Greatness of them near the *new Moon*, and *full Moon*) so constantly waiting on the *Moon's Motion*, that it may be well presumed, that either the one is governed by the other, or at least both from some common Cause.

The first that I know of, who took in the Consideration of the Earth's Motion (*Diurnal* and *Annual*) was *Galileo*; who, in his *System of the World*, hath a particular and very rational Discourse on this Subject. But that Discourse is to be look'd upon only as an Essay of the general Hypothesis; which, as to Particulars, was to be afterwards adjusted from a good *general History of Tides*; which 'tis manifest enough that he had not; and which is yet in a great Measure wanting.

And what I say of *Galileo* I must in like Manner desire to be understood of what I am now ready to say to you. For I do not profess to be so well skill'd in the *History of Tides*, as that I will undertake presently to accommodate my general Hypothesis to the particular Cases; or that I will indeed undertake for the certainty of it, but only as an Essay propose it to farther Consideration, to stand or fall, as it shall be found to answer Matter of Fact.

I consider therefore that in the *Tides*, or the *Flux* or *Reflux* of the Sea, besides extraordinary Extravagancies, or Irregularities, whence great Inundations or strangely High-Tides do follow, which yet perhaps may prove not to be so merely accidental as they have been thought to be, but might from the regular Laws of Motion, if well consider'd, be both well accounted for, and even foretold; there are these three notorious Observations made of the *Reciprocation* of Tides. *First*, The *Diurnal Reciprocation*, whereby twice in somewhat more than 24 Hours we have a Flood and an Ebb; or a High-Water and Low-Water. *Secondly*, The *Menstrual*; whereby in one *synodical Period* of the *Moon*, suppose from *full Moon* to *full Moon*, the Time of those *diurnal Vicissitudes* doth move round thro' the whole Compass of the *Νυχθημερον*, or natural Day of 24 Hours: As for Instance, if at the *full Moon*, the *full Sea* be at such or such a Place just at Noon, it shall be the next Day, at the same Place, somewhat before one of the Clock; the Day following, between one and two; and so onward, till at the new Moon it shall be at Mid-night; (the other Tide, which in the *full Moon* was at *Mid-night*, now in the *new Moon* coming to be at Noon) and so forward, till at the next full Moon the full Sea shall at the same Place come to be at Noon again. Again, that of the Spring Tides and Neap Tides, as they are called, about the full Moon and new Moon the Tides are at the highest; at the *Quadratures* the Tides are at
the

the lowest: And at the Times intermediate proportionably. Thirdly, the *Annual*; whereby it is observed, that at some times of the Year the *Spring-Tides* are yet much higher than the *Spring-Tides* at other times of the Year; which times are usually taken to be at the *Spring* and *Autumn*, or two *Æquinoxes*; but I have Reason to believe, (as well from my own Observations for many Years, as of others, who have been much concerned to heed it, whereof more will be said by and by) that we should rather assign the beginning of *February* and *November*, than the two *Æquinoxes*.

1. Now, in order to give an Account of these three Periods according to the Laws of Motion and Mechanick Principles, we shall first take it for granted, what is now a-Days pretty commonly entertained by those who treat of such Matters that a Body in *Motion* is apt to continue in its *Motion*, and that in the same Degrees of *Celerity*, unless hindered by some contrary *Impediment*: Like as a Body at Rest to continue so, unless by some sufficient Mover put into Motion: And accordingly, which daily Experience testifies, if on a Board or Table some loose incumbent Weight be for some time *moved*, and have thereby contracted an *Impetus* to *Motion* at such a *Rate*, if that Board or Table chance by some external Obstacle, or otherwise, to be stopped, or considerably retarded in its Motion, the incumbent loose Body will shoot forward upon it; and contrariwise, in case that Board or Table chance to be accelerated, or put forward with a considerably greater Speed than before, the loose incumbent Body, not having yet obtained an equal *Impetus* with it, will be left behind, or seem to fly backward upon it. Or, which is *Galileo's* Instance, if a broad Vessel of Water, for some time evenly carried forward with Water in it, chance to meet with a Stop, or slack its Motion, the Water will dash forward and rise higher at the fore part of the Vessel; and contrariwise, if the Vessel be suddenly put forward faster than before, the Water will dash backwards, and rise at the hinder part of the Vessel. So that an Acceleration or Retardation of the Vessel, which carries it, will cause a rising of the Water in one Part, and a falling in another; which yet, by its own Weight, will again be reduced to a Level as before. And consequently, supposing the *Sea* to be but as a loose Body carried about with the Earth, but not so united to it as necessarily to receive the same Degree of *Impetus* with it, as its fixed Parts do, the *Acceleration* or *Retardation* in the Motion of this or that Part of the Earth will cause, more or less, according to the Proportion of it, such a *dashing* of the Water, or *rising* at one Part, with a *falling* at another, as is that which we call the Flux and Reflux of the Sea.

Now, this premised, we are next with him to suppose the Earth carried about with a double Motion, the one *Annual* in *BEC*, the great Orb, in which the Center of the Earth *B* is supposed to move about the Sun *A*; the other Diurnal, whereby the whole moves upon its own *Axis*, and each in its Surface describes a Circle, as *DEFG*.

It is then manifest, that if we suppose that the *Earth* moved but by any one of these *Motions*, and that regularly with an equal *Swiftiness*, the *Water*, having once attained an equal *Impetus* thereunto, would still hold equal Pace with it, there being no occasion, from the quick'ning or slack'ning of the *Earth's Motion*, in that Part where the *Water* lieth, for the *Water* thereon either to be

call

cast forward or backward, and thereby to *accumulate* on the other Parts of the *Water*: But the true Motion of each Part of the Earth's Surface being compounded of those two *Motions*, the *Annual* and *Diurnal*; (the *Annual* in *BEC* being, as *Galileo* there supposeth, about three Times as fast as a *diurnal Motion*, in a great Circle, as *DEF*) while a Point of the *Earth's* Surface moves about its Center *B* from *G* to *D* and *E*, and at the same time its Center *B* be carried forwards to *C*; the true *Motion* of that Point afterwards is made up of both those *Motions*; to wit, of *B* to *C*, and of *G* to *E*; but while *G* moves by *D* to *E*, *E* moves backward by *F* to *G*, contrary to the Motion of *B* to *C*; so that the true Motion of *E* is but the Difference of *BC* and *EG*. (For, besides the Motion of *B* above the Center, *G* is also put forward as much as from *G* to *E*, and *E* put backward as much as from *E* to *G*;) So that the *Diurnal Motion*, in that Part of the *Earth* which is next the *Sun*, as *EFG*, doth abate the Progress of the *Annual*, and most of all at *F*; and in the other Part which is from the *Sun*, as *GDE*, it doth increase it, and most of all at *D*; that is, in the *Day* Time there is abated, in the *Night* Time is added, to the *Annual* Motion, about as much as is *GE*, the *Earth's* Diameter. Which would afford us a Cause of two *Tides* in 24 *Hours*; the one upon the greatest *Acceleration* of *Motion*; the other upon its greatest *Retardation*.

(2.) And thus far *Galileo's* Discourse holds well enough; but then in this it comes short; that as it gives an Account of *two Tides*, so those *two Tides* are always to be at *F* and *D*; that is, at *Noon* and at *Midnight*: Whereas Experience tells us, that the time of *Tides* moves in a Month's Space through all the 24 *Hours*; of which he gives us no Account. For tho' he doth take notice of a *menstrual Period*; yet he doth it only as to the Quantity of the *Tides*, greater or less; not as to the Time of the *Tide*, sooner or later.

To help this *J. Bapt. Balianus* makes the *Earth* to be but a *secondary Planet*, and to move not directly about the *Sun*, but about the *Moon*; the *Moon* mean while moving about the *Sun*, in like Manner as we suppose the *Earth* to move about the *Sun*, and the *Moon* about it. But though this might furnish us with the Foundation of a *menstrual Period* of *Accelerations* and *Retardations* in the compound Motion of several Parts of the *Earth's* Surface, yet there are no good Reasons to admit of this *Hypothesis*.

Instead of this, that *Surmise* of mine (for I dare not yet, with Confidence, give it any better Name) of what I have spoken to you heretofore (and which hath occasioned this present Account which I am now giving you) is to this Purpose.

The *Earth* and *Moon* being known to be Bodies of so great Connection, as that the *Motion* of One follows that of the *Other*, may well enough be looked upon as one Body, or rather one Aggregate of Bodies, which have one common Center of Gravity; which Center of Gravity, according to the known Laws of *Statics*, is in a strait Line connecting their respective Centers so divided, as that its Parts be in reciprocal Proportion to the Gravities of the two Bodies. As for Example, suppose the *Magnitude* (and therefore, probably, the Gravity) of the *Moon* to be about a *one and fortieth* Part of that of the *Earth*; and the Distance of the *Moon's* Center from the Center of

Riccioli.
Alm. Nov.
Tom. 1. l. 4.
2. 10.
n. 111. P.
216. 2.

of the *Earth* to be about 56 *Semidiameters* of the *Earth*, the Distance of the common Center of Gravity of the two Bodies will be from that of the *Earth* about $\frac{1}{42}$ of 56 *Semidiameters*, that is about $\frac{1}{3}$ of a *Semidiameter* of the *Earth*, above its Surface, in the Air, directly between the *Earth* and *Moon*.

Now supposing the *Earth* and *Moon* jointly, as one Body, carried about by the *Sun* in the *great Orb* of the *Annual Motion*; this Motion is to be estimated (according to the Laws of *Statics* in other Cases) by the Motion of the common Center of Gravity of both Bodies. For we use in *Statics* to estimate a Body, or Aggregate of Bodies, to be moved upwards, downwards, or otherwise, so much as its common Center of Gravity is so moved, howsoever the Parts may change Places amongst themselves.

And accordingly the Line of the *Annual Motion* will be described, not by the Center of the *Earth* (as we commonly estimate it) but by the common Center of Gravity of the Bodies, *Earth* and *Moon*, as one Aggregate.

Fig. 52.

Now supposing *A B C D E* to be a Part of the *great Orb* of *Annual Motion*, described by the common Center of Gravity, in so long time as from a full *Moon* at *A* to the next new *Moon* at *E*; the Center of the *Earth* at *T*, and that of the *Moon* at *L*, must each of them, (supposing their common Center of Gravity to keep the Line *AE*) be supposed to describe a Periphery about that common Center, as the *Moon* describes her Line of *menstrual Motion*. And in like Manner, *E F G H I*, from the new *Moon* at *E* to the next full *Moon* at *I*.

Fig. 53.

From *A* to *E* (from full *Moon* to new *Moon*) *T* moves (in its own *Epicyle*) upwards from the *Sun*: And from *E* to *I* (from new *Moon* to full *Moon*) it moves downwards, towards the *Sun*. Again, from *C* to *G* (from last *Quarter* to the following first *Quarter*) it moves forward according to the *Annual Motion*; but from *G* forwards to *C* (from the first *Quarter* to the ensuing last *Quarter*) it moves contrary to the *Annual Motion*.

It is manifest therefore, according to this *Hypothesis*, that from the last *Quarter* to the first *Quarter* (from *C* to *G*, while *T* is above the Line of the *Annual Motion*) its *menstrual Motion* in its *Epicyle* adds somewhat of *Acceleration* to the *Annual Motion*; and most of all at *E*, the new *Moon*: And from the first to the last *Quarter* (from *G* forward to *C*, while *T* is below the Line of the *Annual Motion*) it abates of the *Annual Motion*; and most of all at *I*, or *A*, the full *Moon*.

So that in Pursuance of *Galileo's* Notion the *menstrual* adding to, or deducting from the *Annual Motion*, should either leave behind, or cast forward the loose Waters incumbent on the *Earth*, and thereby cause a *Tide*, (or Accumulation of Waters) and most of all at the full *Moon* and new *Moon*, where those *Accelerations* or *Retardations* are greatest.

Now this *menstrual Motion*, if nothing else were superadded to the *Annual*, would give us two *Tides* in a Month, and no more; (the one upon the *Acceleration*, and the other on the *Retardation*) at new *Moon* and full *Moon*; and two *Ebbs* at the two *Quarters*; and in the Intervals, rising and falling Water.

But the *Diurnal Motion* superadded, doth the same to this *Menstrual*, which *Galileo* supposeth it to do to the *Annual*; that is, doth add to, or subtract from

from

from the *menstrual Acceleration* or *Retardation*; and so gives us *Tide* upon *Tide*.

Fig. 54.

For in whatsoever part of its *Epicycle* we suppose *T* to be; yet because, while by its *menstrual* Motion the Center moves in the Circle *L T N*, each Point in its Surface, by its diurnal Motion, moves in the Circle *L M N*; whatsoever Effect (accelerative or retardative) the *Menstrual* would give, that Effect, by the Diurnal, is increased in the Parts *L M N* (or rather *l M n*, the Semicircle) and most of all at *M*; but diminished in the Parts *N O L* (or rather *n O l*) and most of all at *O*. So that *M* and *O* (that is, when the Moon is in the *Meridian* below or above the *Horizon*) we are to have the *diurnal Tide* or *High-Water*, occasioned by the greatest *Acceleration* or *Retardation* which the *Diurnal Arch* gives to that of the *Menstrual*; which seems to be the true Cause of the *daily Tides*, and withal gives an Account, not only why it should be every Day, but likewise why at such a Time of the Day; and why this time should in a Month run through the whole 24 Hours, *viz.* because the Moon's coming to the *Meridian* above and below the *Horizon* (or as the Seamen call it, the Moon's *Southing* and *Northing*) doth so; and likewise of the *Spring-Tides*, and *Neap-Tides*. For, when it so happens that the *menstrual* and *diurnal Accelerations* or *Retardations* be co-incident (as at the New Moons and Full Moons they are) the Effect must needs be the greater. And although (which is not to be dissembled) this happen but to one of the two *Tides*; that is, the *Night-Tide* at the New Moon (when both Motions do most of all *accelerate*) and the *Day-Tide* at Full Moon (when both do most retard the *annual* Motion;) yet, this *Tide* being thus raised by two concurrent Causes, tho' the next *Tide* have not the same Cause also, the *Impetus* contracted will have Influence upon the next *Tide*; upon a like Reason as a *Pendulum*, let fall from a higher *Arch*, will (tho' there be no new Cause to occasion it) make the Vibration on the other Side (beyond the Perpendicular) to be also greater: Or, of Water in a broad Vessel, if it be so jogged as to be cast forward to a good height above its Level, will, upon its Recoiling, by its own Gravity (without any additional Cause) mount so much the higher on the hinder Part.

But here also we are to take notice, that though all Parts of the Earth, by its *diurnal* Motion, do turn about its *Axis*, and describe parallel Circles, yet not equal Circles; but greater near the *Æquinoctial*, and lesser near the Poles; which may be a Cause why the *Tides* in some Parts may be much greater than in others. But this belongs to the particular Considerations, (of which we are not now giving an Account) not to the general *Hypothesis*.

3dly, The *annual High Tides* having been observed (grossly) to happen about the *Spring* and *Autumn*, they are generally referred to the two *Æquinoxes*. But the Inhabitants of *Romney-Marsh* in *Kent*, where the Sea being kept out with great Earthen Walls, that it doth not at *High-Water* overflow the Level, are generally agreed by their Observations (and Experience dearly bought) that their Times of Danger are about the Beginning of *February* and of *November*; that is, at those *Spring-Tides* which happen near those Times; to which they give the Names of *Candlemas-Stream*, and *Allhallond-Stream*: And, if they escape those *Spring-Tides*, they apprehend themselves

out of Danger for the rest of the Year. And as for *March* and *September* (the two *Æquinoxes*) they are as little solicitous of them as of any other Part of the Year. And I have my self very frequently observed (both at *London*, and elsewhere) that in those Months of *February* and *November* (especially *November*) the Tides have run much higher than at other times; particularly in *November* 1660. I found the Water so high in *King-street*, *Westminster*, that it came up not only into the Boots, but into the Body of the Coach, and the *Palace-Yard* (all save a little Place near the West-End) overflowed; as likewise the Market-Place, and many other Places, and their Cellars generally filled up with Water. And in *November* 1665 it may be well remembered what very High-Tides there were, not only on the Coasts of *England* (where much Hurt was done by it) but much more in *Holland*, where, by reason of those Inundations, many Villages and Towns were overflowed.

'Tis true, there does not happen any single signal Accident, which might cast it on these times, yet there is a Compound of Two that may do it: Which is the *Inequality* of the *natural Day* (well known to *Astronomers*) arising from a double Cause. *First*, because the Sun, by reason of its *Apo-gæum* and *Perigæum*, doth not at all times of the Year dispatch, in one Day, an equal Arch of the *Ecliptick*: *Secondly*, Equal Arches of the *Ecliptick* do not in all Parts of the *Zodiack* answer to equal Arches of the *Æquinoctial*, by which we are to estimate Time.

According to the first of these Causes we should have the longest Natural Days in *December*, and the shortest in *June*; which, if it did operate alone, would give us at those times two *annual High-Waters*. According to the second Cause, if operating singly, we should have the longest Days in the two *Solstices* in *June* and *December*, and the two shortest at the *Æquinoxes*, in *March* and *September*; which would at those times give occasion of four *annual High-Waters*.

But the true Inequality of the natural Days arises from a Complication of those two Causes, sometimes crossing, and sometimes promoting each other; though we should find some Increases or Decreases of the natural Days at all those Seasons, answerable to the respective Causes, (and perhaps of *Tides*) proportionably thereunto: Yet the longest and shortest natural Days absolutely of the whole Year (arising from this Complication of Causes) are about those times of *Allhallontide* and *Candlemas*, or not far from them, about which those *annual High-Tides* are found to be; as will appear by the *Tables of Equation of natural Days*. And therefore, I think, we may with very good Reason cast this *annual Period* upon that Cause, or rather Complication of Causes. For (as we before shewed in the *menstrual* and *diurnal*) there will, by this Inequality of natural Days, arise a physical *Acceleration* and *Retardation* of the *Earth's* mean Motion, and accordingly a casting of the Waters backward or forward; either of which will cause an Accumulation or High-Water.

I must here add, (that I be not mistaken) that whereas I cast the time of the *daily Tides* to be at all Places when the Moon is there in the Meridian;

it must be understood of *open Seas*, where the Water hath such free Scope for its Motion, as if the whole Globe of Earth were equally covered with Water: Well knowing, that in *Bays* and *Inland Channels* the Position of the Banks, and other like Causes, must needs make the Times to be much different from what we suppose in the *open Seas*; And likewise, that even in the *open Seas*, *Islands*, and *Currents*, *Gulfs* and *Shallows* may have some Influence, though not comparable to that of the *Bays* and *Channels*. And moreover, though I think that Seamen do commonly reckon the time of *High-Water* in the open Seas to be then, when the Moon is there in the Meridian (as this *Hypothesis* would cast it;) yet I do not take my self to be so well furnished with a History of *Tides*, as to assure myself of it; much less to accommodate it to particular Places and Cases.

It may be thought perhaps, that if the Earth would thus describe an *Epicyle* about the common Center of Gravity, it would (by this its Change of Place) disturb the celestial Motions, and make the apparent Places of the Planets, especially some of them, different from what they would otherwise be. For though so small a Removal of the Earth, as the *Epicyle* would cause (especially if its Semi-Diameter should not be above $\frac{1}{2}$ of the Earth's Semi-Diameter) would scarce be sensible, if at all, to the remoter Planets; yet, as to the nearer, it might.

To this my Answer is, that such Difference hath been observed, and hath very much puzzled *Astronomers* to give an Account of. Mr. *Horrocks* was forced to have recourse to somewhat like *Kepler's amicable Fibres* (which he had no Affection to at all) to give Account of the Inequalities of the Moon's Motion. And other *Astronomers* have introduced (some upon one Supposition, some upon another) some kind of *menstrual Equation*, to solve the Inequalities of the Moon's Motion, according to her *Synodical* Revolution, or different Aspects (of New Moon, Full Moon, &c.) besides what concerns her own periodical Motion. For which, this Consideration of the common Center of Gravity of the Earth and Moon is so proper a Remedy (especially if it should be found precisely to answer those *Phenomena*, which I have not examined, but am very apt to believe) that it is so far from being, with me, an Objection against it, that it is one of the Reasons which make me inclinable to introduce it.

The like Consideration may reasonably be had of *Jupiter* and *Saturn*, and their *Satellites*, which yet, because of their Smallness, may chance to be so little, as that at this Distance the Change of their apparent Places may not be discernable. For all these *Satellites* are to their Principals as so many Moons to the Earth. And Mr. *Horrocks* expresseth some such little Inequalities in *Saturn's* Motion, of which he could not imagine what Account to give: Which, for ought I know, might have been accounted for, if at that time the *Satellites* of *Saturn* had been discovered, and that Mr. *Horrocks* had thought of such a Notion as the common Center of Gravity of *Saturn* and his Companions to be considerable, as to the guiding of his *Motion*.

2. 1st, To the first Objection, *That it appears not how two Bodies, that have no Tye, can have no common Center of Gravity*: that is (for so I understand the Intendment of the Objection) can act or be acted in the same manner, as

Some Objections answered; By Dr. Wallis *ibid.* p. 281.

if they were connected; I shall only answer, that it is harder to shew how they have, than that they have. That the Loadstone and Iron have somewhat equivalent to a Tye, though we see it not, yet by the Effects we know. And it would be easy to shew, that two Load-Stones, at once applied in different Positions to the same Needle, at some convenient Distance, will draw it not to point directly to either of them, but to some Point between both; which Point is, as to those two, the common Center of *Attraction*; and it is the same as if some one Load-Stone were in that Point. Yet have these two Load-Stones no Connection or Tye, though a common Center of Virtue, according to which they jointly act. And that there is somewhat that doth connect the Earth and Moon (as much as what connects the Load-Stone and the Iron which it draws) is past doubt to those who allow them to be carried about by the Sun, as one Aggregate or Body, whose Parts keep a respective Position to one another: Like as *Jupiter* with his four *Satellites*, and *Saturn* with his one.

To the Second Objection; *That at Chatham and in the Thames the annual Spring-Tides happen about the Æquinoxes; not (as this Hypothesis doth suppose elsewhere to have been observed) about the Beginning of February and November.* If their Meaning be, that *annual High-Tides* do then happen, and then only; if this prove true, it will ease me of half my Work: For it is then easily answered, that it depends upon the *Obliquity* of the *Zodiack*; the Parts of the *Æquinoctial*, answering to equal Parts of the *Zodiack*, being near the *Solstitial* Points greatest, and near the *Æquinoctial* Points least of all. But besides this *annual* Vicissitude of the *Æquinoxes*, not to say of the Four *Cardinal Points* (which my *Hypothesis* doth allow and assert) I believe it will be found, that there is another *annual* Vicissitude answering to the *Sun's Apogæum* and *Perigæum*; and that the greatest Tides of all will be found to be upon a Result of these two Causes co-operating. And to what is said to be observed at *Chatham* and in the *Thames*, contrary to that I alledge, as is observed in *Romney-Marsh*; I must at present *ἀπέχεσθαι*, and refer to a *melius inquirendum*. For a good Diary of the Height and Time both of High-Water and Low-Water, for a Year or two together, even at *Chatham* or *Greenwich*; but rather at some Place in the open Sea, or at the *Land's End* in *Cornwall*, or on the West Parts of *Ireland*, or at *St. Helen's*, or the *Bermudas*, &c. would do more to the resolving of this Point, than any verbal Discourse without it.

3dly, To the third Objection, *That supposing the Earth and Moon to move about a common Center of Gravity; if that the highest Tides be at the New Moon, when, the Moon being nearest to the Sun, the Earth is farthest from it, and its Compound Motion at the swiftest; and that the Tides abate as the Earth approacheth nearer, till it comes into the supposed Circle of her annual Motion; it may be demanded, why do they not still abate, as the Earth comes yet nearer to the Sun, and the Swiftness of its compound Motion still slackens? And so, why have we not Spring-Tides at the New Moon (when the Motion is swiftest) and Neap-Tides at Full Moon (when the Motion is slowest) but Spring-Tides at both? The Answer, if observed, is already given in my Hypothesis it self.* Because

Because the Effect is indifferently to follow, either upon a sudden *Acceleration*, or a sudden *Retardation*. Now both of these happening, the one at the New Moon, the other at the Full Moon, do cause high Tides at both.

4thly, To the 4th Objection, *That the highest Tides are not at all Places about the New Moon and Full Moon, and particularly that, in some Places of the East-Indies, the highest Tides are at the Quadratures*: I answer in general; That as to the particular *Varieties of Tides* in several Parts of the World I cannot pretend to give a satisfactory Account, for Want of a competent History of *Tides, &c.* because, as is intimated in what I wrote in the general, the various Positions of *Channels, Bays, Promontories, Gulphs, Shallows, Currents, Trade-Winds, &c.* must needs make an innumerable Variety of Accidents in particular Places, of which no satisfactory Account is to be given from the general *Hypothesis*, though never so true, without a due Consideration of all those. Which is a Task too great for me to undertake, being so ill furnished with Materials for it.

5thly, To the 5th Objection, *That the Spring-Tides happen not with us just at the Full and Change, but two or three Days after*: I should with the more Confidence attempt an Answer, were I certain whether it be so in the open Seas, or only in our *Channels*. For the Answers will not be the same in both Cases. If only in our *Channels*, where the *Tides* find a large Indraught, but not in the open Seas, we must then seek a Reason of it from the particular Position of these Places: But if it be so generally in the wide open Seas, we must then seek a Reason of it from the general *Hypothesis*: And, 'till I know the Matter of Fact, I know not well which to offer at. I know that Mariners use to speak of *Spring-Tides* at the New and Full of the Moon; though I have still had a Suspicion that it might be some Days after, as well in the open Seas, as in our narrower *Channels*. And therefore I have chosen to say, in my Papers, *about* the New and the Full, rather than *at* the New and Full; and even when I do say *At*, I intend it in that laxer Sense, in which I suppose the Mariners are to be understood, for Near that time. The Truth is, the Flux and Reflux of Water in a Vessel by reason of the jogging of it, though it follow thereupon, yet is, for the most Part, discernable some time after. For there must, upon that Jog, be some time for Motion, before the Accumulation can have made a *Tide*. And so I do not know but that we must allow it in all the Periods: But in my conjectural *Hypothesis*, while it is yet but a Candidate, I did not think myself obliged to speak more nicely.

But now, after all, the clearest Evidence for this *Hypothesis*, if it can be had, will be from *Celestial Observations*. As for Instance; supposing the Sun at *S*, the *Earth's* Place in its *annual Orb* at *T*, and *Mars* (in Opposition to the *Sun* or near it) at *M*: From whence *Mars* should appear in the *Zodiack* at γ , and will at Full Moon be seen there to be, the Moon being at *C*, and the *Earth* at *C*; and the like at the New Moon. But if the Moon be in the First Quarter at *A*, and the *Earth* at *a*; *Mars* will be seen not at γ , but at *a*, too slow: And when the Moon is at *B*, and the *Earth* at *b*, *Mars* will

Fig. 55.

will be seen at β ; yet too slow: Till at the Full Moon, the Moon at C , the Earth at c , Mars will be seen at γ , its true Place, as if the Earth were at T . But then after the Full, the Moon at D , the Earth at d , Mars will be seen, not at γ , but at δ ; too forward, and yet more when the Moon, at the last Quarter, is at E , the Earth at e , and Mars seen at ϵ . If therefore Mars, when in Opposition to the Sun, be found, all other Allowance being made, somewhat too backward before the Full Moon, and somewhat too forward after the Full Moon, and most of all, at the Quadratures, it will be the best Confirmation of the Hypothesis. The like may be fitted to Mars in other Positions, *mutatis mutandis*, and so for the other Planets.

But this Proof is of like Nature as that of the Parallax of the Earth's annual Orb to prove the Copernican Hypothesis. If it can be observed it proves the Affirmative, but if it cannot be observed it proves the Negative; but only proves that the Semi-Diameter of the Earth's Epicycle is so small as not to make any discernable Parallax. And indeed I doubt that will be the Issue. For the Semi-Diameter of this Epicycle being little more than the Semi-Diameter of the Earth itself, or about $1\frac{1}{2}$ thereof, as is conjectured in the Hypothesis from the Magnitudes and Distances of the Earth and Moon compared; and there having not as yet been observed any discernable Parallax of Mars, even in his nearest Position to the Earth, it is very suspicious, that here it may prove so too.

The Variety
of the Annual
Tides, in se-
veral Places
of England,
consider'd, by
Dr. Wallis,
n. 34. p. 652.

3dly, In my Hypothesis for Tides I cast the annual High-Tides for the Coast of Kent, and consequently the Rivers of Thames and Medway, about the Beginning of November and February: Which agrees with Observations on those Coasts, and particularly with that of yours [Mr. Oldenburg's] of Feb. 5. 1662.

The last Year [1667] when I was present in the R. S. I remember an Account was brought us of the annual High-Tides on the Severn, and at Cheap-stow-Bridge, to be about the Beginning of March, and the End of September: Which, though they agree not with the particular Times on the Coast of Kent, yet in the general they agree thus far, That the one is about as much before the one *Æquinox*, as the other is after the other *Æquinox*. You now acquaint me with the High-Tides about February 22. about the Coast of Plymouth, which is later than that of the Coast of Kent, but sooner than that on the Severn. And I doubt not but that in other Parts of the World will be found other Varieties.

The Reasons of these Varieties are, as I have formerly signified, to be attributed to the particular Position of those Parts, rather than to the general Hypothesis.

Of which this, in brief, may serve for some Account at present. The General Hypothesis of the Earth's diurnal Motion from West to East would cast that of the Waters, not following so fast from East to West, which causeth the constant Current within the Tropicks where the Circles are greatest, Westward, from the Coast of Africa to that of America; which is also the Cause of the constant Eastern Breeze blowing in those Parts. But the Sea, thus beating on the Coast of America, is cast back as with an Eddy on either Hand, and consequently

quently returns from the *American* Shore Eastward towards the Coast of *Europe*, where the parallel Circles to the *Æquator* being less, and consequently the *diurnal* Motion slower, doth not cast the Water so strongly Westwards as between the *Tropicks*, and so not strong enough to overcome the *Eddy* which it meets with from the other Motion, which gives the Sea a North-easterly Motion on these Coasts, as to its usual Course. The *Current* therefore of our Seas being North-easterly, we are next to consider, at what time it runs more to the North, and at what more to the East. When it runs most Northerly, it runs up the *Irish-Sea*, and so up the *Severn*: When most Easterly, it runs straight up the *Channel*, and so to the Coast of *Kent*: When between these, it beats against *Devonshire* and *Cornwall*, and those Parts. We are therefore to consider, as to the annual Periods, that the annual Motion of the Earth in the *Zodiack*, and the *Diurnal* in the *Æquator*, are not precisely in the same Direction, but make an *Angle* of $23\frac{1}{2}$ *Deg.* at the *Æquinoxes*, but run, as it were, parallel at the *Solstices*; and as they be nearer or farther from these Points, so is the Inclination varied; which several Directions of Motion do cause the compound Motion of both to vary from the East and West more or less, according as the Sun's Position is farther or nearer the *Solstices*; and therefore nearer to the *Æquinoxes*. This *Inclination* doth cast the constant *Current* of our Seas more to the North and South, and farther from it more to the East and West; which is the Reason, why the *Current* up the *Irish-Sea* is nearer to the *Æquinoxes* (at the Beginning of *March*, and End of *Sept.*) and up the *Channel* or *narrow Seas*, farther from it, (at the Beginning of *Febr.* and of *Nov.*) and against the Coast of *Devonshire* and thereabouts, at some intermediate time.

4. I fear *Dr. Wallis* may be mistaken about the annual Vicissitudes of the Tides, which he contendeth to be about *Allballontide* and *Candlemas*; For,

1st, Our *English Seamen* (who are more to be trusted than the Inhabitants of *Romney-Marsh*) use to say, that the highest Tides in the Year seem to happen rather about the *Æquinoxes*, than those two other assigned times, when the natural Days are longest and shortest.

2^{dly}, If that which he supposeth should be the Cause of the *High-Tides* he mentions at *London*, in *Nov.* 1660, and 1665, the like might be expected every *November*; and as frequently in *February*; of which he gives not one Instance. But those *High-Tides* in the *Thames* in *November*, if we dare credit the *London Watermen*, are caused by the coming down of the *Land-Waters*, after a very great Rain, which, being encounter'd by the Tide of Flood from the Mouth of the *Thames*, cannot but swell to an unusual Height. To induce us to believe which we need only consider, that the latter End of *Octob.* and the Beginning of *Nov.* (or rather both those whole Months) are generally the rainiest Part of the whole Year. Now if the great Rains fall so that the *Land-Waters* come down to the flowing Part of the *Thames* just upon the Full or Change, when the *Spring-Tides* happen, as they did (for Example) *Sept.* 30. 1555. and *Octob.* 22. 1629, (*Stow* and *Howes* are my Authors) those *Spring-Tides* must be the higher, as proceeding from a double Cause.

Animadversions upon Dr. Wallis's Hypothesis; by Mr. Jos. Childrey. n. 64. p. 206.

3^{dly}, There

There is another thing notoriously known by all Seamen to be a Cause of *high* or *low Tides*, namely, the sitting of the Wind at such or such a Point of Compass, and blowing hard. It is the constant Saying of all Seamen in *Ken*, that ever I met with, that the North-West Winds make the *highest Tides* in the *Thames*, *Medway*, and all the Coasts about the *South* and *North Forelands*; and likewise on the Coast of *Holland* and *Flanders*. And the Reason they alledge for it is, because, say they, that Wind doth with equal Force blow in the Tide of Flood on both Ends of this Island of *Britain*; that is, from the Northward between the Coasts of *Scotland*, *Norway*, and *Jutland*; and alio from the Westward by the Coasts of *Cornwal*, *Devonshire*, *Dorsetshire*, &c. up along the *Sleeve*; and for the same Reason they say (and I think truly) that a South-East Wind deads and hinders the Tides there. Agreeably to this I very well remember, when I was a Boy and lived at *Rochester*, that, when the *Tides* were unusually high, the Wind was always *N. W.* and the Moon near the Full or Change. And the Inhabitants about *Chatham*, the Hundred of *Hoo*, and the Isle of *Graine*, will with one Voice say, that they never fear their low *Marshes* being overflowed by the *Tide*; but when the Wind is at *N. W.* or thereabouts, upon the *Spring-Tides*. Here at *Weymouth*, those able and antient Seamen I have talked with tell me, that a *S. S. E.* Wind makes the greatest *Tides*; and that according to the Degrees of the Wind, *ceteris paribus*, the *Tides* rise more or less notably, but that they never observe any extraordinary swelling *Tides* about *Allballontide* or *Candlemas*, unless the Wind be about *S. S. E.* And the Reason they give for that Wind's raising the *Tides* there is, in my Opinion, very convincing, if we consider the lying of the *Haven* in the *Map*. And for the same Reason, I suppose, the Wind from the same Point may make the *highest Tides* at *Southampton*; a Westerly Wind at *Bristol* and *Severne*; an Easterly Wind at *Hull*; a North-East Wind at *Wishbych* and *Lynn*; a Southerly Wind upon the opposite Coasts of *England*, and *Ireland*, &c. And I am confident, if more particular Enquiry be made in *Romney-Marsh*, it will be found, that *Dimchurch-Wall* is never in Danger of being overflowed or broken by the *Tides*, but upon very stormy and tempestuous Weather; especially when the Wind either blows right upon the Shore, or when it sits in that Point that raiseth the *Tides* highest there. And if we do but consider that *Allballontide* and *Candlemas* are no more famous for the longest and shortest natural Days, than they are generally infamous for stormy Weather; especially the former Season, (*Wet* and *Windy* Weather being most concomitant) we have good Ground to attribute *High-Tides* at those times of the Year to another Cause than the Author supposeth, and make a more than probable Conjecture at the Occasion of the Mistake. It is true, *March* is very often more stormy than *February* (tho' seldom so stormy as *October* and *November*) which possibly might occasion that Opinion which some hold (of which Number *Pliny* is one) that the highest *Tides* are about the *Æquinoxes*. And if the Thing were found to hit pretty frequently in *March*, Men might not be careful to observe the other *Æquinox*; tho' yet, it cannot be denied, that we have blustering Weather many times before *Michaelmas*. In Confirmation of all this that I have said, concerning the Influence of the

the Winds being considerable on the Tides, I shall add these following Collections of my own out of Histories, Chronicles, &c.

1250. *Octob. 1.* (Saith *Holinshead*) Upon the *Change* of the *Moon* was a most dreadful Inundation of the Sea, that did exceeding much hurt to *Holland* beyond Sea, *Holland* in *Lincolnshire*, and the *Marsh-Ground* in *Flanders*, and drowned *Winchelsea*. But he tells us withal, that an unheard of Tempest of Wind accompanied it.

1555. *Sept. 30.* (Saith *Stow*) Was a notable Inundation of the *Thames*; but he saith withal, that it was by occasion of a great Wind and Rain that had fallen; the Moon was in *Perigæo*.

1572. *March 10.* I find this Manuscript Note in Latin in an Ephemerides for that Year, over against the Day; *Septentrionis maxima Scivitia: Nivis flocci magni, ingens frigus. Maxime tumescebat æstus Maris die & nocte, nam excurrerebat in Agros late.*

1592. *Sept. 6. Wednesday,* (saith *Stow*) the Wind being West and by South, as it had been for 2 Days before, very boisterous. the *Thames* was made so void of Water, by forcing out the Fresh, and keeping back the Salt, that Men in diverse Places might go 200 Paces over, and then sling a Stone to Land, &c.

1600. *Decemb. 8.* I find this Note written in another Ephemerides for that Year, over against the Day; by an unknown Person; who, as it seems, was then at *Venice* (where a South-East Wind makes the highest Tides;) *Inundatio ventis 6. ped. temp. Sirocco.*

1601. (Saith *Grimston* in his *Netherland History*) The Sea, being forced in by a strong *N. W.* Wind, did some Mischiefe to *Ostend*.

1601. *Octob. 26. St. n.* A great Tempest, saith the same Author, and the Wind *W. N. W.* and the Tide much higher than usual at *Ostend*.

1602. *Febr. 23, 24. St. n.* Blew a terrible North-West Wind, which made the Water rise higher than usual at *Ostend. Idem.*

1604. *March 1. n. st.* The Wind was very great at *West* and *North-West*, with a furious Tempest, the Tide at *Ostend* rising so high, as it had not done in forty Years before. *Idem.*

The *Perigæosis* of the Moon also seems to have, at least, some Influence on the *Tides*, and to make them swell higher than else they would do. For I have found by observing the Tides, as often as I had leisure, several High-Tides and *Inundations*, tho' I must not say all, to happen upon the Moon's being in or very near her *Perigæum*. For Example;

That famous Inundation mentioned before out of *Holinshead*, 1250. *Oct. 1.* was when the Moon was in *Perigæo*, as appears by Calculation.

1630. *Nov. 5.* That Inundation, on which was made the Distich,

*Anno ter deno post sequemille, Novembris
Quinta, stat salsis Zelandia tota sub Undis.*

Was when the Moon was in *Perigæo*.

Vol. II.

00

1552

155 $\frac{1}{2}$. Jan. 13. The Sea, saith *Mitchell* in his Chronicle, broke in at *Sandwich*, and overflowed all the *Marshes* thereabout, and drowned much Cattle; the Moon in Perigæo.

1570. Nov. 1. Was a dreadful Flood at *Antwerp*, and on all the Coasts of *Holland*, that made infinite Spoil; the Moon in Perigæo.

1600. Dec. 8. Such another as above mentioned; the Moon in Perigæo.

160 $\frac{1}{2}$. Jan. 20. Was a great Inundation in *Severne*, mentioned in *How's* Chronicle; that did much Hurt in *Somersetshire* and *Gloucestershire*, &c. the Moon in Perigæo.

1643. Jan. 23. *st. n.* saith a little *Low-Dutch* Chronicle that I have, was a terrible High-Water Flood in *Friesland*, &c. whereby much Hurt was done to the *Dykes*; and at *Gaes*, by *Haerlingen*, the dead Bodies itreamed out of the *Earth*; the Moon in Perigæo.

1651. Feb. 23. *st. n.* (saith the same Chronicle) was *St. Peter's* high Flood, whereby much Hurt was done to the *Dykes* in *Friesland*, *Emberland*, and elsewhere; not far from *Dockum*, by *Oudt-woudumer Zuil*, is a Breach of 42 Roods long, broken in the Dyke; the Moon in Perigæo.

1657. Aug. 2. *st. v.* At *Feversham*, where I then lived, was a very high Spring-Tide; and yet the Wind was at South-East, which deads the Tides there; the Moon in Perigæo.

1658. Aug. 22. *st. v.* At *Feversham* was a very High Tide in the Afternoon, tho' the Wind was Southerly, and blew very stiff, which the Seamen there wondered at; the Moon in Perigæo.

1661. Upon *Michaelmas* Day was a great Overflowing of the *Severne*, that it drowned the lower Ground lying by it; I lived then in *Gloucestershire*, and immediately, as soon as I heard of it, I noted it down in my *Memorandum*; the Moon in Perigæo.

The Scheme of the *Weather* printed in the *History of the R. S.* tells us, that *May 24, 1663.* was a very great Tide at *London*. But it tells us withal, that the same Day the Moon was in Perigæo.

1660. Sept. 19. Here at *Weymouth* I observed myself a very high Tide, and so did several Seamen in that Town, who wondered at it, the Weather being very calm, and that little Wind that was being at North-East, which uses to contribute nothing at all to the Tides in that *Haven*; the Moon in Perigæo.

Farther, that, which inclines me to believe that the Perigæosis of the Moon is of some Concernment in this Matter, is, because it is a *Maxim* amongst our *Kentish Seamen*, that they never have two running Spring-Tides (as they call them) together, but that the next Spring-Tide, after a high running Spring, is proportionably weak and slack; which, if true, is very correspondent to my Opinion; because if the Moon be in *Perigæo* at this *Spring-Tide*, she shall be in *Apogæo* at the next. Accordingly I have received this Account at *Weymouth*, that this present *Feb. 16 $\frac{1}{2}$* , the Spring-Tides ran very high after the *Change*, though the Weather was pretty calm, and that Wind that was not very favourable to the Tides, and the Spring-Tides after the Full were very low and weak, which is exactly according to my Conjecture.

But

But I conceive that the best *Touch-Stone* to prove the Soundness of my Opinion (which I confess I never had the Opportunity to do yet) is to have it observed, whether those Neap-Tides be not apparently higher, *consideratis considerandis*, that happen at the Moon's being in *Perigæo*, either at the first or last Quarter; because it is a received and demonstrable Truth in *Astronomy*, that the Moon being in *Perigæo* at either Quarter comes then nearer the Earth, than when it is in *Perigæo* at the Change or Full.

(5.) That the *Winds* have a great Influence on the Tides of particular Coasts and Havens, I do not at all question; and the like I say of *Land-Waters*, which are, as to Inland Rivers, very considerable, especially as to Inundations upon rising of the Water; for that the Tide and Land Flood should jointly make a greater Inundation than either singly would have done, is not to be doubted. But in my Essay I take no notice of these; because, my Business was to give a statical Account of stated Periods, *Diurnal, Menstrual, Annual*, arising from regular Motions, not of accidental Extravagancies, such as these are.

Answered by
Dr. Wallis,
ibid. p. 2068.

The *Moon's Perigæosis* also is far from being contrary to my *Hypothesis*: But for as much as it doth not still fall out at the same Time of the *Day, Month, or Year*, I could not make it component of any of those noted Periods, *Diurnal, Menstrual, or Annual*; and of more Periods than these I did not know that there hath been any general Notice taken, of which I might think myself obliged to give an Account: But it may very well influence any or all those, according as it falls out advantageous or disadvantageous for them.

And as I do so readily concur with him in all the Particulars by him suggested; so I think he will not be difficult in assenting to all the Materials of my *Hypothesis*. The Account which I give of the *Diurnal* and *Menstrual* Periods, from the common Center of the Gravity of the Earth and Moon, he doth allow as very rational; and consequently, which is the Foundation of it, that any *Acceleration* or *Retardation* of the compound Motion of the particular Parts in the Earth's Surface, is to give such an *Accumulation* of Waters as causeth a Tide; and the Complication of such *Accelerations*, and *Retardations*, concurring or interfering one with another, doth occasion the perplex Varities in them.

If therefore there be no other Periods of Tides but these, or no other remarkable, my Work is done, and I need not be farther solicitous: For then there will seem to be either no other Inequality of *Motions*, or none considerable. But, if there be also observable an *Annual* Period (as perhaps there may be) then are we to seek for the Cause thereof in somewhat of Inequality, (for the *Annual* Period annually recurs; or for any other Period) which doth recur in such a time as that other Period doth require.

'Tis true, I have not insisted on the *Moon's* Apogæum and Perigæum, with the Inequality of *Motion* depending on it; or the *Obliquity* of its *Orb*, which causeth another Inequality both in the Motion of the *Longitude* and *right Ascension*; because I did not know any periodical Vicissitude of Tides consonant thereunto. When any such shall be discovered, we have here a Foundation ready for the salving it. And I the rather think they may be considerable,

siderable, because the *Earth* and *Moon's* *Appropinquation* and *Elongation* doth really alter the Distance of the common Center of Gravity of the *Earth* and *Moon* from the Earth, rendering the Earth's *Epicycle* elliptical; and much favours what Mr. *Childrey* observes of the *Moon* in *Perigæo*. But, as to any annual *Vicissitude*, it is not of Use, because it doth not annually recur.

But if the annual *High-Tides* be at the *Æquinoxes*, not at the times I have assigned, then so much of the *Hypothesis* as concerns the *Excentricity* may be spared, (or allowed to be so little as not to be remarkable) and that of the *Obliquity* alone will give a sufficient Account of it. Or if (to which he seems rather to incline) there be no such annual *Vicissitudes* at all; then may that of the *Obliquity* be spared also, and yet the *Hypothesis* be perfect without it. And, 'till some such be observed and acknowledged, it will be sufficient to say, That tho' both the *Excentricity* and *Obliquity* do cause some Inequality in the Motion, yet so little, as that in the Tides it is not remarkable; they falling just as if the three Motions (Annual, Menstrual, Diurnal) were all exactly circular, and on parallel Axes.

But, as to Matter of Fact in *Romney-Marsh*, I say, that according to the best Account I can there get, and the unanimous Consent as well of Fishermen, and other Watermen, as of other Inhabitants, it is constant; hardly missing (or very seldom) any one Year, be the Weather fair or foul: And as well about *Candlemas*, as about *Allballontide*, every Year, tho' not then so high: Of which, tho' they do not pretend to give any Reason of it, I think a Cause may be very rationally assigned. For, if you consult the Tables of the *Inequality of natural Days*, which Parallel I make use of for the Explication of this, you will find, that about one of the Extremes, in *Jan.* the Increase and Decrease of the natural Days fluctuates very much, sometimes increasing, sometimes decreasing, according as this or that of the two Causes, thwarting one another, doth prevail: But about the other Extreme, in *October*, it is much otherwise; the Increasing and Decreasing going on in a continual Course for a long time together. And the same Causes, applied to the Business of *Tides*, may very rationally be supposed to produce as unequal Effects. And tho' the Seamen at *Weymouth* have not observed any such signal Effects about *Allballontide* and *Candlemas*, yet those about *Chepstow* observe the like to happen about the Beginning of *March*, and End of *Sept.* the one as much before the Vernal, as the other is after the Autumnal *Æquinox*, (like as in our Case it happens) which they call by the Name of *St. David's-Stream*, and *Michaelmas-Stream*; as we do those in *Kent*, *Candlemas-Stream*, and *Allballon-Stream*. Of these different Seasons at *Chepstow-Bridge*, from those of *Romney-Marsh*, I have already given my Remarks. But since it is not yet (it seems) agreed, whether such an Annual *Phænomenon* happen; or if so, not at that time; so that, for ought yet appears, it may be at the Seasons I design, that is, between the *Winter Solstice*, and the two *Æquinoxes* on either Side of it, though on several Coasts severally remote; I think it best to let this Part of the *Hypothesis* stand as it is unrevoked, as that which when it shall be

be discovered, and agreed on, stands ready enough to give a rational Account of it, and, in the mean time, does no hurt. And, in such a Complication of Causes so abstruse, scarce any thing but Observation will determine, which of the Causes, and in what Degree, is to be adjudged predominate.

VI. The sole Principle, upon which Mr. *Newton* proceeds to explain most of the great surprising Appearances of Nature, is no other than that of Gravity, whereby in the Earth all Bodies have a Tendency towards its Center; and there is the like Gravitation towards the Center of the Sun, Moon, and all the Planets.

Mr. Newton's Theory of the Tides explained by Mr. Halley. n. 226. p. 445

Now this Force of a Descent decreases, as the Square of the Distance of the heavy Body from the Center increases.

There is also Room to suspect, that the Force of Gravity is, in the *cælestial Globes*, proportional to the Quantity of Matter in each of them.

From these Principles it is evident, that if the *Earth* were alone, that is to say, not affected by the Actions of the Sun and Moon, the Ocean, being equally pressed by the Force of Gravity, towards the Center, would continue in a perfect *Stagnation*, always at the same Height, without either *ebbing* or *flowing*; but the Sun and Moon having a like Principle of Gravitation towards their Centers, and the *Earth* being within the Activity of their Attractions, it will plainly follow, that the Equality of the Pressure of Gravity towards the Center will thereby be disturbed; and though the Smallness of these Forces, in Respect of the Gravitation towards the *Earth's* Center, renders them altogether imperceptible by any Experiments we can devise; yet the Ocean being fluid, and yielding to the least Force, by its rising shews where it is less pressed, and where it is most pressed by its *sinking*.

p. 445.

Now if we suppose the Force of the *Moon's* Attraction to decrease, as the Square of the Distance from its Center increases (as in the *Earth* and other *cælestial Bodies*) we shall find, that where the Moon is perpendicular either above or below the *Horizon*, either in *Zenith* or *Nadir*, there the Force of Gravity is most of all diminished; and consequently that there the Ocean must necessarily swell by the coming in of the Water from those Parts where the Pressure is greatest, *viz.* in those Places where the Moon is near the *Horizon*. Thus let *M* be the Moon, *E* the Earth, *C* its Center, and *Z* the Place where the Moon is in the *Zenith*, *N* where in the *Nadir*. Then by the *Hypothesis* it is evident, that the Water in *Z*, being nearer, is more drawn by the Moon than the Center of Earth *C*, and that again more than the Water in *N*; wherefore the Water in *Z* has a Tendency towards the Moon, contrary to that of Gravity, being equal to the Excess of the Gravitation in *Z*, above that in *C*: And, in the other Case, the Water in *N*, tending less towards the Moon than the Center *C*, will be less pressed, by as much as is the Difference of the Gravitations towards the Moon in *C* and *N*. Thus rightly understood, it follows plainly, that the *Sea*, which otherwise would be *spherical*, upon the Pressure of the Moon, must form itself into a *spheroidal* or *oval* Figure; whose longest Diameter is where the Moon is vertical, and shortest where she is in the *Horizon*; and that, the Moon shifting her Position as she turns round the Earth once a Day, this *Oval* of Water

Fig. 56.

Water shifts with her, occasioning thereby the two Floods and Ebbs observable in each 25 Hours.

And this may suffice, as to the general Cause of the *Tides*; it remains now to shew how naturally this Motion accounts for all the Particulars that has been observed about them; so that there can be no Room left to doubt, but that this is the true Cause thereof.

The *Spring-Tides* upon the New and Full-Moons, and *Neap-Tides* on the Quarters, are occasioned by the attractive Force of the Sun in the New and the Full conspiring with the Attraction of the Moon, and producing a *Tide* by their united Forces: Whereas in the Quarters the Sun raises the Water where the Moon depresses it, and the contrary; so as the *Tides* are made only by the Difference of their Attractions. That the Force of the Sun is no greater in this Case, proceeds from the very small Proportion the Semi-Diameter of the Earth bears to the vast Distance of the Sun.

It is also observed, that, *ceteris paribus*, the *Æquinoctial Spring-Tides* in *March* and *Sept.* or near them, are the highest, and the *Neap-Tides* the lowest; which proceeds from the greater Agitation of the Waters, when the fluid *Spheroid* revolves about a *great Circle* of the *Earth*, than when it turns about in a lesser Circle; it being plain, that if the Moon were constituted in the *Pole*, and there stood, that the *Spheroid* would have a fixed Position, and that it would be always High-Water under the *Poles*, and Low-Water every where under the *Æquinoctial*: And therefore the nearer the Moon approaches the *Poles*, the less is the Agitation of the Ocean, which is of all the greatest, when the Moon is in the *Æquinoctial*, or farthest distant from the *Poles*. Whence the Sun and Moon, being either conjoined or opposite in the *Æquinoctial*, produce the greatest *Spring-Tides*; and the subsequent *Neap-Tides*, being produced by the Tropical Moon in the Quarters, are always the least *Tides*; whereas in *June* and *Decem.* the *Spring-Tides* are made by the Tropical Sun and Moon, and therefore less vigorous, and the *Neap-Tides* by the *Æquinoctial* Moon, which therefore are the stronger. Hence it happens, that the Difference between the *Spring* and *Neap-Tides* in these Months is much less considerable, than in *March* and *September*. And the Reason why the very highest *Spring-Tides* are found to be rather before the *Vernal*, and after the *Autumnal Æquinox*, viz. in *Feb.* and *Oct.* than precisely upon them, is, because the Sun is nearer the *Earth* in the Winter Months, and so comes to have a greater Effect in producing the *Tides*.

Hitherto we have considered such Affections of the *Tides* as are universal, without Relation to particular Cases; what follows from the differing Latitudes of Places will be easily understood by the following Figure.

Fig. 57.

Let *ApEP* be the *Earth*, covered over with very deep Waters; *C* its Center; *Pp* its *Poles*; *AE* the *Æquinoctial*; *Ff* the *Parallel* of Latitude of a Place; *Dd* another *Parallel* at equal Distance on the other Side of the *Æquinoctial*; *Hh* the two Points where the Moon is vertical; and let *Kk* be the great Circle wherein the Moon appears *Horizontal*. It is evident, that a *Spheroid* described upon *Hh* and *Kk* shall nearly represent the Figure of the *Sea*, and *Cf*, *CD*, *CF*, *Cd*, shall be the *Heights* of the *Sea* in the Places, *f*, *D*, *F*,

D, F, d , in all which it is High-Water: And seeing that in 12 Hours time, by the diurnal Rotation of the Earth, the Point F is transferred to f , and d to D , the Height of the Sea CF will be that of the High-Water when the Moon is present; and CF that of the other High-Water, when the Moon is under the Earth; which in the Case of this Figure is less than the former CF .

And in the opposite Parallel Dd , the contrary happens. The rising of the Water being always alternately greater and less in each Place, when it is produced by the Moon declining sensibly from the *Æquinoctial*; that being the greatest of the two High-Waters in each diurnal Revolution of the Moon, wherein she approaches nearest either to the *Zenith* or *Nadir* of the Place: Whence it is, that the Moon in the *Northern* Signs, in this Part of the World, makes the greatest *Tides* when above the Earth, and in the *Southern* Signs, when under the Earth; the Effect being always the greatest where the Moon is farthest from the *Horizon*, either above or below it. And this alternate Increase and Decrease of the *Tides* has been observed to hold true on the Coast of *England*, at *Bristol* by Capt. *Sturmy*, and at *Plymouth* by Mr. *Coleprests*.

But the Motions hitherto mentioned are somewhat altered by the Libration of the Water, whereby, though the Action of the *Luminaries* should cease, the *Flux* and *Reflux* of the Sea would for some time continue. This Conservation of the impressed Motion diminishes the Differences that otherwise would be between the two consequent *Tides*, and is the Reason why the highest *Spring-Tides* are not precisely on the New and Full Moons, nor the *Neaps* on the Quarters; but generally they are the *third Tides* after them, and sometimes later.

All these things would regularly come to pass, if the whole Earth were covered with Sea very deep: But, by reason of the Shoalness of some Places, and the Narrowness of the *Streights*, by which the *Tides* are in many Cases propagated, there arises a great Diversity in the Effect, and not to be accounted for, without an exact Knowledge of all the Circumstances of the Places; as of the Position of the Land, and the Breadth and Depth of the Channels by which the *Tide* flows; for a very slow and imperceptible Motion of the whole Body of the Water, where it is, for Example, 2 Miles deep, will suffice to raise its Surface 10 or 12 Feet in a *Tide's* Time; whereas, if the same Quantity of Water were to be conveyed upon a Channel of 40 Fathoms deep, it would require a very great Stream to effect it in so large Inlets as are the *Channels* of *England* and the *German Ocean*; whence the *Tide* is found to set strongest in those Places where the Sea grows narrowest, the same Quantity of Water being to pass through a smaller Passage: This is most evident in the *Streights* between *Portland* and *Cape de Hague* in *Normandy*, where the *Tide* runs like a *Sluice*, and would be yet more between *Dover* and *Calais*, if the *Tide* coming about the Island from the North did not check it. And this Force, being once impressed upon the Water, continues to carry it above the Level of the ordinary Height in the *Ocean*, particularly where the Water meets a direct Obstacle, as it does at *St. Malo's*;

St. Malo's; and where it enters into a long Channel, which running far into the Land grows very strait at its Extremity, as it is in the *Severn Sea* at *Chepstow* and *Bristol*.

This Shoalness of the Sea and the intercurrent Continents are the Reasons, that in the open Ocean the time of High-Water is not at the Moon's Ap-pulse to the Meridian, but always some Hours after it; as it is observed upon all the *West Coast* of *Europe* and *Africa*, from *Ireland* to the *Cape of Good Hope*: In all which a *S. W.* Moon makes High-Water, and the same is reported to be on the *West-Side* of *America*. But it would be endless to account all the particular Solutions, which are easy *Corollaries* of this *Hypothesis*; as why the *Lakes*, such as the *Caspian Sea*, and *Mediterranean Seas*, such as the *Black Sea*, the *Straits*, and *Baltick*, have no sensible *Tides*: For *Lakes*, having no Com-munication with the *Ocean*, can neither increase or diminish their *Water*, whereby to rise and fall; and *Seas*, that communicate by such narrow Inlets, and are of so immense an Extent, cannot in a few Hours Time receive or empty *Water* enough to raise or sink their Surface any thing sensibly.

Vid. infra.
§. XI.

Lastly, The Cause of these extraordinary *Tides* in the Port of *Tonqueen* in *China* is proposed by Mr. *Newton* to be from the Concurrence of two *Tides*; the one propagated in six Hours, out of the great *South-Sea*, along the Coast of *China*; the other out of the *Indian-Sea*, from between the Islands, in twelve Hours, along the Coast of *Malacca* and *Cambodia*. The one of these *Tides*; be-ing produced in *North* Latitude, is, as has been said, greater, when the Moon being to the *North* of the *Æquator* is above the Earth; and less, when she is under the Earth: The other of them, which is propagated from the *Indian-Sea*, being raised in *South* Latitude, is greater, when the Moon de-clining to the *South* is above the Earth; and less, when she is under the Earth. So that of these *Tides*, alternately greater and lesser, there comes always suc-cessively two of the greater, and two of the lesser together every Day; and the High-Water falls always between the Times of the Arrival of the two greater Floods, and the Low-Water between the Arrival of the two lesser Floods. And the Moon coming to the *Æquinoctial*, and the alternate Floods becoming equal, the *Tide* ceases, and the Water stagnates: But, when she has passed to the other Side of the *Æquator*, those Floods, which in the former Order were the least, now becoming the greatest, that that before was the Time of High-Water now becomes the Low-Water, and the *Converse*. So that the whole Appearance of these strange *Tides* is, without any Forcing, naturally deduced from these Principles.

Under- Cur-
rents in the
Downs, at
the Straits-
Mouth, and
in the Bal-
tick; By Dr.
Tho. Smith,
n. 158. p. 564

VII. (1.) In the *Offing* between the *North-Foreland* and *South-Foreland* it runs *Tide* and *half-Tide*; that is, it is either ebbing Water or Flood upon the Shore, in that Part of the *Downs*, three Hours, (which is, grossly speaking, the time of half a *Tide*) before it is so off at Sea. And it is a most certain Observation, that, where it flows *Tide* and *half-Tide*, tho' the *Tide* of Flood runs aloft, yet the *Tide* of Ebb runs under Foot, that is, close by the Ground; and so at the *Tide* of Ebb it will flow under Foot.

There is a vast Draught of Water poured continually out of the *Atlantick* into the *Mediterranean*, the Mouth or Entrance of which between *Cape Spartel*

or *Sprat*, as the Seamen call it, and *Cape Trafalgar* may be near 7 Leagues wide, the *Current* setting strong into it, and not losing its Force 'till it runs as far as *Malaga*, which is about 20 Leagues within the *Streights*. By the Benefit of this *Current*, tho' the Wind be contrary, if it does not overflow, Ships easily turn into the *Gut*, as they term the narrow Passage, which is about 20 Miles in length. At the end of which are two Towns, *Gibraltar* on the Coast of *Spain*, which gives Denomination to the *Streights*, and *Ceuta* on the *Barbary* Coast: At which Places *Hercules* is supposed to have set up his *Pillars*. What becomes of this great Quantity of Water poured in this way, and of that which runs from the *Euxine* into the *Bosphorus* and *Propontis*, and is carried at last thro' the *Hellespont* into the *Ægean* or *Archipelago*, is a curious Speculation, and has exercised the Wit and Understanding of Philosophers and Navigators. For there is no sensible rising of the Water all along the *Barbary* Coast even down to *Alexandria*, the Land beyond *Tripoli* and that of *Egypt* lying very low, and easily overflowable. They observe indeed, that the *Water* rises 3 Feet, or 3 Feet and half, in the *Gulf of Venice*, and as much or very near as much all along the *Riviera of Genoa*, as far as the River *Arno*: But this rather adds to the Wonder.

My Conjecture is, that there is an *Under-Current*, whereby as great a quantity of Water is carried out, as comes flowing in. To confirm which, besides what I have said above about the Difference of *Tides* in the *Offing*, and at the Shore in the *Dowms*, which necessarily supposes an *Under-Current*, I shall present you with an Instance of the like Nature in the *Baltick Sound*, as I received it from an able *Seaman*, who was at the making of the Trial.

(3.) He told me, that being there in one of the King's *Frigates*, they went with their *Pinnace* into the middle Stream, and were carried violently by the *Current*: That soon after they sunk a Bucket with a large *Cannon Bullet* to a certain Depth of Water, which gave Check to the Boat's Motion; and sinking it still lower and lower, the Boat was driven a-head to the Windward against the upper *Current*; the *Current* aloft, as he added, not being above 4 or 5 Fathom deep; and that the lower the Bucket was let fall, they found the under *Current* the stronger.

VIII. The *Euripus* is a Streight of the *Ægean Sea*, so narrow, that a *Galley* can scarce pass thro' it under a Bridge, built between the *Citadel* and the *Donjon of Negropont*. But not only this Place, where the Bridge is, is called the *Euripus*, but also 10 or 12 Leagues on each Side of it, where, the *Channel* being more large, the inconstant Course is not so sensible as at the Foot of the *Castle*. For 3 or 4 Leagues on each side there are found 6 or 7 Gulphs, wherein this *Water* shuts itself up, to issue from thence as often as it enters there; and the Situation of these Gulphs contributes to the oddness of this Flux and Reflux, of which the Moon seems to be the principal Cause.

The irregular Flux and Reflux of the Euripus, by F. Jac. Paul Babin. n. 71. p. 2153.

There are 20 Days of each Moon in which the Course of the *Euripus* is regular, and 10 in which it is irregular; that is to say, 5 Days before, and 5 Days after the *New* and *Full Moon*, the Course of it is irregular and strong. And then you see there the like *Phænomena* with those of the *Ocean* at *Bourdeaux*.

deaux. The Sea hath 2 Fluxes and Reflexes in 24 Hours, and every Day it retardeth almost an Hour: But there are 9 or 10 *Changes* of the *Course* of the Water during the remaining 10 Days of *Inequality*, unless it blow hard, and then the *Course* changeth not above 6 or 7 times. I once staid on the *Mill*, which is under the Bridge, $1\frac{1}{2}$ Hour, and I saw the *Course* of the Water change thrice, though the Wind was pretty high, and the *Wheels* of the *Mill* turned as often diverse ways. M de la Hogue, a *Parisian Gentleman*, being curious, staid there almost a whole Day, with a *Janizary*; and, the *Moon* being near the *Full*, he observed the same thing that happens in the *Ocean*. But tho' he designed to stay there full 24 Hours, during the irregular Days, he was dissuaded from it, for fear of the *Turks* that might take him for a *Spy*, and do him some *Mischief*.

The Water riseth not much above a Foot; and when it riseth it runs into the Sea, and when it sinks it flows into the *Channel*, going towards *Constantinople*.

The small Gulphs, that are on the left side of the Port of *Negropont*, are filled when the Water riseth; and emptied, running towards *Thessalonica* or *Constantinople*, when it descend. F. Vaubois took notice of the same at *Constantinople*, viz. That the Waters of the *Black Sea*, that come from *Constantinople*, drive the *Euripus* in its rising towards the main Sea, and that thereafter the Waters retire themselves towards the same place again from whence they came. The same Person also observed, that the swelling of the *Euripus*, which is irregular, lasted not above a good Quarter of an Hour, and the sinking thereof three good Quarters, though then the Water ran with more Rapidity, and seemed to him to come away in thrice as great Plenty as when he saw it rise. I know not whether this proceeded from the Wind, not being able to assure you that this Effect is ordinary.

Between the Ascent and Descent there is a little Interval, wherein the Water seems to be at rest, and stagnating; so that, if there be no Wind stirring it, bits of Wood and Straw lie still upon the Water without Motion.

From what I have said 'tis not difficult to reconcile the *Authors* that have written so differently of the *Euripus*. For those that have said, that there is nothing in it but what is seen in the *Ocean*, that is, two Fluxes and Reflexes in 24 Hours, have only observed it in those 20 Days of its Regularity. And the Ancients have not delivered a Falshood, when they say, that there are 7 *Reciprocations* in one Day, because that happens when the Winds trouble and ratard the *Course* of the Water: And I do assure, by often reiterated Observations, that when 'tis still *Weather*, the Flux and Reflex is made even to 9 or 10 times in a natural Day.

IX. In *Fairay-Sound*, betwixt the Isles of *Fairay* and *Aetha* in *Orkney*, the Sea runneth North-East, for the Space only of 3 Hours in flowing, and 9 Hours South-West in ebbing. This is the *Course* of the Tide only in the middle of the *Sound*, which is but one Mile broad.

Whilst the Sea runneth from West to East in flowing thro' *Westra Firth*, which is 8 Miles in Breadth, there are no greater *Surges* than in any other Place

Extraordi-
nary Tides
about the
Orkneys,
communica-
ted by Sir
R. Moray.
p. 98. p. 6139

Place of the Sea; and in a calm Day it is as smooth as any Lake, though there is constantly a great *Current* in the *Flux* and *Reflux* of the Sea. Yet at the South-East End of a little Island on the S. E. Side of *Westra*, and about a Mile from it, the Sea no sooner begins to run Westward in Ebbing, but there beginneth a *Surge* to appear, which continually encreaseth until the Ebb be half spent, and afterwards it decreaseth until it be low Water; at which time there appeareth no such thing. East and West from this great Surge there are some few lesser *Surges* seen, which are gradually less toward the East and West. I having occasion to pass that way in a little Boat, when we had past over the Eastmost *Surges*, and were beginning to ascend the biggest, upon the 10th of *April*, at one of the Clock in the Afternoon, the *Surge* before us was so high, that it intercepted the Sight of the Sun, and some *Degrees* of the Firmament above it. The *Surge* is about a quarter of a Mile in Length. When there is any Wind, which occasioneth the breaking of the Tops of the *Surges*, there is no passing that way. The Current of the Tide is so strong there, that there is no need of Sails or Oars, save only to direct the Boat as the Helm doth.

X. In that Tract of Isles on the West of *Scotland*, call'd by the Inhabitants *the long Island*, as being about 100 Miles long from North to South, there is a Multitude of small Islands, situated in a Fretum or *Firth* that passes between the Island of *Eust* and *Herris*; amongst which there is one called *Berneray*, some three Miles long, and more than a Mile broad, the Length running from East to West, as the *Firth* lies. At the East End of this Island, where I staid some 16 or 17 Days, I observed a very strange Reciprocation of the *Flux* and *Reflux* of the Sea, and heard of another no less remarkable.

Upon the West-side of *the long Island* the *Tides* which came from the S. W. run along the Coast Northward; so that, during the ordinary Course of the *Tides*, the *Flood* runs East in the *Firth* where *Berneray* lies, and the *Ebb* West. And thus the Sea ebbs and flows orderly some 4 Days before the *Full Moon* and *Change*, and as long after the ordinary *Spring-Tides*, rising some 14 or 15 Foot upright, and all the rest proportionably, as in other Places. But afterwards, some 4 Days before the *Quarter-Moons*, and as long after, there is constantly a great and singular *Variation*: For then (a Southerly *Moon* making there the *full Sea*) the *Course* of the *Tide* being Eastward when it begins to *flow*, which is about $9\frac{1}{2}$ of the Clock, not only continues so 'till about $9\frac{3}{4}$ in the *Afternoon* that it be *High-Water*, but after it begins to ebb the *Current* runs on still *Eastward*, during the whole Ebb, so that it runs Eastward 12 Hours together; that is, all Day long, from about $9\frac{1}{2}$ in the Morning 'till about $9\frac{1}{2}$ at Night. But then, when the *Night Tide* begins to flow, the *Current* turns and runs Westward all Night, during both *Flood* and *Ebb*, for some 12 Hours more, as it did Eastward the Day before. And thus the *Reciprocations* continue, one *Flood* and *Ebb* running 12 Hours Eastward, and the other 12 Hours Westward, 'till four Days before the *New* and *Full Moon*; and then they resume their ordinary regular *Course* as before, running East during the 6 Hours of *Flood*. and West during

Extraordinary
Tides in
the West Isles
of Scotland.
By Sir Rob.
Moray.
n. 4. P. 53.

during the 6 of Ebb. And this I observed curiously, during my Abode upon the Place, which was in the Month of *August*, as I remember.

But the Gentleman, to whom the *Island* belongs at present, and diverse of his Brothers and Friends, knowing and discreet Persons, and expert in all such parts of Sea matters, did assure me, that whereas between the *Vernal* and *Autumnal Æquinoxes*, that is, for six Months together, the Course of *irregular Tides* about the Quarter-Moons is to run all Day, that is 12 Hours, as from about $9\frac{1}{2}$ to $9\frac{1}{2}$, $10\frac{1}{4}$ to $10\frac{1}{4}$, &c. Eastward; and all Night, that is 12 Hours more, Westward, during the other six Months, from the *Autumnal* to the *Vernal Æquinox*; the Current here runs all Day Westward, and all Night Eastward.

*At Ton-
queen, by
Mr. Fr. D.
venport, n.
162. p. 667.*

XI. (1.) During my Stay at *Batsha*, having (without Intermission) observed the daily Course of the Tides, my Advice is, that upon the several following Days of the Moon's Age, in every particular Month of the Year, no *English* Commander should, upon any Occasion whatsoever, adventure over this *Bar*, unless he have a Pilot from the Shore, who undertakes to bring him in; or that he hath only Charge of some small *Bark* or *Junk*, that draws no more than 8 or 9 Foot Water.

In the $\left. \begin{matrix} 1 \\ 7 \end{matrix} \right\}$ Moons, from the $\left\{ \begin{matrix} 3 \\ 17 \end{matrix} \right.$ to the $\left. \begin{matrix} 7 \\ 21 \end{matrix} \right\}$ days of the *Moon's Age* exclusively.

In the $\left. \begin{matrix} 2 \\ 8 \end{matrix} \right\}$ Moons, from the $\left\{ \begin{matrix} 1 \\ 14 \end{matrix} \right.$ to the $\left. \begin{matrix} 5 \\ 18 \end{matrix} \right\}$ days of the *Moon's Age* exclusively.

and from the 27 to the *First* of the $\left. \right\}$ Moon's exclusively.

In the $\left. \begin{matrix} 3 \\ 9 \end{matrix} \right\}$ Moons, from the $\left\{ \begin{matrix} 11 \\ 25 \end{matrix} \right.$ to the $\left. \begin{matrix} 15 \\ 29 \end{matrix} \right\}$ days of the *Moon's Age* exclusively.

In the $\left. \begin{matrix} 4 \\ 10 \end{matrix} \right\}$ Moons, from the $\left\{ \begin{matrix} 9 \\ 23 \end{matrix} \right.$ to the $\left. \begin{matrix} 13 \\ 27 \end{matrix} \right\}$ days of the *Moon's Age* exclusively.

In the $\left. \begin{matrix} 5 \\ 11 \end{matrix} \right\}$ Moons, from the $\left\{ \begin{matrix} 7 \\ 21 \end{matrix} \right.$ to the $\left. \begin{matrix} 11 \\ 25 \end{matrix} \right\}$ days of the *Moon's Age* exclusively.

In the $\left. \begin{matrix} 6 \\ 12 \end{matrix} \right\}$ Moons, from the $\left\{ \begin{matrix} 5 \\ 19 \end{matrix} \right.$ to the $\left. \begin{matrix} 9 \\ 23 \end{matrix} \right\}$ days of the *Moon's Age* exclusively.

And, excepting on these six Days above-mentioned, in every respective Moon, he may safely adventure over the *Bar* any Day, provided always that he mistake not the Time of the Tide, but come over at half Flood or better, tho' he may take notice that the best Tides will be about six or seven Days after the Water's first beginning to increase; and the first Days of the Water's Increase are,

In

In the	1 } 7 }	Moons, on the	5 } 19 }	days
In the	2 } 8 }	Moons, on the	3 } 16 }	days
In the	3 } 9 }	Moons, on the	13 } 27 }	days
In the	4 } 10 }	Moons, on the	11 } 25 }	days
In the	5 } 11 }	Moons, on the	9 } 23 }	days
In the	6 } 11 }	Moons, on the	7 } 21 }	days

of the Moon's Age.

The *Bar* itself being about a Mile and half in Length, and no where, except in its first Entrance, exceeding half a Mile in Breadth, is very even, but yet affords considerably differing Soundings in the same Age and Time of the Tides, according to the Season of the Year (and, which seems to be somewhat strange, hath the highest Tides in the Northerly *Monsoon*, as I have been informed by those who are seemingly best able to give an account thereof) and I must needs say, that the Trial I made on the Bar in *July*, 1678, did accord with what I understood from several of the Fishermen, and others, as to that Month, which induced me to enter this *Information*; and coming over at half Flood, except on the Days afore-mentioned as dangerous to come over in, there will be found according to the Age of the *Tides*,

In the	3 } 4 }	Moons, from 16 to 21 Feet Water.
In the	5 } 6 }	Moons, from 19 to 24 Feet.
In the	7 } 8 }	Moons, from 22 to 27 Feet.
In the	9 } 10 }	Moons, from 17 to 22 Feet.
In the	11 } 12 }	Moons, from 17 to 22 Feet.
In the	1 } 2 }	Moons, from 17 to 22 Feet.

Always the higher the Flood, the lower the Ebb; so that, according to the Strength of the Tides at *Low-water*, the *Soundings* are from 6 to 13 Feet.

On the first and second Days at the Water's *Increase* the *Influxes* are very small and uncertain, but afterwards the *Tides* for 13 Days are *constant* in their *Course*, one *Flood* and one *Ebbing* being compleated in 24 Hours time, equally sharing the Space of a *Lunar Circuition* of the Earth between them, and every *Flood* beginning nearest $\frac{1}{4}$ of an Hour later than the precedent *Flood*, and also

also considerably increasing in the height of the *Tide* every Day from the 3^d unto the 6th and 7th Days of the *Water's Age*, on which two Days the Flood runs very high; but on the 8th Day (which may be accounted the last of the *Spring-Tides*) the Waters begin gradually to decrease again, retaining the same orderly Difference of Time in each Tide, until the next following first Day of the *Water's Increase*; when, during two Days unsettledness, there is a shifting of the *Tides* in respect of the Beginning of the *Flood* and *Ebb*; after which said shifting a Constancy in their inverted Course is again retained in the above-mentioned Order for 13 Days following; as for Example,

On the 25th and 26th Days of the 4th *Moon* (4th and 5th of *June*, 1678, ν in the latter end of ν) being the first Days of the *Water's Increase*, the *Influxes* were very small, there happening on the 26th a falling back of the *Tides* about 13 Hours. But from the 27th (*June* 6th) which was the third Day of the *Water's Increase* after the *last Quarter*, until the 9th Day of the 5th *Moon's Age* (*June* 18, 1678. ν in ≈ 20 .) I noted a very constant Course in the *Tides*, every Flood beginning with the Rising of the *Moon*, and ending at its Setting; the following *Ebb* in like manner continuing during the Time of the *Moon's Age* (*June* 18, 1678.) being the first Day of the *Water's Increase*, their Motion was scarcely perceptible; on the 10th Day there was another falling back of the *Tides* nearest 13 Hours, and on the 11th Day (which was the third Day of the *Water's Increase*, after the first *Quarter* of the *Moon's Age*) the Flood, having (as I said) shifted the preceding Day, took its turn to begin at the *Moon's* Setting, and end at its Rising; and accordingly the *Tides* successively following assumed and kept a constant Regularity, the *Tides* being at highest the 16th of the *Moon* (1678. *June* 24. ν in the middle of ν) which was the 7th of the *Water's Age*, until the 23^d of the said *Moon's Age* (*July* 1, 1678.) on which, being the first Day of the *Water's Increase*, the *Influx* was again scarcely discernible for its Smallness.

N. B. This Bar of *Tonqueen* is about 110 Degrees of *Longitude* to the East of *London*, and in the *Lat.* 20° 50'.

On the 24th Day the *Tides* fall back, as I had found it twice before to have done on the same Days of the *Water's Age*, nearest 13 Hours, by which means the *Flood* on the 25th Day, which was the third Day of the *Water's Increase* after the *last Quarter* of the *Moon*, now again commenced with the rising *Moon*, whereby it hath fallen out always to be *High-water* between Noon and the following *Midnight* every Day, during my Stay here. (*Last Quarter* 22 Days, ν *First Quarter* 8 Days.)

So that it may pass into a Corollary, viz. In the 4th, 5th, and 6th *Changes* of the *Moon*, from the third Day of the *Water's Age* after the *last Quarter*, to the third Day of the *Water's Age* after the first *Quarter* of the following *Moon*, the *Water* begins to flow when the *Moon* riseth, and to ebb again when it setteth in the *Horizon*; and the contrary to the third Day of their *Age* after the *last Quarter*, excluding always their Motion on the two first Days of the *Water's Increase*, because of its Smallness and Uncertainty.

I am

I am informed by the *Inhabitants* hereabouts, that this may hold for a Rule from the 2d to the End of the 7th *Moon*, and that the Converse thereof holds true in the other 6 *Months* of the Year, viz. from the 8th to the End of the first *Moon*: According to which the *Tides* will fall out to be at the highest in the *Evening* for 6 *Months* successively, and the other half Year in the *Morning*; that is to say, between *Midnight* and the following *Noons*. And tho' I cannot aver the Truth of it, yet I find that the *Tide* last Year in the 11th *Moon* (which occasionally, upon the Ship *Eagle's* departure hence, I took some notice of) did fall out, not disagreeing with what they affirm: And I am yet the rather induced to believe, that in every annual Revolution there may be such a Constancy in this different Motion of the Tide appropriated to each Moiety of the Year, because that, during my — Days Stay at *Batsha*, I have found the Predictions of the Natives confirmed by my own Observations of the Tides falling out to be High-Water always between *Noon* and the succeeding *Midnight*, occasioned by the aforesaid falling back at the End of 15 Days; so that on every third Day of the *Water's Increase* the Flood begins at the Hour whereon the Day before it ended.

To prevent Mistakes in the Accompt of the *Moons*, it may be sufficient to inform those who use this Port, that the first Change of the *Moon* after the 15th Day of *January, O. S.* is reckoned for the beginning of the Year, and that *Moon* being accounted the first, the rest follow in order until the Expiration of the 12th, which compleats their Year; except only in their *Leap-Years*, and then they have 13 *Moons*, taking in one extraordinary to make up the Deficiency of the *Moon's Epact* in their Accompt; in which Years the first Day of their *New-Year's-Moon* falls out before the said 15th Day of *January*, as it did this Year, 1678, upon the 12th, being *Leap-Year* with them; so that they reckoned two Months for one this Year; that is to say, the 2d and 3d *Moons* after their *New-Year's-Day* they called 2d *Moons*; for otherwise this present *Moon*, which changed in *July* the 8th, would have been the 7th; whereas now they count it but the 6th *Moon*, and accordingly do the *Tides* fall out. But this *Leap-Year* being past, the first *Moon* in the Year must be reckoned to begin on the Change next following the 15th of *January*, and all other Changes counted successively, as before said, until the Intervention of another *Leap-Year*.

2dly, The Effect of the *Moon* upon the Waters, in the Production of the *Tides* in this Port of *Tonqueen*, is the more wonderful and surprizing, in that it seems different in all its Circumstances from the general Rule, whereby the Motion of the *Sea* is regulated in all other Parts of the *World* I have yet heard of. For first, each *Flux* is of about 12 Hours Duration, and its correspondent *Reflux* as long; so that there is but one *High-Water* in 24 Hours. Then there are in each *Month* two *Intermissions* of the *Tides*, about 14 Days asunder, when there is no sensible Flood or Rising of the Waters to be observed; but the *Sea* is in a Manner stagnant. Thirdly, That the *Increase* of the Water has its 14 Days Period between the aforesaid *Intermissions*, and that at 7 Days End makes the highest *Tides*; from which time the *Water* again gradually abates, and the Flood is weaker till it comes to a *Stagnation*; both *Increase* and *Decrease*

*A Theory of
the Tides at
Tonqueen.
By Mr. Edm.
Halley,
ibid. p. 685.*

observing the same Rule, in being exceeding slow in their Beginning and End, and swift in the Middle. *Lastly*, And, which is most odd, the rising Moon in the one half of each Month makes High-water, and the setting Moon in the other half. Those Particulars considered, together with the Tables shewing the Days of the *Water's Stagnation* in each Month, gave me a light into the Secret of this strange Appearance, so as to be able to bring the hitherto unaccountable Regularity of these Tides to a certain Rule.

And *First*, it appears by the latter of the two Tables, that the *Intermissions* of the *Tides* happen nearly upon those Days that the Moon enters the Signs of *Aries* and *Libra*, or passes the *Æquinoctial*; which divides the Moon's Course nearly into 2 equal Parts, as well as the *Sun's*; and from hence it follows, that the *Tropical Moons* in \ominus and \wp are those which occasion the greatest *Flux* and *Reflux*; and for the Rule of the Change of the Time of *High-water*, which Mr. *Davenport* calls a *falling back of the Tides*, the Example he hath given us lets us know, that the ζ in *Northern Signs* brings in the Flood, whilst she is above the *Horizon*, so as to make *High-water* at her *setting*; and, on the contrary, that whilst she is in *Southern Signs* it flows all the time the Moon is below the *Horizon*, and so makes *High-water* at her *rising*. But it is to be observed, that tho' the Motion passes swiftly from *South* to *North* when she is in or near ν , and from *North* to *South* in or near π , yet the Motion of the Sea, which is the Cause of this *Tide*, is scarce discernable for 3 or 4 Days, when the Moon passes the said *Æquinoctial Points*; whence it appears, that tho' the Declination of the ζ , or her Distance from the *Æquinoctial*, be that whereby the *Tides* are regulated, yet the *Increase* and *Decrease* of the Water is by no means proportionable to that of the Declination of the ζ ; that changing swiftly where the *Increase* of the Water is observed to be most slow. It seems therefore, and I propose it as a probable Conjecture, that the *Increase* of the *Waters* should be always proportionate to the *versed Signs* of the double Distances of the *Moon* from the *Æquinoctial Points*; upon which *Hypothesis* Fig. 58. will give an elegant *Synopsis* of the whole Matter. Let *AB* be the bottom of the *Bar* of *Tonqueen*; *CD* a Perpendicular thereto, whereon to measure the several Depths of the *Water*; *CV*, *Cπ*, the mean Depth, which is that whereat the *Water* is *stagnant* upon the *Moon's* being upon the *Æquinoctial Points*, being commonly about 15 Feet: The ζ \ominus *occid.* the *High-water Mark*, when the *Moon* is in \ominus or \wp , being about 24 Feet: ζ \wp *occid.* the height of the *Low-water Mark*, when the *Moon* is in \ominus or \wp , being about 6 Feet; so that the greatest Rise of the *Water* on the *Tropical Moons* will be about 18 Feet; then dividing ν \ominus and π \wp , into equal Parts, in *EF*, on those two Points, as *Centers*, describe the two *Circles*, each of whose *Radii* are four Feet and a half, which, being kept between the *Compasses*, naturally divide the said *Circles* in the Points, δ , Π , \ominus Ω ; through the which Points, if you draw Lines parallel to the *Base AB*, they shall cut the Perpendicular *CD* in the Heights of the *High* and *Low-water Marks*, which will be at the Entrance of the *Moon* into the said Signs. So the greatest Depth of the *High-water*, when the *Moon* enters δ , μ , Ω , π , is but $17\frac{1}{4}$ Feet, and the least at *Low-water*, $12\frac{1}{4}$ Feet: But when she enters Π , Ω , ζ , π , the *High-water*

Water Depth is $21\frac{1}{4}$ Feet, the *Low-water* is $8\frac{1}{4}$ Feet; as appears by the *Figure*. And this *Hypothesis* not only agrees with all that *Mr. Davenport* hath observed himself, or collected from the *Natives*, but hath been found to hold true since, in the Year 1682, by the ingenious *Capt. Knox* in his Voyage to this Port; so that there is no room to doubt of the Truth thereof. (1.) By this Method may the Time and Height of the *Tides* be with sufficient Certainty computed: But to philosophize thereon, and to attempt to assign a Reason why the Moon should, in so particular a manner, influence the Waters in this one Place, is a Task too hard for my Undertaking; especially when I consider how little we have been able to establish a genuine and satisfactory *Theory* of the *Tides* found upon our own Coasts, of which we have had so long Experience.

XII. *Mr. Boyle* having recommended this Matter, among others, to a learned Physician that was sailing into *America*, and furnished him with a small *Hydrostatical Instrument*, to observe from time to time the Differences of Gravity he might meet with, this Account was returned him; that he found by the *Sea-Glass* the *Sea-Water* to increase in Weight the nearer he came to the Line, 'till he arrived at a certain Degree of *Latitude*; as he remembers, it was about the 30th; after which the Water seemed to retain the same *specifick Gravity*, 'till he came to *Barbadoes*, or *Jamaica*.

The differing Gravities of Sea-water according to the Climates, by . . . n. 18. p. 315.

XIII. *Mr. Haulton* hath now declared his Secret of making *Sea-water* sweet. It consists first in Precipitation made with the *Oil of Tartar*, which he knows to draw with small Charges. Next, he distills the *Sea-water*; in which the Furnace taketh up but little room, and is so made, that with a very little Wood or Coal he can distill 24 *French Pots* of Water in a Day; for the cooling of which he hath this new Invention, that, instead of making the Worm pass through a Vessel full of Water (as is the ordinary Practice) he maketh it pass through one Hole, made on purpose out of the Ship, and to enter in again through another; so that the Water of the Sea performeth the cooling Part; by which Means he saveth the room which the common *Refrigerium* would take up; as also the Labour of changing the Water when the Worm hath heated it. But then, Thirdly, he joins to the two precedent Operations Filtration, thereby perfectly to correct the Malignity of the Water. This Filtration is made by Means of a peculiar Earth, which he mixes and stirs with the distilled Water, and at length suffers to settle at the Bottom.

A Way to make Sea-water sweet, by *Mr. Haulton*, n. 67. p. 2048, 2050.

He maintains, that his distilled *Sea-water* is altogether salubrious: He proveth it first from Experience, it having been given to Men and Beasts without any ill Effect at all upon them. Secondly, From Reason grounded on this; that that peculiar Earth, being mixed with the distilled Water, blunts the Points of the *volatile Spirits* of the Salt, and serveth them for Sheaths, if I may so speak, taking away their Force and *malign Sharpness*.

XIV. It seems probable to me, that the *Sea-water* was the only Element created at the *Beginning*, before any *Animal* or *Vegetable* was created, or the Sun itself. But, upon the Creation of these, the fresh Water had its Rise accidentally, because it owes its Being in great Part (as I have elsewhere

Sea-water made Fresh by *Dr. Mart. Lister*, n. 156. p. 493. *De Font. Med. Angl.*

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shewn) to the Vapours of Plants, and the Breath of Animals; and the Exhalations raised by the Sun. Now, that the Sea-water is made fresh by the Breath of Plants growing in it, I thus demonstrated: I took a long Glass Body, and having filled it pretty full with Sea-water, taken up at *Scarborough*, I put therein common Sea-weed (*Alga Marina*) fresh and new gathered, some with the Roots naked, and some growing on and adhering to Stones. The Glass Body being full I put thereon a *Head* with a *Beck*, and adapted a Receiver thereto, all without any Lute or closing of the Joints; from these Plants did distill daily (though in a small Quantity) a fresh, very sweet, and potable Water, which hath no *Empegreuma*, or unpleasant Taste; as all those distilled by Fire necessarily have.

This I take to be the most natural, most easy, and most safe way of having sweet Water from the Sea; and which may be of great Use, even to supply the Necessity of *Navigators*. And I do not doubt but there may be found other Plants growing in or near the Sea, which would yield fresh Water in much greater Quantities.

Wells of fresh Water near the Sea at Bermudas; by Mr. Rich. Norwood; n. 30. p. 656.

XV. We dig Wells of fresh Water sometimes within 20 Yards of the Sea, or less, which rise and fall upon the Flood and Ebb, as the Sea doth; and so do most of the Wells (as I am inform'd) though farther up in the Country. Wheresoever they dig Wells here, they dig 'till they come almost to a Level with the Superficies of the Sea, and then they find Water, either fresh or salt: If it be fresh, yet if they dig two or three Feet deeper, or often less, they come to Salt-water. If it be a sandy Ground, or a sandy crumbling Stone, that the Water soaks gently through, they usually find fresh Water; but if they be hard *Lime-stone* Rocks, which the Water cannot soak through, but passeth in Chinks or Clefts between them, the Water is salt or brackish.

To examine the Freshness of Water; by Mr. Boyle. n. 197. p. 627.

XVI. (I.) When I remember'd and consider'd, that (as I have found by various Trials) diverse metalline and other mineral Solutions could be readily *precipitated*, not only by the *Spirit of Salt*, but by *crude Salt*, whether dry or dissolved in Water; 'twas no very difficult Matter for me to think, that, by a heedful Application of the *precipitating* Quality of the common Salt, one might discover whether any Particles of it (at least in a Number any way considerable) lay concealed in distilled Water, or any other proposed to be examined. To this End I employed several Drugs, and those not all prepared by one *Menstruum*. And tho' two or three of my other Trials had Successes that I disliked not, when I made them, yet that, which at length I pitched upon as the most certain, and which therefore I meant, when I had the Honour to be sent for by his Majesty about the *Patentees Water*, was that which I think may be understood, as well as recommended, by this short Narrative.

I took some common Water distilled in Glass Vessels, that it might leave its corporeal Salt, if it had any, behind it, and put into a thousand Grains of it one Grain of common dry Salt: Into a convenient Quantity, for Example two or three Spoonfuls, of this thus impregnated Liquor I let fall a fit Proportion, for instance 4 or 5 Drops, of a very strong and well filtrated

Solution.

Solution of well-refined *Silver*, dissolved in clear *Aqua-fortis*; [for a shift common or *Sterling-Silver* will serve the turn;] and I made the Experiment succeed with Spirit of *Nitre*, instead of *Aqua-fortis*; upon which there immediately appeared a whitish Cloud, which, though but slowly, descended to the Bottom, and settled there in a white *Precipitate*. And to make the Experiment rather severely, than at all favourably, there was usually taken somewhat more than a thousand Parts of Water to one of Salt.

But I observed, that, having let fall a few Drops of our *metalline Solution* into the Liquor obtained from Sea-water by the *Patentees* way of sweetening it, there did not presently ensue any white Cloud or *Precipitate*, much less such an one as had been newly afforded by the Water that was impregnated with less than a thousandth Part of Salt. And if, after some time, there happened to appear (for 'tis not absolutely necessary it should) a little Cloudiness in this *falsitious Liquor*, it was both slower produced, and much less, than that which appeared in the impregnated Water.

Perhaps it may be proper that I here observe (what is not wont to be taken notice of) That diverse *Solutions* of *mineral Bodies* may be *precipitated* by *Dilution*; that is (to explain this Expression) when the *Solution* has Time enough allowed to diffuse itself through a great Quantity of Water, the *saline* Parts are thereby so *diluted* and weaken'd, that they are no longer able to sustain the *mineral Corpuscles* they kept swimming before, but make with them and the Water a confused and subsiding Mixture; usually of a whitish Colour. This may appear, when the *Butter of Antimony*, being put into *common Water*, is thereby quickly and plentifully *precipitated* in the Form of that white Powder that *Chymists* (not over-deservedly) call *Mercurius vitæ*. To which I may add, that I have also produced a Powder of that Colour, by pouring into *common Water* a strong *Solution* of *Tin-Glass* made in *Aqua-fortis*. And by the same way we have *precipitated* the *Tincture* (or *Solutions* of the finer Parts) of *Jalap*, *Benjamin*, true *Labdanum*, *Antimonial Sulphur*, and divers other Bodies made in *Vincous Spirits*. If it were not for this Power that *Water* has to weaken most *Solutions* of Bodies, I could have employed, instead of that *Silver*, either *Quick-silver* dissolved in *Aqua-fortis*, or *Lead* crude, or calcined in the same Liquor, or (which is more convenient) in strong *Spirit of Vinegar*; since these and some others are found to be *precipitable* by *Salt-water* into whitish Powders. But though a very heedful Observer may for a shift make use of these *metalline Solutions* to guess at the Quality of Water, as to *Freshness* and *Saltiness*; yet the *Precipitation*, that is made by *Dilution*, is not difficult to be distinguished from that which is performed by a true and proper *Precipitant* (as in our Case by the *common Salt* that is harboured in the Pores of the *Water*) both by the Quickness of the Effect, and the Copiousness of the white Substance produced; and on both these Accounts is very much inferior to it; as may evidently appear in the very different Effects that our *Solution* of — had upon the *Patentees Water*, compared with those it had upon *Water* impregnated with a *thousandth Part of Salt*, and upon divers *common undistilled Waters*.

But to return: The Usefulness of this Experiment is not to be estimated only by the *Examen* it helps us to make of *dulcified Sea-water*, but much more by the Estimate that by its means may be made of *natural fresh Waters*, whether of *Springs, Rivers, Clouds, Lakes, Wells, &c.* For it being generally granted that those Waters, *ceteris paribus*, are the best, as well for the Wholsomeness as divers Oeconomical Uses, as *Washing, Brewing, &c.* that are freest from *Saltiness*, which is an adventitious, and in most Cases a hurtful Quality of *Waters*; by our way of *examining* these Liquors a heedful Eye may in a trice discover, whether there be any latent Saltiness in them, (as most Waters imbibe from the Soil they have traversed or do stagnate in) and may enable one, especially by the Help of a little Practice, to give a near Guess, how much one Water is fresher than another, as I have purposely tried with Pleasure in differing Waters, that are ordinarily drunk even by considerable Persons. And if once you have attentively marked what Change four or five *Drops*, for instance, of our discovering Liquor will make in *Two* or *Three*, or some other small determinate Number of *Spoonfuls* (or rather of *half Ounces*) of *Water*, 'twill not be difficult for a heedful Observer, keeping the same Proportion between the two Liquors, to make a near Estimate, whether any natural Water proposed to him have a greater, an equal, or a less Degree of Freshness or Saltiness, than that Water that he has chosen for his Standard; and how much, in case there be a Difference, the proposed Liquor is less or more free from Saltiness than the other.

And that (to add this upon the by) such a Difference in a Liquor of such frequent inward Use as Water (which is the *Basis* of *Beer, Ale, Mead*, and some other common *Drinks*) may have considerable Effects upon human Bodies in Reference to *Health*, may be probably argued from the differing Effects that Waters more or less impregnated with Salt have upon diverse other Bodies: Since most *Pump-waters*, for instance, will not boil Pease, and Beef, and some other Aliments near so well as Spring-water or Rain-water, which are usually softer, and more free from the Saltiness we speak of. 'Tis commonly known to Barbers and Laundresses, that the same *Pump-water* will not so well and uniformly, or without little Curdlings, dissolve Washballs and Soap, as *Rain-water* and some *Running-waters* usually will: Nay, when I was curious of *tempering Steel*, I remember, 'twas confessed by the skilfullest Artists I made use of, that some Tools (as *Gravers, &c.*) made of the hardest of *Metals*, would receive a differing *Temper* if they were quenched in *Pump-water*, from that, which the like Extinction in Spring-water or River-water would give them.

I might add on this occasion, That, whereas Experience has inform'd several Persons who have consulted it, that diverse *Medicinal Waters*, that are presumed to own their Virtues to the Participation either of *Metalline* or of other *Mineral Bodies*, do upon *Trial* appear to leave sometimes little, and sometimes nothing behind them, except a kind of *common Salt*; our Precipitant may much assist Men to discover, whether a *Mineral Water* propos'd to be examin'd do or do not contain such a *Salt*; and if it do, whether it contain it copiously,

copiously, or no. This I have tried upon more than one of our *English Mineral Waters*, and thereby found in a trice, that one, that is reputed of another Nature, contained pretty Store of *saline Matter*; and that another, which is still, for ought I have learned, of an unexamined and unknown Nature, is impregnated with a surprising Plenty of *saltish Substance*; but how, and with what *Cautions*, our *Precipitant* may be most usefully employed, about the *Examen* of medicinal and other *mineral Waters*, belongs not to this Place. Upon which account I forbear to declare the Use I have sometimes made of our *Precipitant*, in examining the *fresh Urine* of Men, the *Serum* of human Blood, and other Bodies belonging to what the *Chymists* call the *Animal Kingdom*.

I have not, for certain Reasons, ascribed to our Method of examining *Waters* a greater Nicety than to be able to discover *one Part* of *Salt* in a *thousand* of *Water*, that Proportion being great enough to recommend it, and expressed by a round Number easy to be retained in one's Memory: Yet I would not have it thought but that, if it were requisite, our *Method* may make more nice Discoveries. For having sometimes, for Curiosity's Sake, put one *Grain* of *Salt* into no less than 1500 of distilled Water, we could manifestly, tho' not quite so conspicuously as before, make it appear by our way, that even this so lightly impregnated Liquor was not devoid of *Salt*, but had more of that in it than some of the *Patentees Water*, that I kept by me, had; nay, I once found, that a *Grain* of dry *Salt* being dispersed thro' 2000, and another time, that being dissolved in 300 times its Weight of the same kind of Liquor, so inconsiderable a Proportion of *Salt* was plainly discoverable by our *Precipitant*.

It may be objected, That whereas the *Experiments*, hitherto mentioned, have been tried only upon *Waters* impregnated with gross or corporeal *Sea-salt*; this perhaps may not hinder but that they may be imbued with the *Spirits* of *marine Salt*, which by reason of their Activity may be as unhealthful to the *Drinker*, as the grosser *Salt* itself. But tho' to this Surmise I might answer, that a very small Proportion of *Spirit* of *Salt* may in many cases make the *Water* seasoned with it rather *medicinal* than *unwholesome*, yet I shall answer more directly to the Objection, by saying, that, to manifest its not being well grounded, I took above 1000 *Grains* of *distill'd Water*, and instead of *corporeal Salt* put to it one single Drop of moderately strong *Spirit* of *Salt* (for I had much stronger by me that I purposely declined to employ) and, having thak'd it into the *Water*, I let fall into a Portion of this unequally composed Mixture some Drops of our Solution of Silver, which presently began to precipitate into a whitish Foam; insomuch that, for ought appear'd to the *Eye*, this Trial succeeded better than if the *Water* had been impregnated with but the 1000th Part of *corporeal Salt*. The like *Experiment* was made with the *Patentees Water* instead of the other. And, to pursue this Trial a great way farther, I had the Curiosity to diffuse one Drop of *Spirit* of *Salt* into 2000 *Grains* of *distill'd Rain-water*; and upon letting fall some Drops of our *Precipitant* into it I found that the Success well answered my Expectation.

And then, to urge the Trial yet farther, I added as much of the same *distill'd Rain-water*, as by a modest Conjecture made it amount to at least
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half as much more. So that one *Grain* of *Spirit* of *Salt* had a manifest Operation, though not quite so conspicuous as the former, upon above 3000 *Grains* of *Water*, whose Immunity from common Salt we tried apart. And that a Drop of the *saline Spirit*, we made use of, did not equal in Weight a Grain of dry Salt, I found by this; that, having let fall into a counterpoised Piece of *Glass* ten Drops of that Spirit, I found them to want near half a Grain of 9 Grains Weight.

The like Trial I made by substituting above 1000 Grains of Rain Water in the room of the like Quantity of distilled Water.

It is the Opinion of some *Seamen*, and of a Person for whom I have a profound Respect, that *Water* ought to have a little *Saltiness* to preserve it; if this be really a desirable Quality in our *artificial Water*, it may in a trice be supplied with as much *Saltiness*, whether *corporeal* or *spirituous*, as shall be required: and, consequently, as will bring it to be equal in that Quality to the common *Water* of *Rivers* or *Springs*. And perhaps 'twill not be impertinent to add on this occasion, that in some Places, especially lying in hot Climates, it may sometimes be of good Use to know, whether on the Account of the Sun's Heat, or that of the *subterranean Regions* of the *Earth*, the *Rain-water* is impregnated with *volatile*, not *acid*, *Spirits*, like those that are distilled from *Urine*, and which I have, for Curiosity's Sake, obtained from a mineral Body, *native Sal-armoniack*; upon which account I made a Trial that informed me, that if 5 or 6 Drops of *strong Spirit of Urine*, whose Drops I observed to be but small, were shaken into 1000 *Grains* at least of Distill'd or Rain-water, impregnated but with one of *Salt*, our *Precipitant* would make a Discovery of some *Saltiness* in the *Liquor*. And if it were neither to be admir'd nor censur'd, if the *Patentees Water* should sometimes shew a *Change*, when our *Precipitant* is plentifully put, or long kept in it, especially that *Change* being a more light one than that I came from speaking of; since, for ought I have yet observed, not only such *undistilled Waters* are generally allowed to be freely potable, but even those that *Nature* herself distils are not always quite devoid of *Saltiness*.

For I have found Rain-water, that I caused carefully to be saved after the House-tops had newly been well wath'd with former Rain, to grow a little troubled if any Store of our *Precipitant* were kept for some competent time in it. And being gently distilled off it left a Residue, which, with a little of our Solution, afforded a far more suddenly made and copious *Precipitate* than had been produced with the like Quantity even of Pump-water itself. And tho' have met with Rain-water that was more free from Salt than any Spring or River-water that I remember to have examin'd, yet having for Curiosity's Sake made Trial of Snow-water, which, if the Weather had been somewhat milder, would have been Rain; this *Liquor*, I say, which is thought to afford the lightest Water of all natural ones, I manifestly found, by our way of examining it, not to be devoid of *Saltiness*.

It has been surmis'd by some, that even a moderate Action of the *Fire* upon *Water* will make it brackish, and putrid: But that the *Patentees Water* is not *brackish*, appears by the foregoing Trials; and that it is more free from *Saltiness* than most of the Waters Men do without scruple drink: And that it
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may keep sweet longer than is necessary, in a Ship that can from time to time within a few Days supply itself with fresh out of the *Sea*, may be gathered from these two things; The *first* is, That I caused a Pint of it to be *hermetically* seal'd in a Vial, whereof I left, by guess, about a third Part empty; and having about 6 *Weeks* after held this Vessel against the *Light*, I found the *Water* to be clear and *limpid*; tho' I did not judge it had deposited so much as the tenth Part of a *Grain* of *Feculency*. And having opened the *Seal*, and taken out a little of the *Liquor*, I did not find it alter'd either as to *Smell* or *Taste*. The *Second* is, that I have kept a *Bottle* of it in the same unstopt Vessel near eight *Months*, and yet it continues sweet and well-conditioned. And if that which is called *Crudity* in *Water* does consist (as probably it often does) in certain gross *Particles* that are mingled with the purely aqueous ones, it is likely, that the *Action* of the *Fire* may divide and dissipate these into minuter *Particles*, and thereby destroy the *Texture* that makes them hurtful; and, by causing innumerable *Tumblings* and *Roivings* amongst the more earthy *Particles*, give them Opportunity to make little *Coalitions*, whose *Weight* precipitating them to the *Bottom* frees the pure *Water* from them.

And because 'tis but too probable, that the *Unwholsomeness* of diverse *Waters* proceeds not only; or perhaps not so much, from bare *Crudity*, as from a great Quantity of grosser *Particles*, that are not easy to be raised because of their being combined with fixed and earthy ones, that swim up and down in the *Water* they impregnate, as *Silver* or *Mercury* does in a *Solution* made with *Aqua-fortis*, or rather as the *Particies* of *Salt* do in *Pump-water*, and many other *common Waters*: On this Account, I say, the *Patentees* Invention may very much correct such *Waters*, since, by their way of sweetening those *Liquors*, the truly aqueous *Parts* are not only freed from the saline ones, but from the mineral and other gross and hurtful *Corpuscles* that may have lain concealed in the *Liquor*. As may be argued from hence, that having purposely, in the gentle *Fire* of a digestive *Furnace*, slowly distilled off a *Pound* of the *Patentees Water*, it left us in the *Cucurbit* so light and thin a *Feculency*, that the *Bottom* of the *Glass* seemed to be rather sullied than cover'd by it; and I did not judge that the whole *Feculency*, if we could have got it out, would have amounted to so much as two *Grains*.

Perhaps it was upon such *Reasons* that the last *Great Duke of Tuscany*, when he drank *Water*, prefer'd for *Wholsomeness* that which was *distill'd* to that which was not; and, if herein that learned *Prince* and those of the same *Opinion* were not mistaken, it will highly recommend the *Usefulness* of the *Patentees Invention* to *Mankind*: For there are *Multitudes* of *Waters* that are not considerably *brackish* to the *Taste*, that yet, by reason of some unheeded *Saltiness*, as in most *Pump-waters*, more frequently by reason of *Crudity*, are not only unfit, or at best less fit for diverse *Oeconomical Uses*, as *Washing*, *Boiling* of some *Meats*, &c. but are very unwholesome; sometimes to a *Degree*, that makes them mischievous to whole *Communities*, and perhaps *Nations*. I remember I have seen a notable *Instance* of this in those *huge* and *unsightly Tumours* about the *Throat*, which are observed by *Travellers* to be exceeding common among those that inhabit the lower *Traëts* of *Ground* that lie between

the *Rhetian, Helvetian*, and some other neighbouring *Mountains*; which monstrous *Swellings* are generally imputed to the *Snow-waters* that flow from the *Mountains*, and make the usual Drink of the meaner Sort of People; whence 'tis observed, that Persons of better Condition, who drink *Wine* more than *Water*, are either not at all, or far less troubled with these *disfiguring Goitres*, as they call them. But much more notable *Instances* to our present Purpose are afforded me by that great and yet living Traveller, M. *Tavernier*, Baron of *Aubonne*; who, speaking of a Nation of *Cafres* or *Negroes* that come sometimes to trade with the *Portuguese* from a remote Part of *Africk*, informs us, *That the Water of their Country is very bad, which is (says he) the Reason that their Thighs do swell, and it is a wonder to see any of them free.* Nay, which is far more, where he speaks of the *African Kingdom*, or Empire of *Monomotapa*, he has this memorable Passage, *The Natives never live long, by Reason of the Badness of the Waters in the Country. For at the Age of twenty-five they begin to be dropsical, so that 'tis a great Wonder if any among them live above forty Years.*

These People might probably be much relieved, and be brought to live as long as other Nations, if they had so compendious a way as that of the *Patentees* to provide themselves plentifully with Waters whose *Crudity* is corrected, its grosser and heavier Parts separated, and its *Brackishness* destroy'd by the Fire, as its Action is regulated and helped by their Invention.

The Experiment mention'd in this Paper was tried at a *Meeting* of the *R. S.* Feb. 17. 169 $\frac{1}{2}$, by Dr. *Sloane*, with a Success answerable to the Assertions of the honourable Author, and that Drop or two of Spirit of *Salt* mixed with common *Water* would be by the same Method discovered.

By Dr.
Hook, *ibid.*
p. 639.

(2.) At a *Meeting* of the *R. S.* Mar. 2. 169 $\frac{1}{2}$. Dr. *Hook* read a Lecture concerning a Method of his own for the discovering the smallest Quantity of *Salt* contained in *Water*, from a Principle of *Hydrostaticks*; and after his Discourse thereof he produced the *Apparatus*, which he had prepared to exhibit the same, before the Persons then present.

The *Method* of doing which *Operation* was by means of a large *Poise* of *Glass*, somewhat of the Shape of a *Bolt-head*, the *Ball* of which *B* was about 3 Inches Diameter, but the *Stem* or *Neck* thereof *CC* was not above $\frac{1}{4}$ of an Inch. This was so poised by red Lead put into it, as to make it but a little heavier than fair or fresh *Water*. Then this *Poise* was suspended by the small *Stem* to the End of a slender *Beam A*, which was very tender, and being not over-charged with Weight, would turn with a small Part of a Grain. This *Beam* was hung on a *steady Frame*, and the *Poise* hanging at one End of the same, covered with the *Water* to a certain *Mark* or *Division* made on the small Neck at *D*, it was so counterpoised by some small Weights put into the opposite Scale of the *Ballance F*. Then the *Weight* of the *Water* contained in the *Cistern* or *Vessel EE*, into which the *Poise* was immersed, being first known, a 2000th Part of its Weight was taken of common *Salt*, weighed out, and put into the whole 2000 *Parts* of the *Water*, which, by being stirr'd, soon dissolved. Then the *Poise*, suspended as before, was view'd and examined by many then present, and they manifestly saw, that near
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half an Inch more of the Neck emerged out of the *Water* so seasoned, than did before the 2000th *Part* of *Salt* was dissolved therein.

This was only one Use of this Method of discovering very small *Alterations* in the *Constitution* of *Bodies*, the same *Author* having long since, namely, *Octob.* 25. 1677. shewn to the same Society a Method of discovering divers *Alterations* much more curious, namely to the 176000th *Part* of its *Weight*.

XVII. There is an old Spring in the Diocese of *Paderborn* in *Westphalia*, which loses itself twice in 24 Hours; coming always after six Hours back again with a great Noise, and so forcibly as to drive three Mills not far from its Source. The *Inhabitants* call it the *Bolderborn*, as if you should say, the *Boisterous Spring*.

An Ebbing
Well in
Westphalia,
by * * *
n. 7. p. 127.

XVIII. *Lay-Well*, near *Torbay*, is about 6 *Foot* long, and 5 *Foot* broad, and near 6 *Inches* deep, which ebbs and flows very often every Hour, visibly enough. I am informed, 'tis most constant Winter and Summer, tho' I am apt to think it moves faster in Winter, when the *Well* is fuller, than in Summer: Because, when I observed it first (in *July*, 1693.) I think it flowed somewhat quicker than I found it did on my second *Observation*, toward the End of *August* following; for the *Water* was then considerably shrunk in the Well, notwithstanding we had for about a Fortnight much Rain: And tho', when once it began to flow, it performed its Flux and Reflux in little more than a Minute's Time, yet I observed it would stand at its lowest Ebb sometimes two or three Minutes; so that it ebbed and flowed, by my Watch, about 16 Times in an Hour, and sometimes I have been told 20. As soon as the *Water* in the *Well* began to rise, I saw a great many Bubbles ascend from the *Bottom*; but, when the *Water* began to fall, the Bubbling immediately ceased. I measured its High and Low-water Marks, and found them between five and six Inches distant; not of perpendicular Depth, but as it spread itself on a broad Stone, as the Sea does on a Beach or Shore. Tho' I am apt to think its perpendicular Height would be as much or more in that time, were its Out-let damm'd up to try an Experiment; for, as it rises, it runs out with a small Stream, which is greater or less, according as the *Water* in the *Well* rises and falls.

An Ebbing
Well near
Torbay, by
Dr. W. Oli-
ver, n. 104.
p. 909, 910.

That it has any *Communication* with the *Sea* is not manifest, nor is the *Water* brackish at all. The whole Country adjacent is very hilly all along the Coast; inso-much that from *Brixham* to the Top of the Hill is about a Mile and half, and the Well is about half-way up the Hill (which here-about is somewhat uneven and interrupted) and comes out at a small Descent, yet considerably higher than the Surface of the Sea.

I tried it with an *Oaken Leaf* as soon as I saw it the first time, but could not find it change Colour. I drank of it; 'tis very soft and pleasant, has no manner of Roughness in it, and serves for all manner of Uses to the Country People in their Houses; they also use it in Fevers, as their ordinary Diet-drink, which succeeds mighty well.

The Zirchnitzer Sea in Carniola described by Dr. Brown, n. 54. p. 1083. n. 109. p. 194.

XIX. (1.) Having crossed the River *Dravus*, and passed Mount *Luibel* in the *Carnick Alps*, by that noble Passage cut thro' the Rocks and vaulted like that of *Pauslyppe* near *Naples*, I went to *Brounizza*; two Leagues from whence, and beyond the Hills, is the *Zirchnitzer Sea*, receiving that Name from *Zirchnitz*, a Town of about 300 Houses.

This Lake is near two German Miles long, and one broad. On the South Side thereof lies a great Forest, and on the North-side the Country is flat; but the whole Valley is encompassed with high Hills, at some little distance from it. But I saw no Snow upon them, tho' upon other Mountains in the Country I observed Snow in *June*. Upon Hills on the Side of great Lakes the Snow lies not so long as upon Hills more distant.

This Lake is well filled with Water for the greatest Part of the Year, but in the Month of *June* it sinketh under Ground, not only by *Percolation*, or falling thro' the Pores of the Earth, but retireth under Ground thro' many great Holes at the Bottom of it; the little, if any, that remains in the hilly or rocky Part is evaporated: And in the Month of *September* it returns by the same, and in a short time covers the Tract of Earth again, but I cannot determine the Space of Time to a Day. This *Return* and *Ascent* is so speedy, and it mounteth at the Holes with such Violence, that it springs out of the Ground to the Height of a Pike. The *Water* that spouts seems somewhat clear in the Air, but, being spread about, looks as formerly in the Lake.

The Holes generally are stony, not in soft or loose Earth, yet in one or two Places the Earth hath been known to sink and fall in, particularly near a Village called *Sea-dorf*. They are of different Largeness and Figure; some perpendicular at the Beginning, and then oblique; others oblique at first; scarce two exactly alike. Such Holes I have seen in other Parts of *Carniola*, and in other Countries also. We have a Hole call'd *Elden Hole*, not made by Art, but naturally, in the Mountains in the *Peak Country* of *Derbyshire*, above 80 *Fathoms* deep. The great Holes are the same every Year, but possibly part of the Water may sometimes find or make new Passages thro' the Crevices and cribrous Parts of the Field.

When the Water goeth first away, they see it in these Holes for a while, but afterwards it descends lower out of their Sight.

This Piece of Ground in the time of the Retirement and Absence of the *Water* is not unfruitful, but, by a speedy and plentiful Production of *Grass*, yieldeth not only a present Sustenance for the Beasts of the Field, but a good Provision of *Hay* for the Cattle in *Winter*.

The Lake is not only thus filled with *Water*, but every Year well stored with *Fish*. The Prince of *Eckenberg* is Lord of it, and of much Country thereabout. But upon the retiring of the *Water* all have Liberty to fish; and the *Fishermen*, standing up to the *Waste* at the Holes before-mentioned, intercept the Passage of the *Fish*, and take a very great Number of them, which otherwise would be secure for some Months under the *Earth*, and not fail to return in *Sept*. But at that time the Prince will not permit them to make any such Attempt.

The *Fish* of this Lake have a closer Habitation than those of any other I know; for they pass some Months under the *Earth*, and a good part of the

Winter

Winter under Ice. I could not learn that there were any *Otters* in this *Lake*, which otherwise must probably have taken the same Course with the *Fish*; not that there were any remarkable extraneous Substances, any Vegetables, or unknown Fishes brought up by the Water, but those which come up are of the same Kind with those which descend.

The Bottom of the *Lake* is not even, nor near about the same Depth; but sometimes 2 Foot, and then suddenly 20 Yards deep. And, because the *Fish* haunt the deep Places more than the Shallows, they have given Names to the seven chiefest Cavities or Valleys in the *Lake*.

The Water is not always at the same Height, but somewhat differing according unto Rain, Snows, or Drought; and they are sensible of its Height by the Tops of the Hills in it, and its spreading toward *Zirchnitz*, but it alters not very much 'till it begins to go away.

No River enters it, but only inconsiderable *Rivulets* on the South and East Side; nor hath it any other Discharge known, but by the Holes.

There are also divers Caverns and deep Places in the Country of *Carniola*, even where there is no Water.

Between *Sea-dorf* and *Nider-dorf* the Ground sometimes sinks in several Places upon the sudden retiring of the *Lake*; and the aforesaid Prince of *Eckenberg* was once so curious as to descend into one *Hole*, thro' which he passed under a Hill, and came out on the other Side; as I was informed by *M. Andreas Wiser*, the present Judge of *Zirchnitz*, and also by *Johannes Wiser*, who hath formerly held the same Place.

The Country is high about the *Lake*, but the *Lake* is not high in respect of the Country near it, but low.

The Snow falls not 'till after the *Lake* is return'd.

This *Lake* probably may hold Dependance of and Communication with some subterraneous great *Lake*, or Magazine of *Water*, belonging to these hilly Regions; which, when full and running over, may vent itself with Force and Plenty into this Field; and, when Scant of *Water*, absorb and drink in the same again; the *Water* of the *Lake* returning but from whence it came, having no River running out of it whereby to be discharged.

I went also to a noted Stone, commonly call'd the *Fishers-Stone*, which hath somewhat of the Use of the *Nile-scope-pillar* at *Grand Cairo*. It is a large Stone upon one of the Hills, or elevated Parts of the Field; which, whensoever it appears above *Water*, the *Fishermen* upon the *Lake* take notice of, and know thereby that in a few Days the *Water* will retire under Ground. For after the filling of the *Lake* in *September* the *Water* never decreaseth so low again, as to let the *Fisher-stone* appear, 'till it begins to retire under Ground.

(2.) This *Lake* was by the *Antients* called *Lugea Palus*, by the *Moderns* *Lacus Lugeus*, tho' at present its *Latin* Name be *Lacus Cirknicensis*, in *High-dutch* *Zirchnisersee*, and in our *Carniolan* Tongue *Zirknisco Jesero*. Why it was so call'd of old is unknown, or very uncertain, but the *Original* of the present Name is more sure, it being derived from the adjacent Town of *Cirknits*, which took its Name from a *Chapel* of the *Virgin Mary*, that at first stood alone, but now the Town is built round it. This *Chapel* was no great Edifice at first,

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and therefore was called the *little Chapel*, which in the *Language* of the Country is *Zirkviza*; whence the *Lake* was named *Zirkvisco Jesero*, or the *Chapel-Lake*, but now by Abuse, *v* being changed into *n*, *Zirknisco Jesero*.

It is distant from the Capital City of the Province *Labac* 6 German Miles, is a good German Mile long, or better than 4000 Geometrical Paces, and is about half as much in Breadth. Its ordinary Depth is 10 Cubits, its least 5 or 6, rarely 3, but its greatest is 16 Cubits. It is every where surrounded with woody Mountains, which on the South and West-side are very high, and 3 Miles broad, running far in length into the *Turkish* Country, and afford nothing but horrid stony Deserts, overgrown with Trees. On the North and East Side there is between the Mountains and the Lake a small Territory; which, tho' narrow, is nevertheless pleasant, and is inhabited by 1 Town, 3 Castles, and 9 Villages, and adorned with 20 Churches; as may be seen in the Map, which was drawn by myself upon the Place with all possible Care.

Fig. 60.

In the Mountain called *Javornik*, standing near the Lake, there are two Holes, or exceeding deep Precipices, in which many thousand wild Pigeons roost all the Winter; entering in *Autumn*, and coming out with the first of the *Spring*: What they live upon in these *Caverns* is unknown, but I take it to be the *nitrous* Sand. In another Hole, called *Slivenza*, 'tis the Belief of the Country People, that the *Witches* hold their Assemblies, because that several times Lights like *Ignes fatui* are observed there. On the Top of this Hill is a Hole of an unknown Depth, out of which there often breaths out noxious Hail; and for this Reason the *Priest* of *Zirknitz* every *Whitson-Monday* goes to the Hole in Procession, and uses over it a certain Form of *Exorcism*.

There run into this *Lake* continually 8 Rivulets. The two least are called *Belleberch* and *Tresenz*; the third is the Fountain *Oberch*, out of which abundance of *Water* gushes with great Force; the fourth, fifth, and sixth, called *Steborziza*, *Linsinziza*, and *Seromschiza*, may for their Bigness deserve the Name of Rivers; the seventh, *Martinschiza*, breaks out at a Cleft in the Rock: The last, called *Cirknizer-bach*, is a pretty large River.

Fig. 61.

Now this *Lake* being every where surrounded with Mountains, and nowhere running over, Nature has given it two visible Channels, or stony Caverns, call'd *Velka-karlouza* and *Mala-karlouza*, by which the *Water* runs under the *Mountain*; and a third concealed subterraneous Passage, which without doubt communicates with the other two under Ground (as I shall hereafter prove.) These, having run half a *German* Mile, come out at the other Side of the *Mountain*, near the *Chapel* of *St. Cantian*, as I have faithfully drawn it, in a *Desert-place*, at a stony Cave *A*, and become the *River* called by the Inhabitants *Jesero*, that is, the *Lake*. This *River* *Jesero*, mark'd *B*, is reasonably big, and, having run half a quarter of a Mile, enters a wide stony Cavern *I*, running slowly under the Hill for the Space of a good *Musquet-shot*; then coming out again on the other Side, after it has run thro' a small *Plat m m*, it enters a third Cavern or *Grotto* *C*, wherein having passed 50 Paces, one may say *Siste Viator, ne plus ultra*; for it runs no longer peaceably as before, but with great Noise and Roaring falls down a very much inclined Channel of Stone, so that neither I nor any durst follow it farther. In *June*, 1678. I went myself

myself

myself in a small Fisher-boat under the Mountain through the Cave *I*, and entered the *Grotto C*, 'till I came to the aforesaid Falls, without any Danger or Trouble, the Passage being wide enough.

It must be noted, that the Valley wherein this River *Jesero* runs is exceeding steep, but the Plat of Ground *m m* is plain and stony, of an Oval Form, and is surrounded with (as it were) a very high Rampart *K K K*, so steep that it would be impossible for a Cat to climb out of it, unless at one Place, whereat a Man may make a shift to go up and down, tho' not without Peril of his Life; the way being in some Places not above three or four Inches, and no where above 6 Inches wide. In the Year, 1684. I went down here in Company with a *French* Gentleman; but the Water being up, and we wanting a Boat, we could not go under the Hill, nor enter the *Grotto C*; so we returned, and with great Difficulty descended by a steep and narrow Passage at *D*, and came to a Cave bigger than any Church, thro' which the River *Jesero* runs. Here we found several Figures of Stone, the Workmanship of Nature, and strange Holes and Caverns in the Earth; but, by reason the River was then up, we could go no farther. At other times, when the Water is down, one may go with lighted Torches a great way under Ground; and it is said there are here very odd Figures formed by the petrified Water: Among the rest one resembling a Weaver at Work, of which the Country People want not their superstitious Traditions.

But to return to our Lake; I say, that about the Feast of St. *James's Tide*, and sometimes not 'till *August*, the Water runs away, and it is dry: But it fills again, and most commonly in *October* or *November*, yet so as not to observe any certain time; for sometimes it has been dry twice or thrice in a Year; as in the Year, 1685. it was dry in *January*. Again, the Water began to draw off on the 15th of *August*, *St. N.* and it was quite clear by the 8th of *September*; and this present Year, 1687. it has been thrice empty, which makes the Fishing very poor and inconsiderable. Sometimes again, tho' but seldom, it has happened to be three or four Years together full of Water, and then is the best of the Fishing. But it never yet was observed that this Lake was dry for a whole Year together.

The Right of Fishing in this Lake, upon certain Terms agreed on, does at this time belong to the Lordships or Castles following; 1. To *Haasberg*. 2. *Steegberg*. 3. *Laas*. 4. *Schneeperg*. 5. *Avesperg*. 6. *Sitticium*; which is a Monastery of *Cistercian* Monks.

There are 3 Islands in this Lake, *viz.* *Mala-goriza* and *Velka-goriza*, which are uninhabited: The third is a very pretty Island called *Vornek*, that is reasonably big, having upon it a Village of four Houses, called *Ottock*; above this Town upon a little Eminence stands a Church, which is no small Ornament. Those that live on it have Fields, Meadows, Pastures, Wood, Gardens, and Orchards, and all Things necessary for Life.

There is also a very fine *Peninsula* all covered with Wood, called *Dorcassek*. When the Lake is up, and one comes in a Boat between the Island *Vornek* and this *Peninsula*, the farther Part of the Lake, lying under the Mountain, very well resembles a curious Port for Shipping. At the farther End, when the
Water

Water draws off, there appear Rows of Stakes, a Sign that there hath been formerly a *Bridge*, and therefore it is at this Day called the *Old Bridge*.

In this Lake there are many Pits in the Shape of Basons or Caldrons, which are not all of the same Depth or Breadth; the Breadth of them being from 20 to 60 Cubits more or less, and the Depth from 8 to 20 Cubits. In the Bottom of the Pits are several Holes, at which the Water and Fishes enter, when the Lake ebbs away.

The principal Pits, in which they fish, are 18, situated and named as is represented in the Map. They are called *Malijoberch*, *Velkjoberch*, *Kamine*, *Sueiuskajamma*, *Vodonos*, *Louretschka*, *Kraloudour*, *Rescheto*, *Ribesekajamma*, *Rethje*, *Sittarza*, *Lipanza*, *Gebno*, *Koteu*, *Ainz*, *Zeslenza*, *Pounigk*, and *Lewishe*. Besides these there are several other less Pits of no Note, because there is no such fishing in them as in those but now mentioned.

Fig. 60.

In the Months of *June*, *July*, and *August*, when this Lake begins to draw off, it grows quite dry in 25 Days, if no great Rains intervene. And the aforesaid 18 Pits are all emptied, the one after the other, in a certain and never failing Order of Time.

When the Lake begins to sink, which appears by a certain Stone that they observe, the Inhabitants of the Town called *Oberdorff*, or *Seedorf*, give notice thereof to all the neighbouring Fishermen, that are appointed by the several Lords having Right in this Fishing. The People of this Town have Orders not only to watch the falling away of the Water, but likewise to take care that no body presume to fish in the Lake when it is full of Water; that being forbidden: So that these are, as it were, the Keepers of the Lake.

1. The first Pit, called *Malijoberch*, is not properly a Pit like a Caldron, but only a Depression of the Bottom without any Holes in it: But there grows much Grass and Weeds, and many Fish are catch'd therein. Three Days after the Water begins to ebb, this Pit is emptied: Then the Parish Clerk of *Seedorf* gives notice thereof by tolling a Bell, and all the Inhabitants of the Town, Old and Young, Men and Women, lay aside all other Business and go to fishing, stark naked as ever they were born, without any regard to Modesty or Shame.

The Fish they catch they divide in halves; one Part they give to the Prince of *Eckenberg*, as the Lord of the Manour, the other half is their own.

2. The Pit *Velkjoberch* is empty the third Day after *Malijoberch*; the Manner and Right of fishing as in that.

3. Four Hours after this the Pit *Kamine* begins to empty; here they generally fish with a Trawle, as in several other Pits of less Note, having first purchased leave of the aforesaid Lord of the Manour. Here, as likewise in the Pit

4. *Sueiuskajamma* (which sinks one Hour after *Kamine*) is much Fish caught, and Abundance of large *Crabs*; but they are lean, and of no good Taste.

5. The fifth Pit *Vodonos* dries 5 Days after *Kamine*. In this and the other Pits which follow they fish with a long Net or Sayne. Herein they can have no more than five or six *Hawls*, by reason of the great Swiftnes wherewith

the

the Water runs away at the Holes in the Bottom (which is such that a Horse can hardly keep Pace with it) and carries away the Fish with great Violence under the Earth. Sometimes, when Fishermen are not nimble, they can scarce get two Hawls before the Water be gone: To prevent which they have a Mark near this Pit, viz. the *Stone Ribeskekamen*, that is, the *Fisher's Stone*; which, as soon as it begins to appear upon the Recess of the Water, gives notice that it's time to begin the Fishing.

6. The Pit *Louretschka* is evacuated a Day and a half after *Vodonos*; the Fishing is after the same Manner, and the same Caution necessary, because of the sudden Recess of the Water.

7. The Water leaves the Pit *Kraloudour* 12 Hours after *Louretschka*; and three Days after that

8. The Pit *Rescheto*. In this latter, in the Year 1685, after the Lake had been some Years without being dry, there were taken at the first Haul 21 Carts of Fish, at the second 17, and at the third 9; as I have been credibly informed by those that were present.

9. The Pit *Ribeskajamma* falls dry at the same time with *Rescheto*, which is that next to it. In this Pit they fish under Ground, which is a Curiosity not unpleasant, and differing from all the rest. For there is in the Bottom a great Hole in the *Stone*, by which Men may easily go down with lighted Torches, as into a deep Cistern; and there is under a large Cavern like a Vault, the Bottom or Pavement whereof is as it were a Sieve full of little Holes, whereby the *Water* runs away, leaving the *Fish* dry, where they are caught.

10. The Pit *Rethje* is empty two Hours after *Ribeskajamma*, and is of no great Consequence for Fish. An Hour after this, the Pit

11. *Sittarza*; and in five or six Hours more

12. *Lipanza* falls dry.

13. The third Day after *Rescheto* the Pit *Gebno* is evacuated; in this they rarely fish with Nets, but let fall dry; and the Holes in the Bottom being so small, that they exceed not the Size of a Man's Arm, all the great Fish are left behind in the Pit.

14. Two Days after *Gebno* the Pit *Koteu* becomes dry: In this they sometimes take the Fish as in the former; but the Holes being greater let bigger Fishes pass.

15. The Pit *Ainz* empties four or five Hours after *Koteu*: In this they seldom (unless they cannot help it) let the Water run away without using their Nets, as in *Gebno*; because of one great Hole in the Bottom, whereby many great Fishes may escape.

16. The Pit *Zessenza* sinks three Hours after *Ainz*: In this they always fish with Nets; as in

17. *Pounigk*, which is emptied the next Day after *Koteu*.

18. The last Pit called *Levische* is evacuated the third Day after *Pounigk*, that is, the 25th Day from the beginning of the Recess of the Water of the Lake; so that in 25 Days the fishing of this Lake is over. In this last Pit, about 17 Years since, I am certainly informed, that there fell a Flash of *Lightning* about the time of *Fishing*, which stuned a great Multitude of large
Fishes,

Fishes, so as that they filled 28 *Carts* with them: (By a *Cart* is meant as much as one Horse can draw.) These Fish are not properly *Thunder-struck*, but only stunned with the Violence and sulphurous Vapour of the Lightning, which makes them rise and swim as dead upon the Top of the Water; but, if they be taken up and put in fresh Water, they soon recover, otherwise they die. This is no uncommon Accident in this Lake.

The Fishing being thus ended, a Sign is given by tolling the Bell in the Chapel of *St. John Baptist*, near the Town of *Cirknitz*: Upon which all the Inhabitants of the neighbouring Villages, and of *Cirknitz*, without regard either to Age or Sex, go for the most part stark naked into the Lake, and look for Fish among the Weeds and Sedge, and in the smaller Pits: And many creep into the subterraneous *Caverns* and Passages, and find Store of large Fishes there; they having full Liberty to search all over the Lake, excepting in the Pits *Pianze*, *Narte*, and *Velkjoberch*. This barbarous and immodest Custom of going naked has been often attempted to be reclaimed by the *Carthusian* Monks, but all in vain; for so prevalent is a Habit of vicious Practices over good Precepts, that they have not yet been able to persuade them so much as to cover their Secrets.

There are besides these some other Pits in the Lake, as *Skednenza*, *Mala* and *Velka-bobnarza*, in which they fish likewise; as also in *Mala-karlouza* and *Velka-karlouza*: In both these they go far under Ground with lighted Torches, and find Fish; but these Pits are of no great Value. In *Velka-bobnarza* one may go in at great Holes, and descend many Fathoms under Ground. These two Names *Velka* and *Mala-bobnarza* signify in the *Carniolan* Tongue the Greater and Lesser *Drummer*: Nor is it without Reason that these Pits are so called; for, when it *thunders* and *lightens*, there is heard in these two Pits, as it were, the Sound of many Drums beating, which *Anno 1685* I heard with my own Ears; it thundering three times successively, and the Sound of Drums answering accordingly.

The two Pits *Narte* and *Pianze* are never emptied, but always remain *fenny*, when the rest of the Lake is quite dry. It is believed that in these Pits the *Fish* lay their Spawn, and therefore it is prohibited to fish in them. In them is an incredible Number of *Horse-leeches*, which, according to the vulgar Opinion, understand certain Words; for that, upon repeating them, they will come in great Parties towards him that repeats them; whereas, if he be silent, very few of them will touch him. These *Horse-leeches* often stick upon the People in the fishing time some of them being dispersed all over the Lake;) and the Method they take to get them off is to get some other Person to piss upon the *Leech*, which makes it let go its hold; and this, without any respect to Modesty, is practised as well upon the *Women* as *Men*.

There are in the Mountain nigh the Lake, but something higher than it, two great and terribly stony *Caves*, the one called *Urainajamma*, the other *Sekadulze*; which, tho' far distant one from the other, have yet the same effect, *viz.* When it *thunders* and *lightens*, these two *Caves* do emit *Water* with a wonderful and incredible Force, and with it sometimes a great Quantity of *Ducks*, with some Fish; which I myself observed in *October, 1685*, not with-

out

out great Danger of my Life. I took my Horse and rid cross the Lake as far as the Island *Vorneck*, in Company with two old experienc'd *Fishermen*; when suddenly the *Cavern* in the Mountain *Silvenza* began to breath forth misty Vapours, forming a Cloud. Upon which my *Fishermen* advised me to make haste, for without doubt those Clouds would produce a *Tempest*. They had scarce said so, when it began to lighten and thunder dreadfully; and I had Difficulty to persuade them to accompany me as far as the Pit *Velkabebnarza*, being desirous to examine what is said of it; that, when it thunders, the Sound of many *Drummers* is heard in it. This I found 3 times to succeed as reported; and then, with all the Speed we could, we halted to the Island *Velkagoriza*, not being able to go farther, because the Water was in many Places grown out of our Depth, where two Hours before we had passed dry. Here we got one of the little *Fisher-Boats*, which, when the *Lake* is dry, lie dispersed here and there on the Bottom; and having got off my Horse, we began our Voyage, but had the ill Luck to overset our Boat, and so were obliged to swim for it, and with much to do arrived safe on the other *Shore*. Then we could see from the other Side, that the Water gushed with great *Impetus* out of the Cave *Sekadulze*, being cast 3 or 4 Fathom, as if it were forced by a *Fire-Engine*, and several blind *Ducks* were thrown out by the *Water*. It is not to be wondered that the *Lake* fills so fast; for, considering the Violence wherewith the *Water* rushes, it is as much as a great *River*; this Cave *Sekadulze* being a Fathom wide, and higher than a Man. It is looked upon as a dangerous Thing to enter into this Cave, because the *Water* comes so all on a sudden, that if it should chance to come it is impossible to escape it.

When it rains moderately, the *Water* spouts with great Violence two or three Fathoms perpendicularly, out of the Pits *Koteu* and *Zessenza*. It comes likewise forcibly out of the Spring *Tresenz*, as likewise out of *Velkjoberch*; bringing with it, at this latter, Abundance of *Fish*, and some *Ducks*. But when it rains very hard and long together, especially with *Thunder*, then the *Water* breaks out with very great Force, not only from the aforesaid *Pits*, *Holes*, and *Caves*, but likewise at several thousand other little *Holes*, which are all over the Bottom of the *Lake*, and which, when the *Lake* is dry, drink up the *Waters* of the 8 *Rivulets* that run into it, spouting several Fathoms high, from some perpendicularly, from others obliquely, so that there is not a pleasanter Sight than this. And out of the Pits *Vodonos*, *Rescheto*, and some others, having got *Holes* at the *Bottom*, there comes with the *Water* a great Quantity of *Fish*. In case of great Rains, the 8 *Rivulets* are likewise much increased; so that, all things concurring, this *Lake* in 24 Hours Time will, from quite dry, be full of *Water*, and sometimes in 18 Hours; tho' at other times it has been known to be three Weeks in filling. But it is a constant Observation, that *Thunder* and *Lightning* help much to fill it speedily.

This *Lake*, being thus by turns wet and dry, serves the Inhabitants for many Purposes. For 1st, while it is full of *Water*, it draws to it several Sorts of *Wild-Geese*, and *Ducks*, and other *Water-Fowl*; as *Hérons*, *Swans*, and the like; which may be shot, and are very good Meat.

Next, as soon as the Lake is emptied, they pluck up the *Rushes* and *Weeds*, which make excellent *Litter* for *Cattle*. 3. Twenty Days after it is fully dry they do cut a great Quantity of *Hay* upon it. 4. After the *Hay* is in, they plow it and sow *Millet*, which sometimes, by the too sudden coming of the *Water*, is destroyed; but it generally comes to Maturity. 5. While the *Millet* is on the Ground, they catch a great Number of *Quails*. 6. The *Millet* being in, there is good Pasture for *Cattle*. 7. When the Lake is dry, there is great Variety of Hunting; there coming out of the neighbouring *Woods*, and *Mountains*, Plenty of *Hares*, *Foxes*, *Deers*, *Swine*, *Bears*, &c. so soon as the *Water* is gone. 8. When it is full one may fish in it. 9. In *Winter-time* it will be so firmly frozen as to bear all Sorts of Carriages, and is a great Convenience to the People to fetch their Wood and other Necessaries. Lastly, At the time when the *Water* goes away it yields great Abundance of Fish, as hath been already said. And that which is most wonderful is, that all this comes to pass in the same Place, and the same Year, provided the Lake be early dry, and it fill not too soon: But it is to be noted, that the *Hay* does not grow, nor is the *Millet* soon all over the Lake, but only in the more fertile Places.

There are only these Sorts of Fish taken in this Lake, which are very well tasted. They are the *Mustela fluviatilis*, or *Eel-pout*, some of them weighing two or three Pounds. 2. *Tench*, some of them weighing six or seven Pounds. And 3dly, *Pikes* in very great Plenty, 10, 20, 30, and some of 40 Pound Weight; in the Bellies of these it is common to find whole *Ducks*. *Crabs* are found no where but in the Pits *Kamine* and *Sueiuskajamma*: They are large, but ill tasted.

The Cause or rather *Modus* of all these wonderful *Phænomena* in the Lake of *Zirchnitz* is, according to my Opinion and Speculations, as followeth: There is under the *Bottom* of the Lake another subterraneous one, with which it communicates by the several *Holes* described. There are also one or more *Lakes* under the Mountain *Javornik*, but whose Surface is higher than that of the Lake of *Zirchnitz*. This upper Lake is possibly fed by some of those many Rivers which in this Country bury themselves under Ground, and has a Passage sufficient to carry the *Waters* they ordinarily bring into it: But when it rains, especially in *Thunder-Showers*, which are the most hasty, the *Water* is precipitated with great Violence down the steep Valleys, in which are the *Channels* of these *Rivulets*; so that the *Water* in this Lake, being increased by the sudden coming of the Rains faster than it can empty, swells presently, and finding several Holes or Caverns in the Mountain higher than its ordinary Surface, it runs over by them both into the subterraneous Lake, under that of *Zirchnitz*, into which the *Water* comes up by the several *Holes* or *Pits* in the *Bottom* thereof, as likewise by visible Passages above Ground, such as *Urainajamma*, *Secadulze*, and *Tresenz*.

That some of these Passages bring *Fish*, some *Ducks* and *Fish*, others only *Water*, seems to depend on the *Position* of the inward Mouths of these subterraneous *Channels*; for, if they be so constituted as to draw off the *Water* from the Surface of the upper Lake on which the *Ducks* swim, they must needs be

be drawn away by the Stream into these *Caverns*, and come out with the *Water*: But if so that the *Channels* open into the upper *Lake* under the Surface of the *Water*, and from thence ascend obliquely for some Space before they come to descend, then the *Water* they carry is drawn from below the Surface, and consequently can bring with it no *Ducks*, but only *Fish*. Those *Pits*, which yield only *Water*, may well be supposed to be fed by Passages too narrow to let the *Fish* pass, tho' their Multitude may make the Quantity of *Water* they emit to be very considerable.

The Manner of the *falling away* of the *Water*, or *emptying* of the *Lake*, I thus explain. After a long Drought, or Want of *Rain*, all the Springs that feed the upper *Lake* under *Javornik* are much diminished; so that, wanting fresh Supplies, it ceases to run over by the several Channels but now mentioned: Hence the *Lake* of *Zirknitz*, and that under it, are fed only by the 8 Rivulets that always fall into them; and then the *Water* draws off faster than it comes in, both by the Channels of *Mala* and *Velká-karlouza*, as also by a concealed subterraneous Passage out of the under *Lake*, which latter alone is able to transmit more *Water* than the said 8 Rivulets afford. Consequently the *Lake* must sink, and that in a certain Proportion of Time, depending on the Quantity of *Water* to be evacuated, compared with the Excess of that that runs out, above that that enters at the same time. 1. Those *Pits* that are higher are soonest dry, the lower latest, and so come to be emptied in the Order above described; and, when the *Lake* is all dry, then the said Rivulets soak by several little Holes in the *Bottom* into the under *Lake*, and all their *Water* is carried away by the aforesaid *subterraneous Passage*.

That there is such a *Passage* is very evident, and that it communicates under Ground with the Channels of *Mala* and *Velka-karlouza*, coming out with them, as hath been already said, near *St. Cantian* at a *Rocky Cave*, and making the River *Jesero*: For when the *Lake* of *Zirknitz* is very full, and runs out of both *Velka* and *Mala-karlouza*, the River *Jesero* at *St. Cantian* overflows, and runs with great Violence; when it only runs out at *Mala-karlouza* (which is somewhat lower than the other) then the *Water* of *Jesero* is much less rapid; but, when the *Lake* is so fallen that it runs out at neither of the two, the River *Jesero* is still less, but runs with a considerable Stream, 'till two Days after the *Lake* has been dry; after which the said River becomes little, voiding no more *Water* than the *Lake* receives from the 8 Rivers that run into it: By which it is clearly proved, that this *subterraneous Passage* does meet with the Channels of *Velka* and *Mala-karlouza*, and needs no farther Illustration.

Hence it appears, why this *Lake* sometimes is twice or thrice dry in a Year, at other times continues full for three or four Years together, but was never known to be dry for a whole Year's time; for it falls dry at any time, when there falls but little *Rain* in a long Space of time; and in rainy Years it continues always full; but it never happens in this Country that there is a Drought for a whole Year together.

The *Ducks* I have so often mentioned, and which are cast out with the *Water*, are generated in the *Lake* under the Mountain *Javornik*; when they first come out they swim well, but are stark blind, and have no *Feathers* on them, or but few, and therefore are easily caught; but in 14 Days time they get *Feathers*, and recover their Sight yet sooner, and afterwards fly away in Flocks. They are black, only white on the Forehead, their Bodies not big, resembling ordinary *Wild-Ducks*, and are of a good Taste, but too fat, having near as much Fat as Lean.

I killed some of them as soon as they had been cast out at *Sekadulze*; and, opening their Bodies, I found in them much *Sand*, and in some few small Fishes, in others green Stuff like Grass or Herbs, which was the more strange, because I never found any green Thing growing in any of our *subterraneous Grottoes* or *Lakes* in *Carniola*; I tried also to procure some of the Fish at the time of their being cast out, to open them, and see what they live upon; but notwithstanding all my Endeavour, I could not get any of them to satisfy my Curiosity withal.

Almost every Year, at a Hole in the Mountain called *Storfeg*, about half a German Mile from the Lake of *Zirchnitz*, near the Town of *Laas*, whenever there happen great Floods of Rain, this Sort of *Ducks* is cast out in great Abundance, by the Water gushing out with much Force. I conceive that this *Cavern Storfeg* is another Passage out of the same Lake under *Javornik*, that overflows and fills up our Lake of *Zirchnitz*; but, this being somewhat higher, it never runs out, unless the said *Lake* be more than ordinary swelled by the Violence of the Rains. The casting out of great Numbers of *Ducks* here is so common, that it is looked upon as no Rarity.

It may seem strange and hard to believe, that there should be such *subterraneous Lakes* and *Channels* as we may suppose; but, besides that without them it would be impossible to account for all these several Effects, which are most true, and which I myself have observed, there is a most notable Instance of the like Things found in the *subterraneous Cavern*, called the *Grotto Podpetschio*.

Fig. 3.

This *Grotto* is in *Carniola*, in the Parish of *Guetenfeld*, distant four German Miles from the City *Labac*; *a* is a Hole or Entrance into the rocky Mountain; *b* is a great *Cavern* in the Mountain, capable to hold above a hundred Horsemen; *ik* is a Channel big enough for a Man to pass by as far as the Lake *o*, out of which Lake the Inhabitants hereabouts draw all their Water, having none nearer, and fetch it with lighted Torches. Into this Lake *o* the Water runs with a great Stream by the Channel *l*, and out of this Lake it falls down a Precipice into a great *Cavern*, with so much Noise, that the Discharge of a Pistol would not be heard here. There is likewise another Channel *m*, which tends upwards obliquely, and leads to the great Lake *n*, whose Length and Breadth are hitherto undiscovered; I looked about it with many Lights, and could see nothing but Water; and, throwing Stones several Ways as far as I could, I heard them all fall in the Water: And I found the Depth of it near the Bank to be ten Cubits, and doubt not but it is much deeper in the Middle.

The

The Country People told me, that this Channel *l* affords always an equal Quantity of Water, or else is quite dry; and that sometimes it will cease to run in a Moment, and continue dry for some Weeks; and then on a sudden it will run again with great Force, so as the Noise thereof frequently frights the People as they come for Water.

Out of the Cave *b* there is another Channel *c*, which is divided into three others *d e f*. This Channel *f* tends obliquely downwards, 'till it comes to a running Water in *g*, from whence one may go on to *b*, where, looking thro' a little Hole, one may see another little Lake.

All the Channels I have mentioned are formed in a very hard Rock, and are smooth or polished, as if cut by Men's Hands. These may be seen by any one that will go with lighted Torches; and there are many such, in which I have not been.

If any one would carry a Boat to the Lake *n*, and would row upon it, I doubt not but he might find several curious Things. I believe this *subterraneous* Lake to be a German Mile long: For from this *Grotto Podpetschio*, at a Mile's Distance, there is a Village called *Kompale*, whose Inhabitants have no other Water than what they fetch out of a Hole in the Rock, going with lighted Torches, by a large Channel, to a great Lake under Ground. I measured with good Geometrical Instruments, such as Miners use, the Level of these two Lakes of *Podpetschio* and *Kompale*, and found them to be in one *Horizon*; and this I did twice, both when the Channel *l* at *Podpetschio* run, and when it did not run. When it began to run, I found, that the Lake *n* was two Cubits higher than it had been before; when it ceased to run, I came again on purpose to observe it, and found that then also the other Lake at *Kompale* was in the same Level; from whence it is most certain, that these two are only one continued *subterranean* Lake.

XX. The Lake of *Geneva*, which is one of the most pleasant Places of the World, lies like a *Croissant* of Water, one Extremity whereof is 18 Leagues distant from the other, and the Banks of which are gently raised to some Heights, then to Collines, at length to stupendious Mountains; which yet are not so linked to one another, but that they leave betwixt them Interstices of 15 or 20 Leagues Prospects, checkered by Meadows, Corn-Fields, Orchards, Vines, Forests of Fir-Trees, Snow lying on the Sides of the Rocks. All these Objects, which at a Distance are confounded, and seem to make but one, have near hand their several Beauties. That Point, where *Geneva* stands, is somewhat longer and more extended than the other. This *Croissant*, where 'tis largest, which is from *Morges* to *Thonon*, is about 5 good Leagues over.

The Water of this Lake is very good to drink, and so limpid also, that even in the rolling of the Waves, which sometimes go high enough, the Water is not troubled but along the Banks. And if one do attentively look down from the Castle of *Chilon*, or from any of the neighbouring Heights, into the Bottom of the Lake, he may see high Mountains under the Water. And the Water is so deep before *Veuvay*, that the sounding Line at the End of 400 *Fathoms* seems, because it will not stay, to touch upon something slippery

The Lake of
Geneva;
by ***

n. 86. p. 5043

slippery. 'Tis held to be 500 *Fathoms* deep before *Roole*; and 'tis affirm'd, that near this great Depth there may be seen a kind of Isle under Water.

The *Rhone* enters at one of the Points of the *Croissant* into the Lake, and issues out at the other; but with this Difference, that whereas he comes in dirty and miry, he ever goes out io pure and clear, that under the Bridge of *Geneva*, where the Water is deep 25 Feet in Summer, you may well discern the smallest Stones at the Bottom. And the same Water, which in this Place appears of a *Sapphyrine Blew* in the Shade of the Houses, appears altogether *Green*, nor is so transparent, when the Sun shines on it.

Having heard the Sentiments of the Curious of *Lausanne* and *Geneva*, and the Opinions of the most knowing Fishermen, that are there in great Number, and especially at *Coupet*, I believe with the latter; that although the *Rhone* entering into the Lake loseth its Violence, yet doth he still keep some sensible Motion in some Places, and every where observable; and that no *Trouts* are taken any where in this Lake but in this *Current* of the *Rhone*.

The Water of this Lake commonly begins to encrease about the End of *January*, or the Beginning of *February*, and continues to do so unto the 20th of *July*, and often unto the very Month of *August*; and then it insensibly decreaseth, so that the Water is less high in the Winter than Summer, by 12 or 15 Feet. About this Increase of the Water there are different Opinions; 'tis true, they all believe in general, that the principal Cause of the Increase of the Water is the melting of the Snow, and of the Mountainous Ice, that is in the Winter formed of the Waters of the Springs, and Torrents, which the Frost fixeth. This is so true, that, when there is much Snow in Winter, the Waters are very high the ensuing Summer: But when great Rains chance to fall in *January*, then the Snow, not yet being well harden'd, melteth on a sudden altogether: And, when this Melting is not so violent, all the Snow, that will melt, melts at the End of *May*, or the Beginning of *June*; so that, there remaining but the Stock of Ice for entertaining the Increase of the Water unto the Month of *August*, some have thence been induced to assign other Causes.

At the Issuing out of the Bars, that from *Geneva* on the Side of the Lake, are seen in the Water two or three huge Flints standing out of the Water, the chief of which they call *Niton*: And the Tradition is, that it formerly was an Altar consecrated to *Neptune*, there being also a Place cut out in the Middle, which they take to have been the Place for the Sacrifice. On this Flint 7 or 8 Persons can sit; and sometimes, when the Waters are very low, there are found about it Knives, and Needles, as thick as Bodkins of Tweezers, and much longer; both of Brass, well enough made, and esteemed for to have served for the Sacrifices.

This Lake in serene and calm Weather appears sometimes, and that even before Sun-rising, as if it were made of diverse Pieces differently coloured; part of it being browner than the rest; which seems to be caused by a Breath of Wind passing thorow the Water, coming either from the Bottom of the Lake, or from above; though others think this gentle Agitation

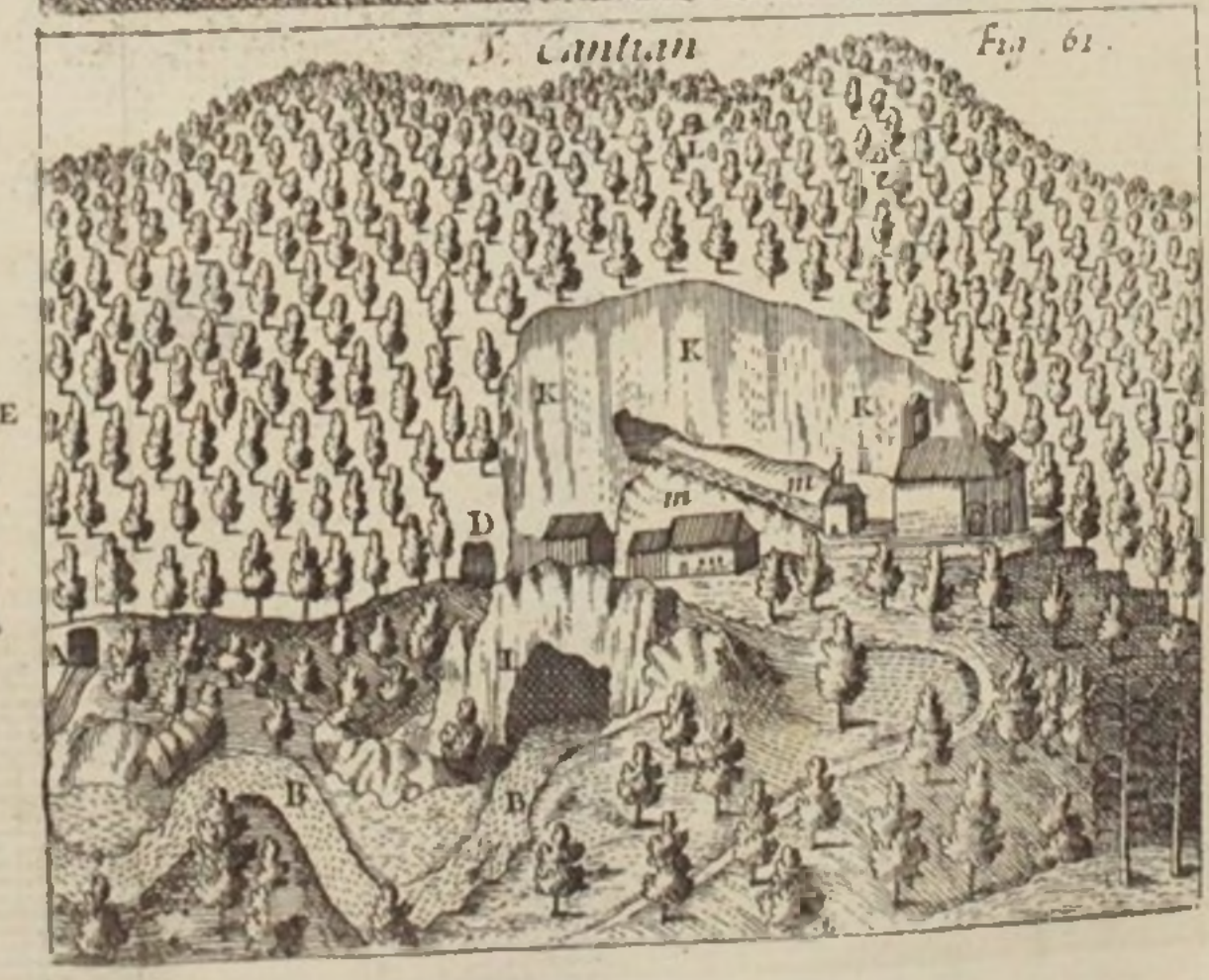
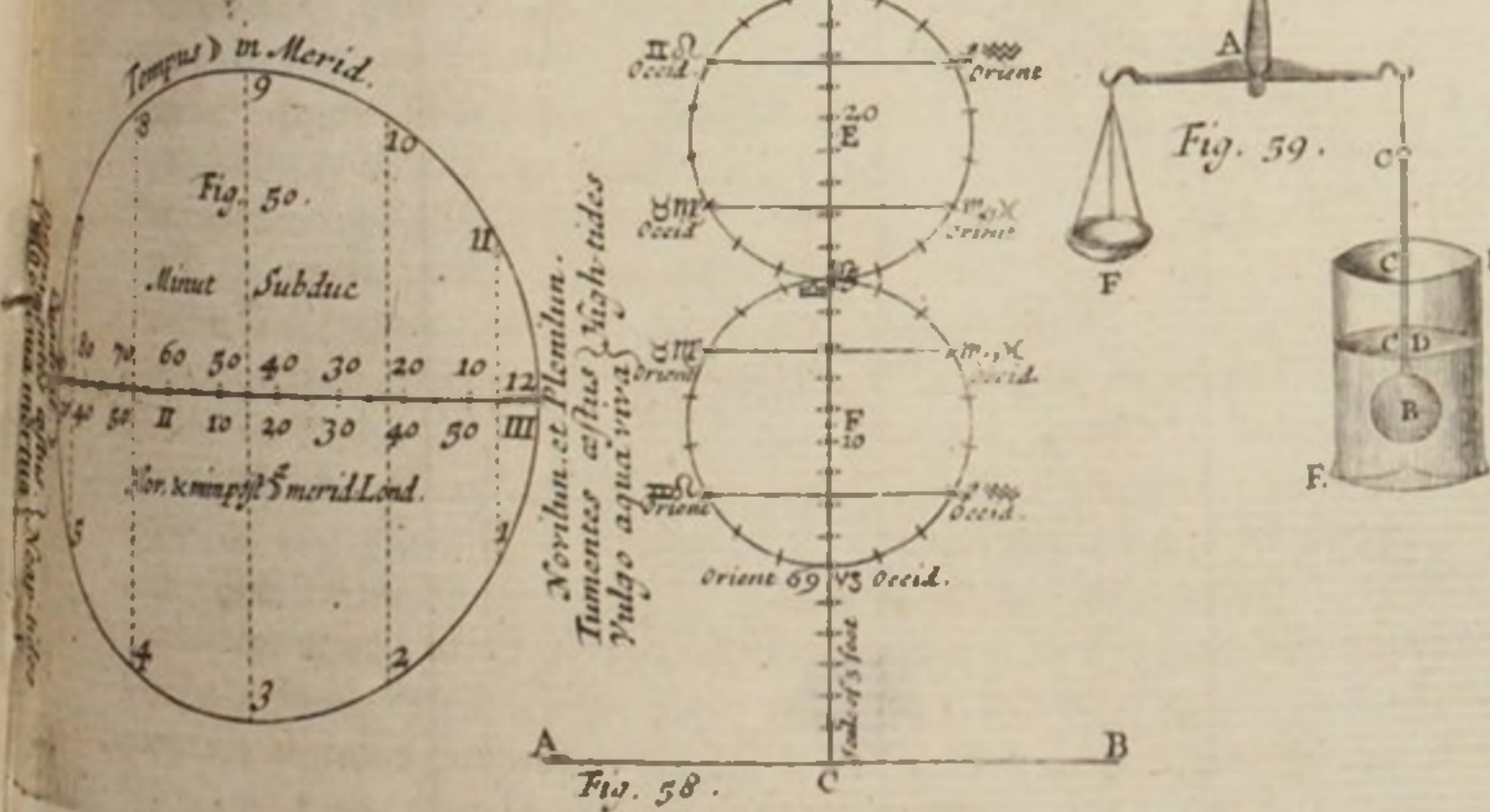
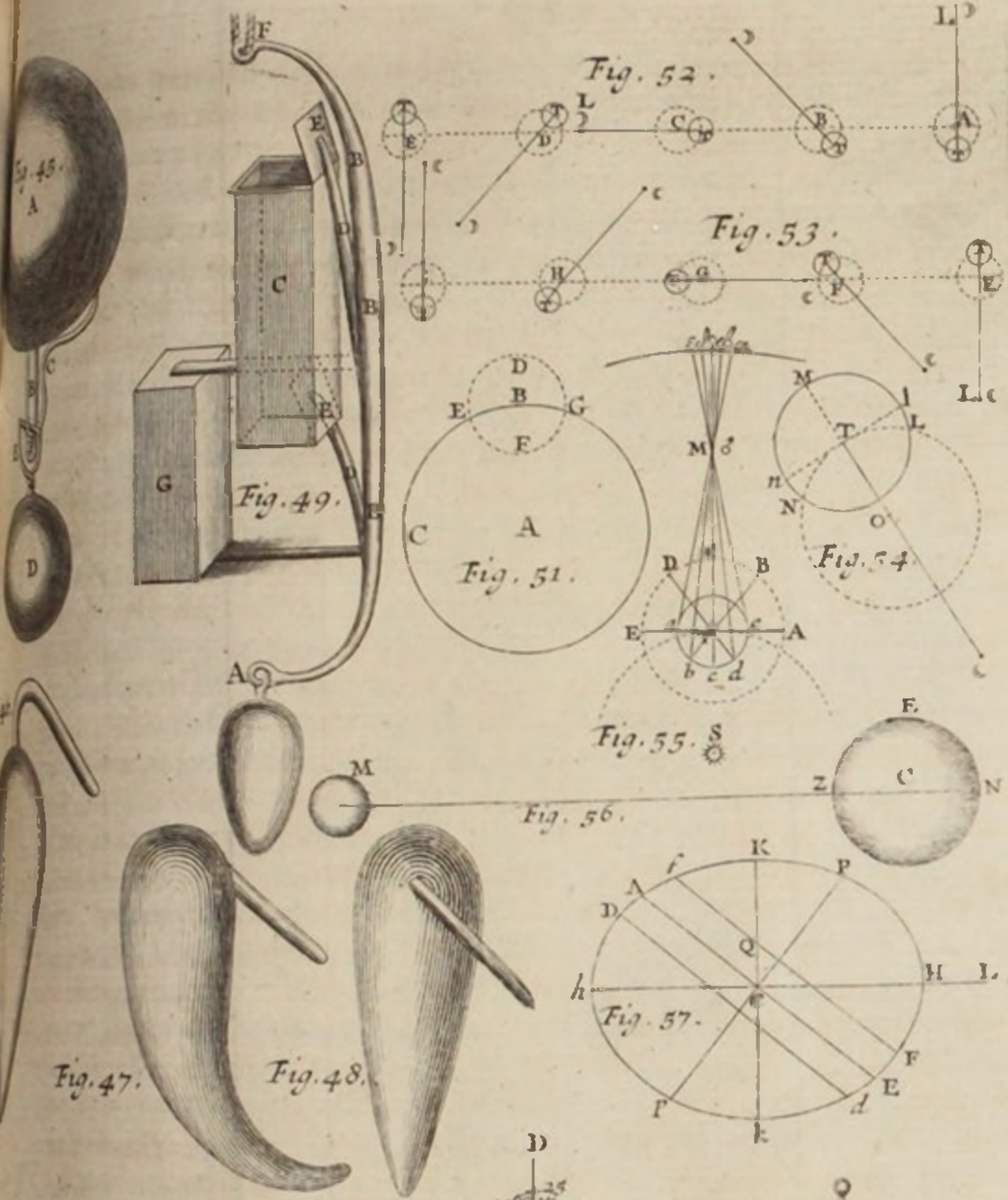
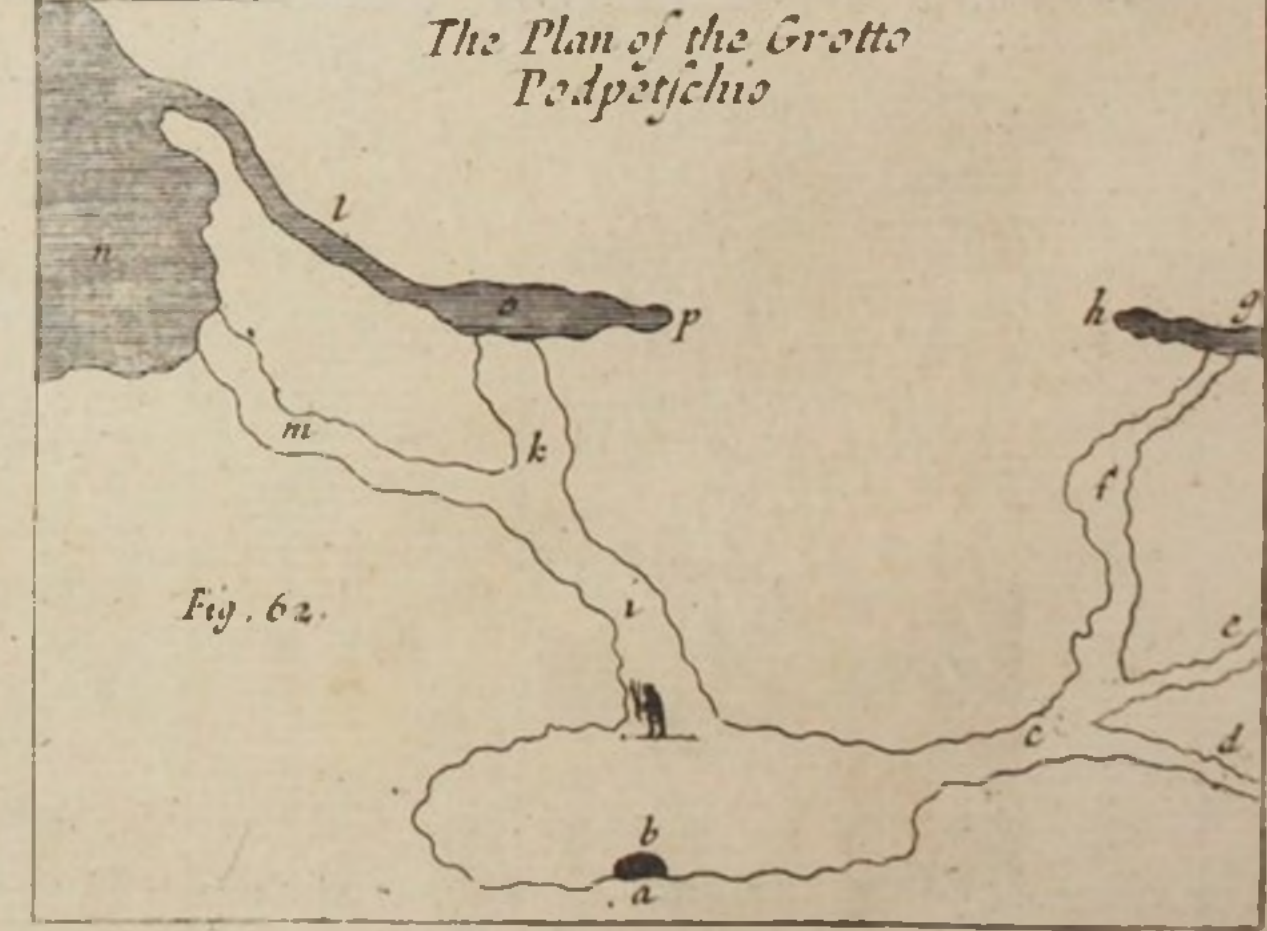
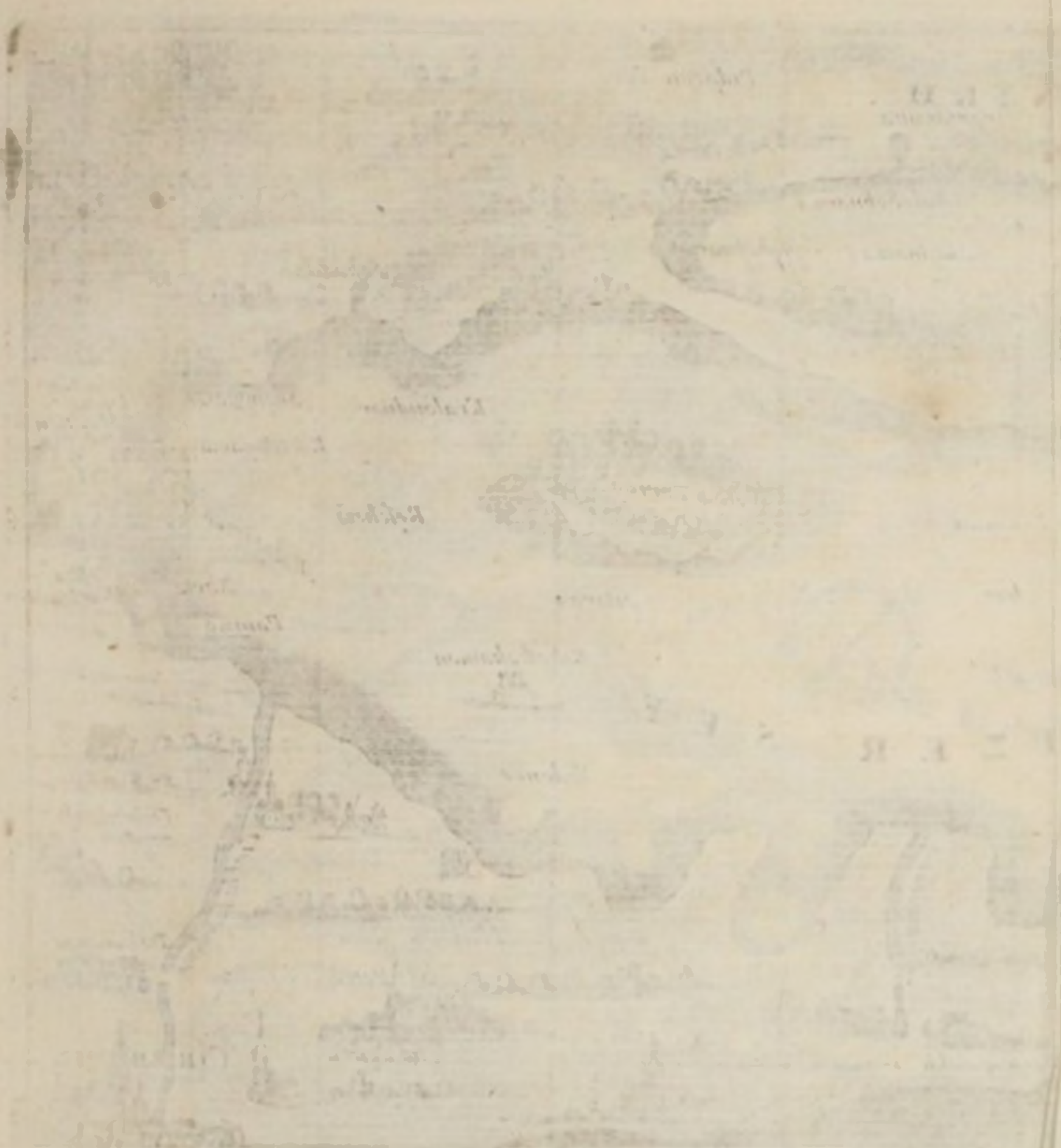


Plate 4.
Vol. 2.
Pag. 318.





The plan of the canal
at ...



[Faint, illegible handwritten text on the right page of the book, possibly a description or notes related to the maps.]

tation to proceed from some Springs that are at the Bottom, making the Water shiver above. But that Part of the Water, that is not moved, appears as even and smooth as a Looking-Glass, or like Water traced by a Ship. And, as for the Colours, they are, in my Opinion, an Effect of the neighbouring Mountains; the different Images of which, being confounded in the Water, make an Appearance of very pale Colours.

After that the *Rhone* is entered into the Lake, he retakes not his impetuous Course before a Quarter of a Mile's Distance from its coming forth again, that is, above *Geneva*. And the nearer he comes to that Town, the more his Bed becomes narrow, and consequently his Course more rapid. Yet this Rapidness hath been in our times once surmounted by Wind, and once by Water.

In the Winter of the Year 1645. there arose in the Morning, about nine o'Clock, so furious a Wind, that not only it uncovered the House, but also laid dry the Bed of the *Rhone* above the Bridge; so that many, in the View of all the Town, crossed quite over it (to the little Island) dry on Foot, and one of the Sons of M. *D'Aubigny* took up some Medals, which he found in his way. This Passage was free during an Hour's time, at the End of which the River retook its Course. At that Season the Water being very low, and a West-Wind to arrive at *Geneva*, being pressed by the high Mountains, that bring it upon the Town as by the Nose of a Pair of Bellows, it came to pass, that the Wind did violently bear upon the Water near the Bars, keeping suspended the Water that was beyond, and those Waters that were beneath running away downwards by a Declivity, and under the Shelter of the Houses. Whilst I was scrupling at this Relation, they brought me *Gallastus* his Commentary upon *Exodus*, printed 1560; where 'tis recorded, that the like Accident had fallen out at *Geneva*, at the time when that Minister lived there; a South-West Wind having made the *Rhone* to recoil into the Lake, and many People having thereupon passed over dry for an Hour's time.

Concerning the other Accident; you may remember that the River *Arve*, which is a kind of Torrent, falls into the *Rhone*, about 1000 Paces beneath *Geneva*. In the Month of *December*, in the Year 1652, the said *Arve* did so extraordinarily swell, that not only it over-run its Banks with Impetuosity, but also interrupted the Course of the *Rhone*, and forced it to re-enter into the Lake for the Space of 14 Hours.

This Lake doth very much abound with Fish, which have, as it were, cantoniz'd themselves, and divided the Lake amongst them. The Trouts are not to be found there, but, as hath been already mentioned, in the Current of the *Rhone*, the Carps have taken up their Quarters towards *Vevey*; the Pikes and *Pearches* have also their Habitations a-part: But some other Fish, that are but Passengers, not living constantly in the Lake, spread themselves almost every where indifferently. The great Trouts pass out of the Lake for 4 Months of the Summer, and are taken in Autumn when they are returning thither. The Fishing is farmed out at *Geneva*; and there are Conservatories, where many of these big Trouts are kept; among
which.

which there are some that weigh Fifty Pounds. Sometimes they catch *Pikes* there of 80 Pounds Weight; and a Pound Weight at *Geneva* you know to be 18 Ounces.

In the Months of *July* and *August* they fish for the Fry of *Pearches*, at a Time when they are no bigger than the smallest Taggs. These are a very delicious Dish, there called *Mille Cantons*.

The Lake A-
vernus; By
Dr. Benedic-
Robinson,
n. 17. p.
1038.

XXI. I have seen many Water-Fowl feeding upon and flying over the *Lake Avernus*, reported by many of our own, as well as foreign Writers, to kill Birds at a Distance. I observed several Land-Fowl also to fly over that Lake, without the least Disturbance, from all Sides and Ends. But peradventure the poisonous Steams (if there are any peculiar to that Lake) sometimes vanish and return again; or else may be alter'd by new *Effluvijs* intermingled with them.

The Lake of
Mexico; By
.....
n. 130. p. 758

XXII. The Lake of *Mexico* hath this of extraordinary, and perhaps peculiar, that Part of its Water is sweet, and the other Part salt; which makes it believed to be derived from two Sources, whereof the one holds sweet Water, the other comes from some Mineral and *Saline* Earth found in the Hills through which this *Water* passeth, and is impregnated with the Salt which is dissolved in its Course: Or, if it have no peculiar Source, it must be, that that, which makes Part of the Lake salt, is the Bottom of the *Earth* under the *Water*, being in that Place full of Salt; which is confirmed by Experience, much Salt being made of it every Day, of which that City drives a great Trade with remote Parts, even the *Philippines* themselves, whither it is transported in considerable Quantities. That Part of the Lake, which is sweet, is still and quiet; the salt Part is agitated and moved according as the Winds blow. The sweet Water is very good and wholesome, breeding Plenty of little Fishes; that, which is moved, is bitter Salt, breeding no Fish at all. The sweet Water is higher than the other and falls into it. The *Water* of the salt Part is 7 Leagues long, and as many Leagues broad, and hath above 22 Leagues in Compass; that of the sweet Water is near as big; and the whole Lake contains about 50 Leagues in Compass.

An Inland
Sea near
Dantzick,
yielding in
Summer a
poisonous
Substance;
By Mr.
Kirkby,
n. 3. p. 4095

XXIII. Near a small Village call'd *Tuckum*, $2\frac{1}{2}$ German Miles distant from *Dantzick* Westward, there is an *Inland-Sea* (made by the meeting of 3 Rivulets, some Springs from the adjoining Hillocks, and the descending Rain and Snow-Water) of about half a German Mile long, and an eighth Part of such a Mile broad. The Soil of the Ground round about seems to be Sand mixed with Clay. Its Shore generally sandy, as is its Bottom also; its Depth, where deepest, four Fathoms; but for the most Part but one, or one Fathom and a half. 'Tis stored with wholesome and delicate Fish, as *Pearch*, *Roach*, *Eels*, &c. and famed for a small Fish much esteemed here, and not much unlike a *Pearch*, only not so party-coloured, and having a larger Head proportionable to its Body, called the *Coal-pearch*. The *Water* is sweet and wholesome; but only in the three Summer Months, *June*, *July*, and *August*,

August, it becomes every Year, during the dry Weather, Green in the Middle with an *bairy Efflorescence*, which *green Substance*, being by some violent Wind forced ashore, and with the Water drunk by any Cattle, Dog, or Poultry, causeth certain and sudden Death; whereas at the same Time, that a knowing and ingenious Person (who first acquainted me with it,) saw three Dogs killed with it, the Horses that were ridden into the *Water* beyond the Place, where this *green Substance* floated, drunk without any hurt; and that also, during the same Season, the *Water* in the Streams, that flow from it, are *wholesome*.

XXIV. 1. There is a little Lake in *Straberrick* on the Lord *Lovel's* Lands, which never freezes all over (even in the most vehement Frosts) before *February*; but one Night's Frost thereafter will freeze it all over, and two Nights then will make the Ice of a very considerable Thickness. I have heard of two other Lakes, one of which, is on Lands belonging to myself, called *Loch Monar*, of a pretty Largeness, which steddily keeps the same Method. There is another little Lake in *Straglasb* at *Glencanich* on Lands belonging to one *Chiffolm*, the Lake lies in a Bottom 'twixt the Tops of a very high Hill, so that the Bottom itself is very high. This Lake never wants Ice on it in the Middle, even in the hottest Summer, though it thaws near the Edges: And this Ice is found on it, though the Sun, by the Reason of the Reflection from the Hills, in that Country is very hot; and Lakes lying as high in the Neighbourhood have no such Phenomenon. 'Tis observable also, that about the Borders of this Lake the Grass keeps a continual *Verdure*, as if it were in a constant Spring, and feeds and fattens Beasts more in a Week than any other Grass doth in a Fortnight.

Our famous Lake *Ness* never freezes; but, on the contrary, in the violentest Frosts, the greater Clouds of Steams do arise from it. And I remember, that at two several Times, I being at *Inverness*, walking in the Evenings along the Bridge over the River *Ness*, a Mist of those Steams coming from the Lake and falling down to us over the River (for there was no Mist in any Place thereabout but on this Lake and River only) our Hair became all white, like the Whiteness of a Hoar-Frost, but it was soft and warm; and this was in the midst of Summer and in warm Evenings. Doctor *George Mackenzy* (who lives at *Inverness*) told me, that he observes *Rosemary*, though uncovered, to continue in the Gardens about that Lake's Side, notwithstanding the last Winter's long and violent Frosts; whereas a far less violent Winter ordinary kills all the *Rosemary* which is in Gardens that lie in warmer Places, and at the Sea-side: And though I live near it, and in a better Soil and warmer Situation, yet any *Winter*, more than ordinary cold, kills my *Rosemary*, though covered over with *Straw* and *Litter*. This he attributes (and I think on good Ground) to the Warmth occasioned by those *Steams* that frequently arise from that *Lake*.

In *Glevely*, at a Place called *Achigniglium*, there is a little Rivulet, which so turns *Holly* into a *greenish Stone*, that they ordinarily make Moulds of it for casting of Balls for Fuzees, and Tinkers that work in Brass make both their

Some extraordinary
Lakes in
Scotland;
By Sir Geo.
Mackenzy.
n. 114. p. 307

Moulds and melting Pots of it, and *Women* their round Wharls for spinning. May it not be, that by the long Infusion in *Water*, descending from Hills, which perhaps abound in *Marle*, capable to be dissolved into small Particles by the constant washing of the *Water*; may it not be, I say, that these little Particles do intrude into the cleansed Pores of the *Holly*, and so make up that soft *Stone*? And any thing ligneous remaining of the very hard Timber, being all incrustated with this *Marle*, may it not thereby be guarded from the Action of the Fire?

By Mr. Ja.
Fraser,
n. 254. p. 230

2. The Lake *Nefs*, according to Highland Tradition and Bards, has its Name from one *Nysus* an *Irish Hero*, that fix'd a Colony in *Strathbarig*, with *Dornadillo* his Wife. The Promontory, upon which he had his Residence, is to this Day called *Doun Dearnill*; and he being the first that ever offered to set out Boat or Barges upon this Lake, it is after him called *Loch-Nefs*. It is 24 Miles in Length, and in most Places two in Breadth. One *George Scot*, tried 500 Fathoms, and Capt. *Orton* a whole Barrel of Plum-line, but found no *Bottom*. The Banks of this Lake ascend high and mountainous, with *Woods*. The Lake never freezes, which is imputed to the many great Springs and Fountains in it; the only Fish in it is *Salmon*. This Lake *Nefs* discharges itself in a River of the same Name, six Miles in Length, which runs slowly, yet never freezes, but still smoaks with Frost: And from this Smoak is spread a Fog over all the adjacent Country.

On the Side of *Loch-Nefs* stands the famous Castle of *Urquhart* upon a Rock; the great Ditch round it was for the most Part cut out of the Rock, and received the *Water* of the Lake. This Castle consisted of seven great Towers, and 'tis said was built by the *Cathines*, but had its Overthrow by King *Edward* the first of *England*; and nothing remains now but one Tower to the East.

To the *Westward* of this Castle about four Miles, upon the Side of *Loch-Nefs*, stands that great Mountain *Meal suor conny*, of a round, neat, high Shape; it will be two Miles of perpendicular Height from the Lake. Upon the very Top of this Hill there is a Lake of cold fresh *Water*, about 50 Fathoms in Length and six Broad, no Course or Stream running to it or from it. I plum'd with 100 Fathom of small Line but could find no *Bottom*. It is always equally full, and never freezes.

About 23 Miles West from the End of the River of *Nefs*, there is a Forest called *Affaruck*, in which there is a Mountain called *Glenin-tea*; and on the North-side, under the Shade of a great sloping Rock, stands a Lake of fresh *Water*, called *Lochan-Wyn*, or *Green-Lake*, 18 Foot in Diameter, about a Fathom deep. This Lake is always covered with Ice, Summer and Winter.

Lough
Neagh in
Ireland; by
Mr. Will.
Molyneux.
n. 158 p. 552

XXX. i. It is generally agreed by all the Inhabitants thereabouts that *Lough-Neagh* has a petrifying Quality: But that no Wood will petrify in it except *Holly*. It is also asserted with some Probability, that the Earth about the *Lough* has this petrifying Quality: For I am certainly informed, that a Gentleman of the County about this *Lough*, a little before the Rebellion, cut down some Timber for building, and amongst others cut down a large

a large *Holly* Tree, but being diverted by the Rebellion from building, his Timber lay on the Ground in the Place where it was fell'd, upon the Banks of the *Lough*, all the miserable Time of the War, 'till at last the Kingdom being settled, the Gentleman went to look for his Timber, and found the other Timber overgrown with Moss, and the *Holly* petrified, tho' the Water of the *Lough* had never reached it.

And perhaps the *Holly* itself, that grows upon the Banks of this *Lough*, may be more apt to be petrified, than the same Wood growing other where, and brought thither, and put into the *Lough*; for certainly if the Ground has this Quality, this is very likely to follow.

That what we call *Lough Neagh Stone*, was once *Wood*, is most probable on these Accounts. *First*, It will not stir with *Acids*. 2. It will burn and flame, and the Smoak of it smells like the Smoak of Wood. 3. When burnt it betrays the very Grain of Wood with the other Vessels belonging to *Vegetables*. 4. I have many of them of various Degrees of *Petrification*, some that have clearly lost the Colour of Wood, and are become perfectly black, and very hard; others, that are not so black nor hard; but one more especially was sent me about a Year ago, which is a Parallelopiped of about 4 Inches long, and an Inch thick; cut, I suppose, whilst Wood, in that Shape purposely, whose outward Coat is very black, and smooth; but this is merely superficial, for being cleft longwise through the Middle, (which it suffered far more easily than that which is more thoroughly petrified) I there discovered the whole Body perfectly of the Colour and Grain of *Holly*, for I can scrape it with my Nail; but what was most surprizing in it was, the Discovery of the *Pith*, as plainly and as perfectly distinct in Colour and Texture from the rest (but it also was petrified) as it could possibly have been seen in the natural Wood.

I never have seen nor could hear of any Part of the Stone in the least resembling Iron.

I have used some Endeavours to procure a Piece of this *Lough Neagh Stone* to which the Wood was yet fastened, but I never could attain it, tho' some assert they have seen Pieces two or three Foot long, with about eight or ten Inches of *Stone*, and the rest Wood. Tho' I am apt to believe this may be stretching the Matter too far, for I conceive that that Humour that petrifies one Part, when it begins to operate, insinuates itself soon throughout the whole Body.

'Tis observed that this petrifying Quality is not equally diffused throughout the whole *Lough* (which is about 15 or 16 Miles long, and 8 or 9 Miles broad in all Places) but is most strong about that Part where the *Black Water* (a River so called) empties itself into this *Lough*, that is about the South West Corner; as likewise it is said to be more strange about the Edges of the *Lough*, than farther into the *Water*.

I have found upon Trial, that this Stone is not *Magnetical*, for it will not n. 156. p. 810 stir a *Needle*, or *Steel-filings*, neither will it apply to the *Magnet*, in *Powder* or *Calcined*.

T t ?

Upon

Upon farther Trial I find, that though it will not apply to the *Magnet Crude*, yet being *Calcined* it applies most briskly: The occasion of my former Error being, that I did not *Calcine* it long enough.

By Mr. Edward Smith,
n. 174. p.
1108.

2. No Experiment, or Observation yet made, (that I can hear of) can prove that this *Lough* has really the Quality of petrifying Wood; or that the *Water* does any way help or promote the Petrification. On the contrary, a neighbouring Gentleman of good Credit and Worth, about 19 Years ago, stuck two *Holly Stakes* (a *Wood* which all agree will soonest petrify in this *Lough*) in two several Places of the *Lough*, near that Place where the upper Band enters into it; and that Part of the Stake, which for so long Time has been washed by the *Water*, remains there without any Alteration, or the least Advance towards Petrification. It is reported indeed that the *Water* has this Virtue, especially about those Places, where the *Black Water* discharges itself into the Lake: But it seems evident from the very Nature of liquid Bodies, that any Virtue received in one Part must necessarily be diffused through the whole, at least in some Degree; and therefore there is good Reason to believe, that the *Water* is wholly destitute of this petrifying Quality.

But that this Virtue is certainly, if not only, in the Ground or Soil, I judge for these Reasons; that there are many *Stones* turned up daily, especially at their breaking up new Ground, which we cannot in any Probability think were brought thither: They are often found at two Miles Distance from the *Lough*, seldom farther, in great Numbers, and very deep in the Ground; and a Gentleman (on whose Credit I received the Information) saw a Stump of a *Tree* digged out of the *Ground* at a small Distance from the *Lough*, which by handling of it he found to be petrify'd: He assured me the Roots and all were Stone, and altogether like those *Stones* that are ordinarily found, and go by the Name of *Lough-Neagh Stones*. This Gentleman was of Opinion these were *Lapides sui generis*, 'till this Observation convinced him. And that these *Stones* were once Wood, is, I think, very certain, for they shew the plain *Vestigia* of Wood; they likewise *burn, cleave*; *Filings* of this *Stone* thrown into the Fire emit a *fragrant Smell*; and they cut kindly with a Knife, though not so easily as other Wood.

That not only *Holly*, but also other *Wood* has been petrified about this *Lough*, and in the *Soil* adjacent, I have sufficient Grounds to conjecture on this Account; because some Fishermen, being Tenants of a Gentleman from whom I had this Relation, told him, they had found buried in the *Mud* of this *Lough* great *Trees*, with all their *Roots* and *Branches* petrified; and some of that Bigness, that they believed they could scarcely be drawn by a Team of Oxen. They broke off several Branches as big as a Man's Leg, and many bigger, but could not move the great Trunk. By this Bulk of it, I guess it to be *Oak*, no *Trees* in that Country, these excepted, growing to that prodigious Bigness; at least 'tis certain that *Holly* never grows to that Bigness.

Two Gentlemen of the *North* told me, that they themselves had seen the same Body partly *Wood* and partly *Stone*: But the only Reason for thinking so, being the Diversity of Colours, which might well enough proceed from

from several Degrees of Petrification, we may properly think them deceived; for they made no *Experiments* on that Part which they reputed *Wood*.

The *Bark* is never found petrified, as I am informed by a diligent Inquirer, but often something rotten about the Stone answerable to the *Bark*.

XXVI. A Gentleman tells me, that he hath met with a Place in *England*, where, tho' there be no *petrifying Spring*, (for that I particularly asked) *Wood* is turned into *Stone* in the sandy Earth itself, after a better Manner than by any *Water* I have yet seen. I find it to be a very odd Substance, wonderfully hard and fixed. Here is a certain Stone, that is thought to be *petrify'd Bone*, being in Shape like a *Bone*, with the *Marrow* taken out; but with a fit *Menstruum*, I found that I could easily dissolve it, like other soft Stones. And possibly it may prove as fit as *Osteocola*, for the same medicinal Uses.

Petrification, by Mr. Rob. Boyle, n. 6. p. 107.

XXVII. From the *But* of a growing Elm near *Wadley* (a Mile from *Ferrington* in *Berks*) one of the spreading Claws having been formerly cut off with an *Axe*, that Part of the *But* from whence the same was severed, being about $1\frac{1}{2}$ Foot above Ground, and inward within the Trunk of the Tree, hath contracted a petrify'd Crust, about the Thickness of a Shilling all over the *woody Part* within the *Bark*; the Marks of the *Axe* also remaining very conspicuous, with this petrify'd Crust upon it.

By Mr. Ph. Packer, n. 19. p. 329.

XXVIII. We have some Waters in *Scotland* that *petrify*. Upon the North Side of the *Firth* of *Forth*, some 8 Miles from the City, there is a Cove close upon the Sea, the Roof of which is covered with a *Stalagmites* a Foot deep, like the Fringe of a Bed; the upper Coat is of a Sea-colour, the Juice is as white as the *Sal Prunelle*; the Water which droppeth from it, if it touch the Skin, maketh it smart. Near to this same Cove, is a Piece of an hollow Rock, which within, from the Top to the Bottom, is full of so many Orders of Columns, resembling the Pipes of a Church Organ, and some of different Figures, I broke a small one and found it somewhat hollow in the Middle. All the Ground in this Place is full of *Lime-stone*.

Petrifying Waters in Scotland, by Sir Rob. Sibbald, n. 222. p. 321.

XXIX. As I travelled over *Stanemore* in *Yorkshire*, I observed the River *Greata*, (a River about half as big as *Charwel* at *Oxford*) run under Ground for about a Mile, so that we passed over it dry Foot. The Passage under Ground is but narrow; so that in Winter when the Streams are high, it keeps the Channel above Ground.

The River Greata running under Ground, by Mr. Hugh Todd, n. 163. p. 729.

XXX. At some Leagues Distance from *Gottenburgh* in *Sweden*, that River rushes down from a prodigious high *Precipice* into a deep *Pit* with a terrible Noise, and such a mighty Force, that the *Masts* (which are floated down this River to *Gottenburgh*) usually turn topsy-turvy in their Fall, and do often fly to Pieces when dashed against the Surface of the *Water* in the *Pit*. This occurs if the *Mast* falls side-ways upon the *Water*: But if they fall end ways, they dive so far under Water, that (according to my Information, they rise not again.

A Contract in Gottenburgh River by Mr. Gourdon, n. 266. p. 691.

again for $\frac{1}{2}$ Hour; others $\frac{1}{2}$ Hour; several $\frac{1}{4}$ of an Hour; and some a whole Hour and upwards. The *Lake* or *Pit* into which they fall has been often sounded with a Line of some hundred Fathoms long, but never could they find any Ground.

River Water
recovered af-
ter stinking
by . . .
n. 127 p. 652

XXXI. Tho' it be commonly reputed peculiar to the *Thames Water* alone, upon stinking, to be recoverable or portable again; I can affirm, upon my own Knowledge, that Water taken a-board at *New-London* in *New-England*, tho' in 8 Days time it stunk intolerably, yet when we came to *Virginia*, it recovered so perfectly, that I made no scruple to drink of it in Harbour, even when we had fresh Water newly brought from Shore; nor could I easily perceive it had any Relicts of its late Corruption.

Inundations
in Gascoyne,
by M. Ph.
Col. n. 1. p. 9.

XXXII. 1. In the Beginning of *July* 1678, after some gentle rainy Days, which had not swelled the Waters of the *Garonne* more than usual, one Night this River swelled all at once so mightily, that all the Bridges and Mills above *Toulouse* were carried away by it. In the *Plains* which were below this Town, the Inhabitants who had built in Places which by long Experience they had found safe enough from any former Inundations, were by this surpriz'd, some were drowned, together with their Cattle, others had not saved themselves but by climbing up Trees, and getting to the Tops of Houses; and some others who were looking after their Cattle in the Field, warned by the Noise which this horrible and furious Torrent of Water (rowling towards them with a Swiftness like that of the Sea) in *Bretaigne* he means, made at a Distance could not escape without being overtaken, though they fled with much Precipitation: This nevertheless did not last many Hours with this Violence.

At the same time exactly, the two Rivers of *Adour* and *Cave*, which fall from the *Pyrenean Hills*, as well as the *Garonne*, and some other little Rivers of *Gascoyne*, which have their Source in the *Plain*, as the *Gimone*, the *Save*, and the *Rat*, overflowed after the same Manner, and caused the same Devastations. But this Accident happened not at all to the *Aude*, the *Ariege*, or the *Arise*, which come from the Mountains of *Foix*, only that they had more of the same than those of the *Conserunt*, the *Comminge*, and the *Bigorre*.

M. *Martel*, by the Order of M. *Foucault*, hath searched after the Cause of this *Deluge*, being assured that it must have had one very extraordinary. For all who had seen the Circumstances agreed, that it had rained indeed, but that the Rain was neither so great, nor lasted so long, as to swell the Rivers to that Excess, or to melt the Snows off the Mountains.

But the *Nature* of these Waters, and the Manner of their flowing from the Mountains, confirmed him perfectly in his Sentiments. For, 1. The Inhabitants of the *Lower Pyreneans* observed, that the Water flowed with Violence from the Entrails of the Mountains, about which there were opened several Channels, which forming so many furious Torrents, tore up the Trees, the Earth, and great Rocks, in such narrow Places where they found

not

not a Passage large enough. The Water also which spouted from all the Sides of the Mountain in innumerable Jets, which lasted all the Time of the greatest overflowing, had the Taste of the Minerals.

2. In some of the Passages, the Waters were stinking, as when one stirs the Mud at the Bottom of the mineral Water, in such Sort, that the Cattle refused to drink of it, which was more particularly taken notice of at *Lombex*, in the overflowing of the *Save* (which is one of the Rivers) where the Horses were eight Hours thirsty before they would endure to drink it.

3. The Bishop of *Lombex* having a Desire to cleanse his Gardens, which the *Save* passing thorough by many Channels by this overflowing, had filled with Sand and Mud; those which entred them felt an Itching, like to that which one feels when one bathes in *Salt Water*, or washes one's self with some strong *Lixivial*. This *Itching* could not be produced by either *Rain* or *Snow Water*, but by some mineral Juice, either *Vitriolick* or *Aluminous*, which the Waters had dissolved in the Bowels of the Mountains, and had carried along with it in passing through those numerous Crannies.

For these Reasons *M. Martel* believes the true Cause of this overflowing to be nothing else but *subterraneous Waters*. And to explain the Means of this *Irruption*, he supposes that there is in the Earth a great Number of *Basins*, *Cavities*, or great *Receptacles* of a vast Extent full of Water, from which by diverse Issues into lower Passages there gets and runs out Water enough to furnish that which runs above the Earth, during the Seasons that it rains little or nothing.

One cannot well doubt of the Truth of this Supposition, if he considers,
 1. That in *Mines* as well as in *Pits*, the more one digs, the more abundance of *Water* is met with. 2. That there are *Rivers* that the *Earth* swallows, as that of *Guadalquivir* in *Spain*, and others that gush out of it complete *Rivers*.
 3. That there are *Gulphs* in diverse Parts of the Sea. 4. That there are *Lakes* without *Bottoms*, consonant to what *P. Kircher* remarks in his *Mundus subterraneus*, which diminish not at all, and yet receive little or nothing of *Water* from above. Such as are in the same *Pyrenean Mountains* in the *Lake* of *Berwale* of *Barboicu*, and *St. Pé*. 5. And to conclude, That there are found in *Caves* vast *subterraneous Lakes*; as amongst others, that in a *Cave* near *Grenoble*, of which *Francis the First* had the Curiosity to desire to know the *Extent*, having caused a *Boat* to be made for this Purpose. Hence we must conclude, that the *inner Parts* of the *Earth* are like a *Sponge* dipped in *Water*, and soaked on every Side; or like our *Body* filled with differing *Vessels* which are the *Canals*, through which the *Blood* is communicated to the whole *Body*.

This being so, 'tis not at all difficult to understand how the *Earth* thus constituted may suffer, in Process of Time, great Changes within its Bowels, as well as on its Superficies, where the *Parts* of *Mountains* and vastly great *Rocks* separating and tumbling down, crush sometimes whole *Towns*, as it happened in the Year 1618, to the *Town* of *Pleurs* in the *Valtole*, by the Fall of a *Rock* which hung over that *Town*. This Matter is more easily to be done in the Bowels of the *Earth*, because the *Waters* or *subterraneous Rivers* do soak,
 and

and by degrees undermining the Parts of the *Earth*, which uphold the heaviest *Mountains*; whence it must necessarily follow, that these same *Mountains* must sink down in Proportion to the *Mass* they have lost. And 'tis certain that somewhat like this happened in these *Mountains*, for the People which inhabited those Parts, have seen the *Earth* cleft in diverse Places, and have observed also, that in some Places there have happen'd *Foundering*s of the *Earth* for a very considerable Extent, one Part of the *Mountain* being *separated*, sunk down, which appeared by the profound *Clefts* many Feet deep, but of little Breadth. So this *Mass* of the *Mountain* in its settling all at once upon the *Water* of the *Gulphs* or *subterraneous Lakes*, which are under the highest *Pyrenean Mounts*, in all the Extent they take up from *Le Foix*, even to *Bern*, do force the *Water* to gush out altogether with great Violence to the same Quantity with the Bulk of that Part of the *Mountain* which is settled in the *subterraneous Lakes*, which is the Cause of this prodigious overflowing.

But that which will not suffer me to doubt at all but that there was some such *subterraneous* tumbling down, is this, that three *Months* after this furious *Inundation*, that is to say, about the end of *September*, there happened a second *overflowing* in some Places near to those where the first happened, which made also great Spoil, particularly that which came from the River of *Ariege*. And 'twas then remarkable, that a Fountain that runs from a Rock upon the *Lot*, near the *Cabors*, considerable for the Abundance of its *Water* which turns three Mills at its very Source, became all red, which was never seen before in the Memory of Man.

Some Effects
of Vitriolate
Waters; by
Mr. J. Beau-
mont, Ph.
Cell. n. 2. p. 6.

2. One *William Dally*, an able Miner, being employed at *Weck* in *Glocestershire*, about two Miles from *Kenysham*, to renew an *old Work* which was about six *Fathom* deep, and was more than half full of *Water*, he drew what he could out with a *Bucket*, and then he went down into the *Mine*, to clear out the Remainder. Having stood in the *Water* some Days, his Legs began to itch extremely, and swelled very much, and at length broke out into Sores. I enquired of him how the *Ore* lay in its *Mine*, and he told me the Vein of *Ore* grew in the Middle of a Vein of *Sulphur* (as he called it) that is, *Marchasites*, which was about a *Yard* wide; from this I easily gathered, that the *Waters* in the *Mine* having stood a long Time on that large Bed of *Marchasites*, was strongly impregnated with the *Vitriolate Salts*, which abound in them, and was the Cause of the *itching* and *swelling* of his Legs.

An Inunda-
tion in Ire-
land, by Dr.
Hook, Ph.
Coll. n. p. 1.

XXXIII. *June* 26th, 1680. An *Inundation* happened not far from *Londonderry* in *Ireland*, more monstrous than that in *Gascoygne*. 'Tis suspected that both proceeded from some extraordinary Change in the *subterraneous Caverns* of those Hills from whence the *Water* gushed, very few *Mountains* being without them.

Inundations
in Yorkshire
by Mr. R.P.
n. 245. p. 382

XXXIV. 1. The *Inhabitants* of *Kettlewell* and *Starbotten*, in *Craven*, in the County of *York*, suffered a very great Loss in *June* 1686, by a sudden *Overflow* of *Water*. The Towns are situate under a great Hill on the East and West; the Country is very *mountainous* and *rocky*. The Descent of *Rain* was

was

was after a Thunder-clap, for about the Continuance of an Hour and half with extraordinary Violence, and by several Eye-witnesses the *Rock* on the East-side open'd visibly, and Water they beheld thence into the *Air* the Height of an ordinary Church-steeple, so that the *Current* of *Water* came down the Hill into the respective Towns, as in one entire Body, and with a *Breast* as if it would have drowned the whole Town, several Houses were quite demolished, and not a Stone left; others gravelled to the Chamber-Windows; some Inhabitants driven until this Day from their Habitations, the *Current* of the *Water* running thro' their Houses; mighty Rocks descended from the *Mountains* into the *Valley*, and there lay unmoveable; many fair Meadows covered with Sand and Stones, that the Worth of the Soil will not regain the same; Household-goods taken away into the great River of *W'barfe*, and so lost, besides many quick Goods. The Loss reputed to be many thousand Pounds; many Families quite ruined, others in Part only.

There have been two other Floods since the first, tho' not so great and dangerous. The *Becks* or *Currents* of *Water* which run thro' these Towns, were so gravelled up by the first Flood, that the Passage is much altered, and cannot be regain'd, though there have been many Hundreds of Men set to do it.

2. *March* 22d 169^t, at half an Hour after 12 o'Clock, being calm, but a little rainy Weather, the River which passeth by the plain Ground of *Noordwyck*, did in the Space of a quarter of an Hour swell to that Height, that the *Sugar-mill*, the *Sugar-work*, and almost all the said Ground was thereby ruined, the most Part of the *Sugar-Canes* being rooted or torn out of the Ground by the Violence of the *Torrent*. We cannot imagine whence so sudden a Swelling of this River has been caused, while the *Rain* not being very hard, could not be of that Effect; for, in such a Case, it should have continued longer; for, about 12 o'Clock, when the Company's Servants assembled for their Dinner, the Water of the *River* was at its ordinary Height, and before they had half dined all the Country was overflowed by the Water, *viz.* one Foot higher than two Years ago, by Reason of the *Hurricane*, when we had as violent a Storm as ever we heard of. And at one o'Clock all the extraordinary Water was gone, and the River again at its ordinary Height. There has been no *Earthquake* that could cause it, neither was there any such Thing in other Rivers.

In *Mauritius*
island; *By*
M. Roel of
Diodati; n.
241. p. 268.

XXXV. In Order to compare the Quantity of *Rain* with the Quantity of *Water* running away in *Springs* and *Rivers*, it is necessary to measure these two Sorts of *Water*. Those that make Profession of governing and conveying *Spring-waters*, say, that a Cubick Inch of *Water* yields in 24 Hours, 144 *Muids*, (the Name of a *French Measure* holding 280 *French Pints*;) others say, it yields but 70 of that Measure.

The Origin of
Fountains
and Rivers,
by M. - - -
n. 119. p. 447

But I have Reason to believe, that it yields 83 of this Measure, and follow those that say, that a Vessel of two Foot deep, long and broad, holds one *Muid* of *Water*.

And therefore if a *Conservatory* should hold 3378 *Muids* of *Water*, it would furnish for a whole Year a sufficient Quantity to make an *Inch* of *Water* run constantly. As for the Measure of *Rain-water* I have found by *Observations*, that from *Oct.* 1668, to *Oct.* 1669, there had fallen so much of it as mounted to the Height of 18 Inches 7 Lines; and from the same Month 1670, to the same Month 1671, there happened only so much as came to the Height of $8\frac{1}{2}$ Inches; and from *Jan.* 1673, to *Jan.* 1674, to the Height of $27\frac{1}{2}$ Inches. Of which, taking the *Medium*, we have 19 Inches and $2\frac{1}{2}$ Lines.

This supposed, let us estimate some River, as it runs from its very *Source* to a Place where some *Rivulet* enters into it, and see, whether the *Rain-water* that falls about the Course thereof, if it were put into a *Conservatory* would be sufficient to make it run a whole Year. In order to this, I have considered the *Seine*, which from its *Source* to *Ainay le Duc* is about 3 *Leagues* long, and the Sides of its Course extend themselves on the Right-hand and the Left about two *Leagues* on each Side, where there are other little Rivers that run another way: And, since that those *Rivulets* need *Water* to maintain them as well as the *Seine*, I will count but half that Space of the Sides, and say, that the Place where the *Seine* passes hath from its *Source* to *Ainay le Duc* three Miles long, and two Miles large. Whereupon I say farther, if a *Conservatory* were made for this Bigness, it would be six Square *Leagues* in Surface, which being reduced to *Fathoms*, would make 31245144 *Fathoms* in Surface. In this *Conservatory*, imagine that during a whole Year there has fallen *Rain* to the Height of 19 Inches $2\frac{1}{2}$ Lines, as was said before. This Height of 19 Inches and $2\frac{1}{2}$ Lines, gives 280899942 *Muids* of *Water*, or thereabout, according to the Measure supposed.

All this *Water* thus collected is that Stock which is to serve to make this *River* run for a whole Year, from its *Source* to the Place before named, and which must also serve to supply other Occasions and Losses, such as are the feeding of *Trees*, *Herbs*, *Vapours*, and extraordinary Swellings of the *River* whilst it rains, and *Deviations* of the *Water* running another way.

Concerning the Measure or Estimate of the *Water* of this *River*, it would be difficult to find it just and precise, and to determine what Quantity it furnishes. Yet so far as I was able to judge, it can have no more than 1000 or 1200 *Inches* of *Water* always running, compensating the lesser Quantity it hath at its *Source* with the greater it hath towards *Ainay le Duc*: The which I so judge by the Comparison I make of these Waters with those of the *River* of the *Gobelins*, in the Condition wherein it is towards *Versailles*, where it hath 50 Inches of *Water*, according to the Measure taken of it. So that I esteem it will be enough to allow twenty-four or twenty-five Times as much to our *River*. For the Channel of it is to be four or five *Fathom* large, and for Depth it is but shallow, it carries no Boats, and serves only to float down some loose Billets.

These Particulars being thus supposed, I say, that 1200 *Inches* of *Water* do furnish in 24 Hours 99600 *Muids* of *Water* after the rate of 83 *Muids* to an *Inch*, that is, 36436000 for a whole Year. And therefore taking this Quantity

ty of $36\frac{1}{2}$ Millions from the 280 Millions, that falls into the *Conservatory*, above described, there will remain yet above 188 Millions of *Muids*, which amounts to almost five Times as much, and which serves to furnish for the *Losses*, *Diminutions*, and other *Wastes* above taken notice of. So that there needs but the 6th Part of the Rain and Snow-water that falls in a Year, to run continually thro' the whole Year.

Now if these *Rain-Waters* are sufficient to make one River run, they may also suffice for all the rest in Proportion; considering especially, first, what remains for waste, which is superabundant; and *secondly*, what little Space I allow to both Sides of the River's Course, which is but of one League on each Side. For Rivers are not commonly two Leagues near one another.

It may be objected, that there are Countries where it rains but seldom, but somewhere it rains not at all, and yet there are considerable Rivers. But I answer, that the Rivers of those Countries where it rains but seldom, do not run continually, being only big in Winter, but in Summer almost quite dried up. The Reason of both which Effects is, that they being nigh some high Mountains whence they come, the Snow that falls in Abundance on those Hills, and is melted afterwards, is able, as long as that Water lasts, to make them run abundantly in Winter, leaving them dry when it ceases in Summer.

As for the Countries where it rains not at all, there are but few of them in the World. The *Torrid Zone* (where that may be more true than any where else) is a *Climate* abundantly moistened with *Rains* twice a Year, and it may be more than these *Northern Countries*, at least in greater Plenty at certain Seasons. But if there should be any Countries where no Rain at all should fall, that will not hinder the running of *Rivers* there, because they may have their Sources in other Countries where it rains, as the *Nile* in *Aegypt*, where it rains not.

XXXVI. 1. About two Leagues from *Paderborn*, is a treble Spring called *Methorn*, which has three *Streams*, two whereof are not above one Foot and an half distant from one another, and yet of so differing Qualities, that whereas one of them is limpid, blewish, lukewarm, bubbling, and holding *Sal-Armoniac*, *Ochra*, *Iron*, *Vitriol*, *illum*, *Sulphur*, *Nitre*, *Orpiment* used against *Epilepsies*, bad *Spleens* and the *Worms*; the other is Ice, cold, turbid; and whitish, much stronger in *Taste*, and heavier than the former, holding much *Orpiment*, *Salt*, *Iron*, *Nitre*, and some *Sal-Armoniac*, *Allum* and *Vitriol*; of this all Birds observed to drink of it do die; which I have also privately experimented by taking some of it home, and giving it to Hens, after I had given them *Oats*, *Barley*, and *Bread Crumbs*: For soon after they had drunk of it, they became giddy, reeled and tumbled upon their Backs, with *Convulsion Fits*, and so died with a great Extention of their Legs. Giving them common *Salt* immediately after they had drunk, they died not so soon; giving them *Vinegar* they died not at all, but 7 or 8 Days after were troubled with the *Pipp*. Those that died being opened, their *Lungs* were found quite shrivel'd together. Yet some Men that are troubled with *Worms*, taking a

Mineral
Springs,
about Pader-
born in Ger-
many, by
- - - n. 7.
P. 133.

little Quantity of it, and diluting it in common Water, have been observ'd by this means to kill the *Worms* in their Bellies, so that a great Number of *Worms* came from them; whereupon tho' they are sick, yet they die not. As to the 3d Stream that lies lower than the other two, about 20 Paces distant from them, it is of a greenish Colour, very clear, and of a sour sweet Taste, pleasing enough. It hath about a middle Weight between the other two, whence we guess that it is mixed of them both, meeting there together; to confirm which, we have mixed equal Quantities of these Two, with an Addition of a little common *Well-water*, and have found, that they being stirred together, and permitted to settle, made a Water just of the same Colour and Taste of the third Stream.

At Basil, by
- - - - - ib.
p. 134.

2. At *Basil*, the Spring running in the *Gerbergasse* (or *Tanners-street*) from *St. Leonard's-Hill*, is of a blewish Colour, and somewhat troubled, holding *Copper*, *Bitumen*, and *Antimony*, about three Parts of the first, one of the 2d, and two of the last; and have been examined by skilful Persons. Our *Tanners* do water their *Skins* in it, and being a well-tasted and wholesome Water, it is both much drank, and used to bath in.

There are two others, called *Randulph's Well*, and *Brun Zam Brunnen*, very observable: The former of them having a Camphory and drying Quality, and used against hydropical Distempers; the latter containing some *Sulphur*, *Salt-petre* and *Gold*, and being an excellent Water to drink.

Near Yeoville, in Somersetshire, by Dr. J. Beal, n. 18. p. 323. n. 20. p. 359.

3. Mr. *Philips*, of *Montague*, has in his Pastures of *Socke*, about 3 Miles from *Yeoville*, a large Pool to which Pigeons resort, but the Cattle will not drink of it, no not in extream want of Water. To the Taste it is not only brackish, but hath other loathsome Tastes. In a *Venice* Glass it looked greenish and clear, just like the most greenish Cyder as soon as it is perfectly clarified. I boiled a Pint of it in a Posnet of Bell-metal, and suddenly it yielded a thick Froth, having somewhat of a vitriolate Taste. Suffering the Water to be boiled all away, it left much of the same on the Sides and Bottom of the Posnet.

On Malvern Hill in Herefordshire, by Dr. J. Beal; n. 20. p. 358. n. 57. p. 1161.

4. There is a Spring near the Top of *Malvern Hill*, having a long and old Fame for healing of *Eyes*; and about a *Furlong* lower is another healing Spring. When I was for some Years molested with *Tetter*s on the Back of one and sometimes of both my Hands, notwithstanding all Endeavours of my very friendly and skilful *Physicians*, I had speedy healing from a neighbouring Spring of far less Fame. Yet this Spring healed very old and ulcerous Sores on the Legs of a poor Fellow, which had been poisoned by *Irons* in the *Goal*, after other Chirurgery had been hopeless. And by many Trials upon my Hands and the *Tetter*s, I was persuaded, that in long Droughts, and lasting dry Frosts, those Waters were more effectually and more speedily healing, than at other Times. I held this Water in my Mouth till it was warm, and perchance somewhat intermingled with *Fasting-spittle*, and so dropping it upon the *Tetter*, I there could see it immediately gather a very thin Skin upon the raw Flesh, not unlike that which is seen to gather upon Milk over a gentle Fire. This Skin would have small Holes in it, thro' which a Moisture did issue in

in small Drops, which being wiped away, and the Water continued to be drop'd warm out of the Mouth, the Holes would diminish, and at last be all quite healed up.

For the Eye-Waters, I conceived them more strongly *Tersive*, and clearing the Eyes; and they had a rough Smartness, as if they carried Sand or Gravel into the Eye.

5. I think the Waters we call *Chalybeate*, and particularly this at *Farrington*, to be impregnated principally from the *Vitriol*, or *Salt of Iron*, which is very Volatile; so that little of it can be found by Evaporation of a great Quantity, or from the precipitated Sediment. I put 4 Ounces of ordinary clear Water into a Glafs, and impregnated it with a known Proportion of *Gall*: Then by Degrees I let fall into it the *Salt of Iron*, until I found it thereby as deeply tinged Red, as the same Quantity of *Farrington-waters* would be by the same Proportion of *Gall*: The Quantity of the *Salt of Iron* that performed this, was near two *Grains*. This Water, so tinged, tasted and smelled just as the natural Water from the Spring with *Gall* did: If I added a greater Proportion of *Salt*, it would make it nauseous and *Emetical*.

At Farrington in Dorsetshire; By Dr. Highmore, n. 56. p. 1130.

It begins to be in high Esteem for extraordinary Cures of the *Scorbute*, *Asthma*, &c. It hath [as I have found upon Trial] a larger Proportion of the *Minerals*, than *Astrop-water*; but the Force holds not, if removed from the *Spring-head*.

n. 51. p. 1039.

6. About a Mile and half out of *Durham*, on the North-east-side near *Butterby*, is lately discovered a *Medicinal Spring*, which is this Year much frequented, and may be of great Benefit to the Country. It was found out by Workmen that dug in that Place for Coal. When they were 12 Fathom and an half deep, they discovered this Treasure of *Natural Physick*. They then tried the Rock about 100 Yards off; where they lost themselves much about the same Depth; and instead of *Coal* discovered a *Spring* of excellent clear Water, which issues out at the Hole which their Instruments made.

In the Bishoprick of Durham. By Mr. Hugh Todd, n. 163. p. 727.

7. At *Lancarim* in *Glamorganshire*, is a *Medicated Spring*, much frequented from several Counties, Time out of Mind, for the *King's-Evil*. There is a Rill of about an Ell broad between two Collines, covered with Wood; about 12 Yards from this Spring, the Rill falls from a Rock 8 or 9 Foot high, which makes a grateful Noise; the Spring (which is exceeding clear) comes out of a pure white *Marle*; tho' I thought there had been no white *Marle* in *Wales*, for the Earth is red. A *Graduate Doctor* hereabouts imputes the Virtue of this Spring to the *Lime-stone*; and says, one of the chief Ingredients of the Doctors for the *King's-Evil* is *Lime-water*.

In Glamorganshire; By Mr. Aubry, n. 233. p. 727.

8. I had a *Mineral Water* sent me, not long since, by Mr. *Duncan* (a Surgeon) from *Eglingham* in *Northumberland*. I found it turned almost quite Black with *Galls*, though it had been brought at least 30 Miles by Land-Carriage. After I had slowly, in a Glafs, evaporated more than one half of this Water, it still retained the same *atramentous* Quality, and struck yet as deep with *Galls* as ever; and at last it yielded me a real and genuine *Vitriol*. I say nothing of the *Ocre* which this Water let fall in very great Plenty that being a Thing common to all *atramentous Waters*.

At Eglingham in Northumberland; By Dr. Cay, n. 245. p. 365.

I was

USED

I was surprized at this Phænomenon: For I could not bring myself to think it possible, that the *Pyrites*, lying constantly under *Water*, should ever yield *Vitriol*; and I knew of nothing else (at least in *England*) that I could expect it from. But having lately an Opportunity to visit this notable Well, I found our mighty Rarity, our *vitriol Water*, to be only an old *Drift* made for the draining of a Row of old wrought *Coal Pits* a little above, and I informed myself from some old Men, that had formerly wrought in these Pits, that there was Plenty of the *Pyrites* there, by them called, *Brass Lumps*; and that this *Drift* was sometimes dry, and sometimes ran with a plentiful Stream; which is as fair and full an Account how this Water comes to have *Vitriol* in it, as any one need to desire.

A: St. A-
mand near
Tournay; by
Mr. Geoffry,
n. 347. p.
430.

9. There has been found a *Mineral Water*, called *St. Amand's-Water*, which has been very much in use the last Summer and Autumn, in all Sorts of Sickneses, rather for its Novelty, than for its great and extraordinary Properties. It is called *St. Amand's-Water*, because its Spring is in the Land depending on the *Abby* of the same Name, of the Order of *St. Benedic*, in the Diocese of *Tournay* in *Flanders*; but the *Fountain* is called particularly, *La Fontaine du Bouillon*, for the impetuous boiling of that springing Water.

This *Fountain* is situated in a shallow and marshy Ground; the *Bason* of the Spring is 450 Foot square, there is in the *Bottom* of that *Bason* the *Mud* of 20 Foot deep; beyond that they find the *Sand*, which sometimes is very moving, and at some other times is very firm. Very often this *Fountain* casts up a great Quantity of *Sand*: And last Year in a little time it cast up more than 16 Cart Loads of it, by the which all the *Bason* was border'd.

There is to be found three Sorts of *Earth*; the first and superficial is black, and burns as *Turf*, with the same Smell; the second is white; and the third has the same Colour as the *Slate*. These two last Sorts of *Earth* do give by *Lixivium*, a *Salt* like *Sal Gemma*.

This *St. Amand's-Water* in its Spring is clear and *Lukewarm*, and appears much hotter at Night and in the Morning, than the rest of the Day. It has the Smell and Taste like standing *Water*. If it is exposed to the Air it loses its Smell and Taste in a short Time. By that Facility to lose its Taste and Smell, one may judge that it has a *Sulphur* very *Volatile*; and for that great *Volatility* and *Subtility* it is almost impossible to make any Experiment upon it.

This *Mineral Water* has the same Weight as the *Seine* River Water. It altered not the Colour of the *Syrup* of *Violets*, nor the *Tincture* of *Turne Sol*, *Lime Water*, the *Oil* of *Tartar*, the *Volatile Spirit* of *Sal Armoniack* and *Hart's Horn* have whited that *Water*, and have made it a light *Coagulum*.

This Water, mixt with the *Dissolution* of *Armoniack Salt*, has not given any Smell. It has not altered the *Infusion* of *Galls*. Mingled with the *Solution* of *Vitriol*, has troubled it a little, and has given a greenish Colour, and at length is precipitated a yellow Powder.

Acid

Acid Spirits have not fermented at first with that *Water*, but afterwards it has made some little Bubbles which remained to the Side of the Glasses wherein were contained the Liquors.

I have distilled five Pints of that *Water*; the distilled *Water* has not had any Taste nor Smell, and it has not changed the Tincture of *Turne Sol*, neither the *Lime-water*. There remained from that five Pints (or 160 Ounces) 70 Grains of *Residue*; the which, by *Lixivium* has given to me 55 Grains of grey Earth, and 15 Grains of *white Salt*, almost like *Sal Gemma*.

The *Residue* of the evaporated *Water* put upon the burning Coals, has not cast any Smoak, neither has made any *Detonation*; the *Spirit of Nitre* poured upon it, has very much fermented; the *Spirit of Wine* has not extracted any Tincture from that *Residue*.

One may conclude by all these Experiments, that this *Water* has not any acidity, it participates not of *Vitriol*, nor of *Alum*; and there is in it but a little Quantity of the *white Earth*, and less also of *Salt* very like *Sea Salt*.

They are the Parts of *Earth* and *Salt*, which shew themselves in the Mixture of the *Lime-water*, &c. of fixed or volatile *Alcalis*.

They are the same Parts which begin that light *Fermentation* in the Mixture of *Acid Spirits*; but that *Fermentation* is imperfect because of the little Quantity of the *Earth*, which is drown'd in so great a Quantity of Liquor; in Effect when the *Water* is evaporated, the *Acid Spirits* do ferment very much with the *Residue*.

It appears by the Smell of that *Water*, that it contains a *Sulphur* very subtle, which dissipates itself very easily, and which is not sensible in the Experiments. 'Tis nevertheless to be attributed to that *Sulphur*, the principal Effects which they do attribute to that *Mineral Water*, as of helping in the *Palsy*, &c. In other Sorts of Distempers where the nervous Gender is attack'd; in *short Breath*, and in all Affections of the *Lungs*; and of remedying many other Infirmities which are caused by the sharp Ferments, the which are sweetned by that *Water*. For the other Properties of it, as of *Purging*, of taking away Obstructions, of tempering the hot *Intrails*, &c. it may have the same Effects with common *Water* being drunk abundantly.

One may drink many Glasses of this *Water*, beginning by 4, 6 or 8 every Morning, and augmenting till 12, 18, 20 or more, according as the Stomach is able to support it. This *Water* passes readily by *Urine*, and many Persons are purged by it. Sometimes one may mix with it some *Diuretick Salt*, to make it pass more freely, and for rendering it more *De-obstructive*. At other times one may put some *Manna* or other Things for making it more *Purgative*. One may wash also in the Mud of that *Fountain*, according to Necessity.

XXXVII. I have observed a *Spring*, that in all the extrem F frosts, that have been these 10 Years, hath yielded a small Stream, which running over a large Tract of Pasture, keeps all the Banks and Borders Green, and free from freezing, dissolving the *Snow*, and smocking all the way where it runs.

A Spring that is never frozen; by Dr. J. Beale, n. 56. p. 1139.

XXXVIII. 1. The

The Baths in
Somerset-
shire; By
Mr. Jof.
Glanville,
n. 49. p. 977.

XXXVIII. 1. The Country round *Bath* is very hilly and uneven; but the Hills lie in Order; they are generally rocky and steep from South-West and by West, to North-East and by North: The whole Tract of the Country, within five and seven Miles, abounds with Coal-Mines, more or less. But there are no other considerable Mines that I can hear of, nearer than *Mendip*, which is 10 Miles hence, excepting some of Lead at *Berry* in *Gloucestershire*, which lies upon the *North* of this Place, about four or five Miles distant.

2. The Hills for the most part afford a Free-stone; and on the North-West of *Lansdown* (which hath that Situation to the Town, and is just above it) the Stones digged there are a Sort of Head Stone, commonly called a *Lyas* blue and white, polishable.

3. The *Town* and *Baths* are of very great Antiquity. Besides what I find in very ancient Chronicles to that Purpose, one of our great Antiquaries (Mr. P.) asserts, that these *Baths* were 800 Years before *Christ*: which if so will give Occasion to enquire, how consistent with it that Hypothesis concerning the Cause of the *Heat* of these *Waters* may be, which makes it to be the *Fermentation* of Minerals *in fieri*; and whether it be likely, that the Minerals through which these *Waters* pass, should be in that State of Imperfection so many hundred Years. But this other Opinion seems to me very probable which supposeth the Cause of the Heat to be, that two Streams having run through and imbibed certain Sorts of different Minerals, meet at last and mingle their Liquors, from which *Commixture* arises a great *Fermentation* that causes *Heat*; like as we see it is in *Vitriol* and *Tartar*, which when mingled beget an *intense Heat* and *Ebullition*.

4. It is affirmed here, that the *Town* for the most part is built upon a *Quagmire*, though the Places all about it are very firm Ground. Some Workmen, that have been employed in Digging, have found a *Mire* 10 Foot deep, without the *North Gate*, the highest Place of the *Town*, at *Seaven*. The *Earth* between is a kind of Rubbish; sometimes they find *pitching* a Man's length under Ground, and Passages for the Water to pass; seven or eight *Feet* down they have met with *Oyster-shells*.

5. The *Town* and *Country* circumjacent, generally abound with *cold Springs*: And in some Places the *Hot* and *Cold* arise very near each other; in one Place, within *two Yards*, and in others, within 8 or 9 of the main *Baths*.

6. The *Guides* of the *Cross-Bath* inform me, that when there is a great West Wind abroad, standing by the *Springs* they feel a cold Air arising from beneath: If the Wind be at East and the Morning close with a little misting Rain, the *Cross-Bath* is so hot as scarce to be endured, when the *King's* and *Hot Baths* are colder than usual. In other Winds let the *Weather* be how it will, this *Bath* is temperate. The *Springs* that *Bubble* most are *coldest*. The *Cross-Bath* fills in 16 Hours, both in *Winter* and *Summer*, without any Difference from *Heat* or *Cold*, *Floods* or *Drought*; that of the *King* in 12 or 14 Hours.

7. A Man may better ordinarily endure four Hour's Bathing in the *Cross-Bath*, than $1\frac{1}{2}$ in the others. In the *Queen's-Bath* (which hath no Springs of its own, but comes all out of the *King's*) they have found under a flat Stone, which upon Occasion was taken up, a Tunnel, and a yielding Mud in and under it, into which they thrust a Pike, but could feel no Bottom. In the *King's-Bath* there is a Spring so *hot*, that it is scarce sufferable; so that they are fain to turn much of it away, for fear of enflaming the *Bath*. The *hottest Spring* will not harden an Egg.

8. The *Bath-Water* does not pass through the Body like other *Mineral Waters*; but if you put in *Salt* it purgeth presentiy: Upon *Settlement* it affords a black Mud, useful in *Aches*, applied by way of *Cataplasm*; to some more successful than the very *Waters*. The like it *deposits* upon *Distillation*, and no other; nor hath any more been discovered upon all the *Chymical Examinations* that have come to our Knowledge. One Dr. *Astendoff* found, that the Colour of the *Salt*, drawn from the *King's* and *Hot-Bath*, was yellow; that which was extracted from the *Cross-Bath*, *white*. This Dr. concluded, that the *Cross-Bath* had more of *Alum* and *Nitre* than the *hotter Baths*, which abound more with *Sulphur*. And yet that *Bath* loosens *shrunk Sinews*, by which it should seem it abounds not much with *Alum*. It is harsher to the Taste than the other *Baths*, and soaks the Hands more.

9. A Man cannot drink half the Quantity of strong Drinks in this *Bath*, that he can out of it; but, if he hath drunk before to Excess, it allays much, and is a great Refreshment to the Body. The *Bath* provoketh *Urine*.

10. They are very useful in *Diseases* of the *Head*, as *Palsies*, *Epilepsies*, and *Convulsions*, in *Cuticular Diseases*, as *Leprosies*, *Itches* and *Scabs*; in all *Obstructions* of the *Bowels*, as *Spleen*, *Liver*, and *Mesentery*, and the *Schirrosity* and *Hardness* in those Parts; in most *Diseases* of *Women*; in the *Scurvy*, and *Stone*: As to which last, while I am writing, an Alderman of the City assures me, that his Wife, who had been exceedingly troubled with the *Stone*, went into the *Cross-Bath* for it, and voided there several *Stones* as big as those of *Olives*, and was never troubled with that Distemper after. The *Bath* is also good in *cold Gouts*, as they call them.

The same Alderman tells me, that it gives him present Ease, when he is troubled with the Fits of it. He uses to go in as soon as the Fit takes him; which then goes off presently, and returns not in a considerable time after: He puts his Feet upon the hottest *Spring* in the *King's-Bath*.

But it had a contrary Effect in *hot Gouts*; and some, who are troubled with that Distemper, tell me, that the *Bath* puts them in a Fit, if they go into it without Preparation; or, if they have the Fit before, it inflames it more, and sends it about the Body, and disables the Joint so, that there is no treading on it for the present. Further, the *Bath* is effectual in the *Diseases* of *Children*, particularly the *Rickets*, removing the Humours that proceed from it without Fail. 'Tis also good for *Women*, that are apt to *miscarry*, if used moderately. The *Bath-guides* go in, when they are apt to lie down; and other *Women* of the *Town* use it ordinarily through-

out their Time, and are never observed to miscarry. It facilitates Delivery. It is very effectual besides for the strengthening of *broken Bones*, and good in all *cold* and *moist Distempers*, and *Weakness of Nerves*, *Stupefactions*, *Relaxations*, and violent *Pains*: In all which it gives Ease, except the *Lues Venerea*; but in that (except the Malignity be overcome by the Methods of Physick) it exasperates the Pain more. 'Tis an excellent Remedy to remove the remaining *Weakness* in *Gouts*, as hath been remarkably exemplified in Old Men, even to the Age of 83 Years.

11. There is no Instance of Cures performed by it in former Times, but we have the Experience of it in ours; yea, and in some others, as in *Dropsies*, *Cachexies*, *Spleen*, &c. in which Cases they were shy heretofore of using the *Bath*, for fear of confirming those *Obstructions*; whereas 'tis now found that their Cure is facilitated by it.

12. The *Bath-Guides* live to a very great Age; sometimes to near 100 Years; ordinarily, if they are temperate, to 70. There are two at this Time above 80, a Man and his Wife.

13. In the *Cross-Bath* the *Guides* have observed a certain black Fly with sealed Wings, in the Form of a *Lady-Cow*, but somewhat bigger. They say, it shoots quick in the *Water*, and sometimes bites. It lives under the *Water*, and is never found but in very *hot Weather*. They suppose it comes up with the *Springs*. It is not to be seen elsewhere.

14. The *Cross-Bath* eats our Silver exceedingly; and I am told that a Shilling in a Week's Time hath been so eaten by it, that it might be wound about one's Finger. The *Baths* agree (as the Vulgar speak) with *Brass*, but not with *Iron*: For they will eat out a Ring of this Metal in seven Years, when *Brass* Rings seem to receive no Prejudice at all from it.

15. When Women have washed their Hair with the Mixture of beaten Eggs and Oatmeal, this will poison the *Bath* so, as to beget a most noisome Smell, casting a *Sea-Green* on the *Water*, which otherwise is very pure and limpid. This will taint the very Walls, and there is no cleansing of it, but by drawing the *Bath*.

16. In Summer the *Baths* purge up a green Scum on the *Top*, but in Winter never; but then leave a yellow on the Walls.

17. The Walls that keep in the *hot Springs* are very deep set, and large; 10 Foot thick, and 14 deep from the Level of the Street. The *Cement* of the Wall is yellow Clay, Lime, and beaten Bricks. In the Year 1659 the *Hot-Bath* (a *Bath* particularly so called, of equal Heat with the *King's-Bath*) was much impaired by the breaking out of a *Spring*, which the Workmen at last found again, and restored. In digging they came to a firm Foundation of factitious Matter, which had Holes in it like a *Pumice-Stone*, thro' which the *Water* played; so that 'tis possible the *Springs* are brought together by *Art*: Whence probably was the *Necromancy* the People of antient Times believed and reported to have contrived and made these *Baths*; as in a very antient *Manuscript Chronicle* I find these Words: *When Lud. Hiclibrass was dead, Bladud his Son, a great Nygromancer (so 'tis there writ) was made King; He made the Wonder of the Hot Bath by his Nygromancy;*

mancy; and he reigned 21 Years, and after he died and lies at the New Troy. And in another old Chronicle 'tis said, That King Bladud sent for the Necromancers to Athens to effect this great Business; who, 'tis like, were no other than cunning Artificers, well skill'd in *Architecture* and *Mechanicks*.

18. It hath been observed, that *Leaves*, like those of *Olives*, come sometimes out of the Pump of the *Hot-Bath*.

(2.) These *Waters* have been long famous for the Cure of *Palsies* and *Barrenness*: An Instance of both in one Person I shall now give you. A Gentlewoman of about 30 or 32 Years of Age, having been married about 10 or 12 Years, and never with Child, was suddenly seized with a *Palsy* on the Left-side; for which (after 8 or 10 Months Trial of other Means to little Purpose) she was brought to the *Bath*, where (after usual Preparations, and some internal Means) she continued that Season about six Weeks; the Winter coming on, she was forced to desist; but (by the Advantage she received) was encouraged to come very early the next Year, and did continue with us the whole Summer, and recovered, in great measure, the Use of her Arm and Hand, Leg, and Tongue; and not only so, but, in a few Weeks after, she returned to her Husband, conceived with Child, and had (about a Year and half's Distance between them) five Children following. She shewed me four of them lusty and strong, and well grown for their Age; the fifth died: She herself had no Return of a *Palsy*, but is *infirm*, I think, *consumptive*: She is now about 51 Years old.

By Dr.
Pierce; n.
169. p. 944.

XXXIX. At *Baden*, a little City in *Austria*, 4 German Miles Southward from *Vienna*, seated on a Plain, but nigh unto a Ridge of Hills, which are the Excursions of Mount *Cetius*, are convenient *Baths*; Two within the Town, Five without the Wall, and Two beyond a Rivulet called *Swechet*.

Baths in
Austria and
Hungary, by
Dr. Edw.
Brown; n.
59. p. 1044.

The *Duke's-Bath*, which is the largest, is about 20 Feet square, in the middle of an House of the same Figure, built over it. The Vapour passes through a Tunnel of Wood, at the Top. And the Water is conveyed into the Bottom of the *Bath*, at one Corner, through wooden Pipes and Trees, under the Town-Wall, from the Spring-Head, which riseth at a little Distance Westward. The Springs of the rest of the *Baths* rise under them, and are let in through Holes of the Plancher; for all the *Baths* are waincoated, the Seats, Sides, and Bottoms being made of Fir. The Water, for the most part, is clear and transparent, yet somewhat blewish, and maketh the Skin appear pale in it, as doth the Smoak of *Brimstone*. It coloureth Metals (except Gold, whose Colour it also heightens) turning them black in a few Minutes. The Coin of this Country, mixt of Copper and Silver (having $\frac{2}{7}$ of Silver, and $\frac{5}{7}$ of Copper, is in a Minute's Time turned from a white into a dark yellow, and soon after becomes black. To the Moss and Plants, which it walheth, it gives a fine green Colour, and leaves often a Scum upon them, of a purple mix'd with white. As it runs from the Spring-Head it somewhat resembles the *Sulphur-River* in the way from *Tivoli* to *Rome*, but is not so strong or stinking, nor doth it incrustate its Banks.

I passed to the Spring-Head (which riseth under a rocky Hill) about the Length of 40 Yards, through an arched Passage cut in the Rock, which is also a *natural Stove* (as that of *Tritola* and *Bejae*) made by the *hot Bath-water* running under it. Most Part of this Cave is incrustated with a white Substance, by them called *Salt-petre*: At the Mouth of the Cave it becomes harder and stony.

I caused some of the Pipes, through which the *Bath-water* runs, to be opened, and from the upper Part of the Pipe I took some Quantity of *fine Sulphur* in Powder, somewhat like *Flower of Brimstone*; this being as it were sublimed from the Water, and not deposed, being found in the upper Part of the Pipe. *Oleum Sulph. per Campanam*, dropped into this Water, is received into it quietly. *Oleum Tart. per Deliquium* caused an *Ebullition*, as in the making of *Tartarum Vitriolatum*.

The second *Bath*, within the Wall, is that of our *Lady*, about 12 Foot broad, and 24 long. One End of it is under a Church of the same Name. This is fuller of Sulphur than the rest, and more blew, and leaveth a yellow Flower upon the Boards, as the others do a white.

The third is the *New-Bath*, out of the Town nigh the Gate.

The fourth, the *Jews-Bath*, which hath a Partition in the Middle to separate the Men from the Women.

The fifth, *St. Jobi's Bath*, of a Triangular Form.

The 6th is called the *Beggar's-Bath*, and is always so shallow, that they lie down in it.

The 7th, the *Bath* of the *Holy Cross*, about two Fathoms square, chiefly for the *Clergy*.

The eighth, *St. Peter's Bath*, greener than the rest.

The ninth, the *Sour Bath*, set about with Stone-balasters, and covered with a Cupola and Lanthorn. The Water is very clear: In the Steam of this *Bath* I have often coloured Money black without touching the Water; and, staying only in the Room where the *Bath* is, the Buttons of my Cloaths, and what else of Silver the Vapour could come at, were colour'd yellow, or gilded: And yet the Water itself once cold changeth not the Colour of Metals, though boiled in it.

The *hottest* of these *Baths* have not the *Heat* of the *Queen's-Bath* at *Bath* in *England*. They use no *Guides*, as with us, but direct themselves with a short turn'd Staff.

Manners-dorff, seated under an Hill on the East-side of the River *Leyta*, hath only one *Bath*. It riseth under a Church, that is built over the Spring-Head.

The Water of it is *lukewarm*; and therefore they boil it in great *Coppers*, when they desire it *hotter*, and *bathe* in Tubs filled with this boiling Water. From the Substance, which sticks to the *Coppers* in boiling, it is collected, that it is impregnated with *Sulphur*, *Salt-petre*, and *Chalk*. This Water coloureth the Stones in it of a fair Green like a *Turkois*; and the Steam of it, which sticks to the Moss under the Church, turns into Drops of Gold or Amber.

Dotis, two Hungarian Miles from *Comorra* in Hungary, hath also sulphurous Baths, said to be warm in Winter. In *March* and *October* I found their Warmth very remiss, scarce perceivable. In Colour they are blewish, and to Taste acid. The Queen's-Bath and the Great-Bath rise in a Marsh, Northward of the Castle.

There is another Bath in the Governour's Garden within the *Town*. They are used as those of *Manners-dorff*.

At *Banka*, two Hungarian Miles from *Freistat*, in a Meadow, I took notice of 15 Baths: And there have been more, but the River *Waag* eateth away the Banks, and swallows up the Bath; and into three of these 15 it hath also broke in. The Water of these is like to that of *Baden* in *Austria*; it leaves a white Sediment upon the Moss and Places it washeth, and tinctureth Metals black. I stuck some Money into the Ground, over which the Water passeth; that Part which was in the Ground retained its own Colour, and the other Part in the *Bath-water* acquired a Coal Black. These Baths are open, and very hot.

The Baths of *Boinitz*, nigh the River *Nitra* in Hungary, are of a moderate gentle Heat, much beautified by Count *Palsi*, Palatine of Hungary, and all of them covered under one large Roof; the first is the Nobleman's Bath, built of Stone, descended into on all Sides by Stone-Stairs: Four more there are of *Wood*, but very handsomely and well built.

At *Stuben*, three Hungarian Miles from *Newsol*, and two from *Chremnitz*, near to a Rivulet, are diverse Baths of great Esteem. The Water whereof is clear, and smells of *Sulphur*, the Sediment green. It colours the Wood over it green and black, but does not change the Colour of Metals so soon as most others. I left Money in it a whole Night, which was yet but faintly coloured. The Springs arise underneath, and pass through the Holes in the Plancher of the Baths. The Heat thereof is answerable to the King's-Bath in *England*. These Baths are seven.

The first is the Noblemen's Bath; the second the Gentlemen's Bath; the third, the Country-man's; the fourth, the Country-woman's; the fifth, the Beggar's Bath; the sixth, for such as are infected with the *Lues Venerea*; the seventh, the Bath of the Gypsies, of whom there are many in those Parts. These Baths are in a Plain, encompassed on all Sides with Hills; the highest unto them are towards the East, and it is the same Ridge of Hills, which on the other Side are so rich in Metals.

Glass-Hitten, an Hungarian Mile, or about 7 English Miles from *Schemnitz*, hath five Baths; two of which are large. It deposes a red Sediment, and incrustates the Wood and Seats of the Bath under Water with a stony Substance; and it also gildeth Silver. But the most remarkable of these Baths is that which is called the *Sweating-Bath*, whose hot Springs drain thro' an Hill, and fall into a Bath built to receive them; at one End of which, by ascending, I went into a Cave, which is made a noble Stove by the Heat of these *Thermæ*, and so ordered with Seats, that every one who sits in it, either by chusing a higher or lower Seat, may regulate his Sweating, or enjoy what Degree of Heat he desireth. This Cave as also the Sides of the
Bath:

Bath are covered, by the continual dropping of those hot Springs, with a red, white, and green Substance; the red and green make the best Shew, but the white is used against the Stone, and cureth Ulcers, and sore Backs of Horses.

Eisen-bach, about four *English* Miles from *Glass-Hitten*, and five or six from *Schemnitz*, hath also *Hot Baths*. I have seen great Trees placed at the Top or Superficies of the Water in these Baths, which have suffered Petrification. Here are two convenient Baths, much frequented; and a third, which is made by the Water let out of the former, called the *Snake's-Bath*, from the Number of *Snakes* coming into and delighting in it, when 'tis filled with these warm Waters.

The natural Baths of *Buda* are esteemed the noblest of *Europe*, not only in respect of the large and hot Springs, but the Magnificence of their Buildings.

For the *Turks* bathe very much, and tho' little curious in most of their private Houses, yet are they very sumptuous in their publick Buildings, as their *Cbans* or *Caravansara's*, *Moschs*, *Bridges*, and *Baths* declare.

There are eight Baths, whereof I had Opportunity to take notice, during my Stay at *Buda*; three towards the East and South East Part of the City, in the way leading towards *Constantinople*; and five toward the West-end of the Town in the way towards *Old Offen*, and *Strigenium*.

The first is a large open Bath at the Foot of an high rocky Hill, formerly called *Purgatorium*, whereof the People have some odd and scrupulous Apprehensions.

The second is covered with a *Cupola*, and stands nigh the same Hill, but more into the Town, and near a Place where they use *Tanning*.

The third is called the *Bath* of the *Green Pillars*, tho' at present they be of a red Colour; and it stands over-against the *Caravansara*. The Water is hot, but tolerable without Addition of cold Water. It is impregnated with a petrifying Juice, which discovers itself on the Sides of the *Bath* upon the Spout, and other Places, and maketh a grey Stone; and the Exhalation from the *Bath*, reverberated by the *Cupola*, by the Irons extended from one Column to another, and by the Capitals of the Pillars, formeth long Stones like *Icicles*, which hang to all the said Places; such as may be observed in many subterraneous *Grottoes*, and particularly in *England* in *Okey-Hole* in *Somersetshire*, and *Pooles-Hole* in *Derbyshire*.

The Water is let out at Night, when the Women have done *Bathing*, who often stay late. The *Bath* is round, set about with large Pillars, supporting a *Cupola*, which hath Openings to let out the Steam thereof, and yet the whole Room continues to be a hot Stove.

The *Baths* of the West-end of the *Town*, are;

1. *Taßalli*, or the *Bath* of the *Table*; a small *Bath* covered: The Water white, and of a sulphurous *Smell*.

They drink of this as well as bathe in it. What they drink, they receive from a Spout bringing the Water into this Place. I delivered a *Five-Sols* Piece to a *Turk*, bathing in it, to gild for me; which he did in about a Minute,

Minute, by rubbing it between his Fingers, while the hot Water fell from the Spout upon it.

2. *Barut Degrime*, or the *Bath of the Powder-Mill*. It rises in an open Pond near the High-way, and mixeth with the fresh Springs; so that the Pond is of a whitish Colour in one Part, and clear in the other, as also cold and hot in several Parts. This conveyed cross the High-way into a *Powder-Mill* becomes useful in making of *Gun-powder*. They conceive here, that this Bath communicates with the sulphurous Springs at *Dotis*, many Miles distant.

3. *Cuzzoculige*, the little Bath, or the *Bath of the Saint*; for which Name the *Turks* give a superstitious Reason. 'Tis kept by *Turkish Monks*; the Bath, where the Springs arise, is so hot as scarce to be endured; but, being let out into another Bathing-place at some Distance, it becomes tolerable, and fit for Use. This Water hath neither Colour, Smell, nor Taste, different from common Water, and deposeth a Sediment; only the Sides of the Bath are green, and have a fungous Substance all over.

4. *Kalip*, a very noble Bath; but Part of the Buildings were consumed this Year (1669) by a great Fire which happened in *Buda*, but is by this time repaired by the *Turks*. The Water is very hot, not without petrifying Juice in it. The Buildings about it are eight Feet square, with a noble Bath in the Middle, with a *Circle* or *Trench* of Water about it for the better Ornament. On every Side it has a *Nichio*, wherein is a Fountain. In the Middle of the *Anti-chamber* (where they leave their Cloaths) there is also a fair Stone Basin, and a Fountain.

5. The *Bath of Velibey*, which hath a strong sulphurous Smell, and a petrifying Juice in it, and is so hot, that to make it tolerable it requires the Addition of cold Water, is the noblest Bath of any. The *Anti-Chamber* is very large, the Bath-room capacious and high-arched, and adorned with five *Cupola's*; one, a very fair one, over the great round Bath in the Middle; and one lesser, over each of the four Corners; where are either Baths or Bath-stoves for more private Use: In these the *Turks* take off the *Hair* of their Bodies by a *Pfilotbrum*, mixed with *Soap*; it being not their Custom to have any *Hair* except on their *Beards*, and a Lock on the Crown of their *Heads*. Twelve Pillars support the great *Cupola*; between eight whereof are Fountains of the hot Water, and between the other are Places to sit down, where the *Barbers* and *Bathmen* attend. And each of these Places have two Cisterns of Free-stone, into which are let in hot Bath-water, and also cold Water, to be mixed and tempered, as every one pleaseth.

Men bathe in the Morning, and *Women* in the Afternoon. When any Man intends to bathe, having entered the first Room, he finds there diverse *Servants* attending, and furnishing him with a *Cloth* and *Apron*. Then he puts off his Apparel, and having put on the *Apron* he entereth the second Room, wherein the great Bath is, and sits on the Side of the Bath, or between the *Pillars* nigh a Fountain; where the *Barber* strongly rubs him with his Hand opened, stretching out his Arms, and lifting them up; after which the Party batheth. Then if he be a Subject of the *Grand*

Seignior's,

Seignior's, or it be the Custom of his Country, he hath his Head shaved; and, if a young Man, his Beard, except the upper Lip. Next, the Barber rubs his Breast, Back, Arms and Legs with an *Hair-cloth*, while he either sitteth or lieth with his Face downward; then washes his Head with Soap, and after throws cold Water upon him all over his Body, and so the Party walks about in the Steam of the *Bath* for a time.

These *Baths* are made use of two ways; either by entering into the Water, or sitting about the *Bath* in the Steam. For the Vapour of the *Bath* makes the whole Room a Stove, and most sweat as long as they stay in it; and some enter not the Water at all, but have it poured upon them, or else only continue in the Steam of the *Bath*, which sufficiently provoketh Sweat.

At Aponum
near Padua,
by Mr. Dod-
dington, n.
83. p. 4067.

XI. Five Miles from *Padua* are the Waters called *Aponensia*, from a Town called *Aponum*. They are actually very *hot* and *stinking*, and yield a great deal of very fine Salt, of which the *Natives* serve themselves in their ordinary Occasions. The Salt is gathered after this manner: The *Natives*, after Sunset, stir Pieces of Wood in the Water, and presently the Salt sticks to them, and comes off in small Flakes, exceeding white, and very salt; this never loseth its Savour. The People there with the same Water used to wash their Walls, to render them whiter than ordinary; which it doth even whiter than *Lime*. Such *Walls* conserve their *Saltness* some few Days only, and then become insipid, even tho' they sweat forth a white Excrecence in thin and light Flakes, like *Nitre*, many Years after. But that Salt, that is collected from the Stones, Gravel, and Earth, by which the Rivulets descending from these Baths do run, is without any Taste of Salt, though there be no Difference in the Form or Colour from that which is gathered with the wooden Instruments.

Hot Springs,
and other
Mineral
Waters in
Jamaica, by
Sir William
Breston, n.
220. p. 226.

XLI. In *Jamaica* there is a very *hot* Spring of *mineral Water*, but the Distance and Trouble of getting to it has kept People from trying it 'till this last Month (*viz.* March 169 $\frac{1}{2}$.) when two Persons, the one very much macerated with the *Belly-Ach*, and another with the *Pox*, as is supposed, went to it, carried *Cloaths*, built a *Hut* to keep them from the Rain and Sun, and both presently by *drinking* and *bathing* found such Ease, that in about ten Days they returned perfectly cured. It comes out of a Rock in a fresh *Current*, near to a fine Rivulet of good cool Water, but is so *hot*, that they all affirm it soon boils *Eggs*, some say *Craw-fish*, *Chickens*, and even a *Turkey*; but perhaps this last wants good *Confirmation*. However it is certain, that, near where it comes forth, there is no enduring any Part of the Body, but it takes off the Skin. It cures *Ulcers*, and *contracted Nerves* and *Sinews*, in a few Days, to a Miracle. Colonel *Beckford*, who was given over by the *Physicians*, with Pains in his Bowels very acute, that had worn him out, and another for the *Venereal Disease*, and one for the *Belly-Ach*, went up since. Col. *Beckford* is finely recovered, and the other almost cured of his *Ulcers*; so that the Water is beyond doubt, and many are resorting to it.

It has been tried with *Galls* in my *Sight*, and it makes the *Water* only in 24 Hours look only like *Canary*, or *Old Hock*. But we have a fine large River runs by the sides of this Town, which serves all the People for drinking and other Uses, and was by the *Spaniards* call'd *Rio Cobre*, or the *Copper River*; this now our Curiosity has led us to try with *Galls*, and in one Night the *Water* turns to a deep Green, more inclining to Black, deeper colour'd than any *Emerald* I ever saw; which makes me doubt the *Copper-Mines* in it are not enough digested, and that 'tis unwholsome; but were the *Copper* more refined and excellent, it would be a salubrious *Water*. I have also tried several *Water-springs* and *Rivers* hereabouts, and find them all ting'd with some Metal or other.

2. We have lately discover'd two *Hot Springs* in *Jamaica*; one to *Windward*, which seems sulphurous; the other to *Leeward* is very salt, but, as I am told, does not partake of *Brimstone*; and both very much magnified for the *Epidemick Diseases* of these Parts, the *Dry Belly-ache*, *Pains of the Nerves*, and *Yaws*.

By Mr. Rob.
Tradway,
n. 232. p. 712

XLII. Tho' the Particles of *Water* are so minute, that we cannot discern them with our *Eyes*, yet by feeling we may distinguish the acute and vigorous Particles of *healing Waters*, from the languid and hurtful Particles of common *Waters*. The *healing Water* will intermingle with their Asperities such an agreeable *Titillation*, as will invite us to rub in, or press on the cleansing and terfive *Water*; and will all along recompense the Pain of searching the *Wound* by their active Frictions with such speedy Reparations, and such indulgent Degrees of *Sanation*, as mitigates the Torment with Store and Variety of Pleasures. Other common *Waters*, even those of some of the purest and almost crystalline Fountains, are most poisonous; encreasing *Tetters*, and fomenting *Ulcers*, with an inward and sullen Painfulness. This dextrous *Water*, by a most favourable *Chirurgery*, searches to the bottom of old and cancerous *Ulcers*, sweeps or shaves away the Roots of *Tetters* and *Cancers*, and appeaseth the unnatural *Rage*; and some of these *healing Waters* are benign, whether we apply them outwardly, or trust them inwardly for the Relief of our *Entrails* and *Vitals*. And by these remarkable *Indications*, and the Effects I have seen succeeding, I have been confirmed of the real Virtue of some of the (so call'd) *Holy Wells*, of oldest Reputation in *England*, and have discovered other *healing Springs*, whose Virtues were not much known, or noted before.

Observations
concerning
Healing
Springs, by
Dr. J. Beal.
n. 57. p. 1155

Our *Eyes* also may be in some Sense good Witnesses of peculiar *Figures* in the Particles of those *Spring Waters* which are proper for the *Eyes*. They seem to scour the *Eyes*, as it were with sharp but very fine *Gravel*. And by this *Indication* I have tried and found the *Springs*, which are extraordinary for the *Eyes*, and perhaps to cleanse *Optick Glasses*. About 30 Years ago, in a very hot and droughty Summer, there was an *Epidemical Distemper* of Mens *Eyes* and *Eye-lids*; I found it so at *London* and *Westminster*, and almost in every House where I came, as I travell'd Westward on both sides *Severn*; *Verjuice*, or the Juice of *Crabs*, was found the best Remedy; and where they knew it not I gave notice of it; and all that try'd it, confess'd that it was not a very

unpleasant *Application*. Their *Eyes* had a fretting *Itch*, and *Verjuice* prov'd more agreeable than *Vinegar* or *White Wine*, or any other *Liquor* or *Mixture*. Some such tickling *Pleasure*, but yet more delicate and tender, there is in some *Spring-waters*, which are for the *Eyes* peculiar.

The *Springiness* of *Wool*, more than of *Linen*, offers another visible and tangible *Demonstration*, how the stronger and quicker *Springs* of some *Water*, more than of other, may conduce more or less to healing; or may be more or less noxious, either inwardly taken or outwardly applied.

I knew one, who was shot in his *Heel* with an *Arrow*, which carried with it a very small *Rag* of the *woollen Stocking*: This *Rag* not being found by the *Chirurgeons*, tho' they were then of the best *Note*, the *Wound* became for a *Year* or two incurable; and the *Pain* was so intolerable, that it was thought necessary to cut off his *Foot*. At last by chance the *Rag* was found, and taken away, and then the *Cure* was soon perfected. *Wool* and *Linen* may have their *Turns* and *Seasons*; the one as a *Mechanical Operation* for *beating* by a close and permanent *Friction*, the other as a quiet *Lenitive*. Our tender *Skin* can hardly bear the incessant *Springiness* of *Wool*; in a deep *Wound* we can less endure it. But the *Springs* of some *Waters* may be lined with a softer *Liquor* than the hairy curled *Filaments* of *Wool*; and hence we may perceive how some *Waters* may by their rolling *Particles* be the greatest *Probes*, and yet the surest *Searchers*, *Cleaners*, and *Healers*. And hence also, on the contrary, we may see how some *Waters*, which cure *Uicers* and *Cancers* by outward *Application*, may be too busily corrosive and dangerous, if taken inwardly.

I think I may note, that generally all the *Springs* in *England* that are of very antient *Esteem* for *Healing*, and were commonly call'd *Holy-Wells*, (such as *St. Winifred's Well* in *Flintshire*, of which I never made *Trial*, but it carries the greatest *Fame*) are all very pure, and yield no kind of *Sediment*. In this our *Hot-Baths*, and perhaps some few mineral *Springs*, are to be excepted. I must yet be more particular.

I know a *Spring*, which the Old People there call the *Holy-Well*, on the side of a low *Hill*, in an arable *Field*, which (besides the *healing Qualities*) hath an extraordinary *Efficacy* in clearing the *Skin* from *Sun-burnings* and *Freckles*; and addeth as much *Lustre* as agrees with the finer *Art* of concealing *Art*, and with *Modesty*; and after washing 2 or 3 *Mornings* it makes the *Skin* as smooth as *Glass*. It passeth thro' a *Vein* of light *Sand*, if I may call it *Sand*; 'tis more like to some kind of bluish crisped *Marle*; 'tis so light and hollow, as it were freshly working by some *Ferment*; and 'tis full of very small and thin *Laminae*, seeming to be *metalline* and *bright* like the purest *Silver*, but the *Refiners* could not find it to be of any *Value*. I was inquisitive to search it out, whether this *Water* had the *beautifying Property* from the *Silver-like Laminae*, or rather gave those *Veins* of the *Earth* that *Tincture* and *Ferment*. Only two things I can affirm: 1. I saw many *Springs* opened in the lower *Grounds*, which seemed in all appearance to run from the same *Head*, and had also the same very bright *Ferment* in their *Passages* where they were opened, but these had nothing of the same *Property* for

Healing

Healing or for *Beautifying*; as I found by many Trials, more than daily, for some Years together. 2. The common Fields adjoining had on their Cloths and Fallows somewhat of the same Glittering, much faded, but enough to dazzle their Eyes that fixed them on it in a bright *Sun-shining*. May not some *subterranean Steam* give the *Tincture* both to that Vein of Earth thro' which it passed more freely, and also more forcibly to that Spring, by a greater Resort, or by some Advantage it got by the *Ascent* of the Ground? (And we commonly find these *healing Springs* either near the Top, or on the Side, or near the Foot of some Hill, or running from the Hill:) And thus the *Stems* reverberated and dashed down by the Motion of the Air, and by the *Weight* of the Atmosphere, may beget the same *metalline Tincture* in the adjacent Fields. This was far enough from yielding Sediment, and it had a pleasing Smoothness, and was very inoffensive to the Stomach; but it searched the Eyes somewhat smartly, and cleared them speedily, and was generally commended for many *Healings* both inwardly and outwardly, and was every way much more pleasing than tormenting.

Within two Miles of the same is another of their old *Holy-Wells*, on the Brow of such another Hill, in an arable Field, within half a Mile of the lofty *Melvern-Hill*: This is very kind for the Eyes, and hath also done many Cures upon putrid and foetid Ulcers, which were many Years deplorable for incurable, as I can affirm upon my own Knowledge. I have seen it tried often, and always to good Effect; sometimes considerably wonderful.

Id. sup.
§. xxiv. 4.

Many drink of it, and much extol it for Healings: And I never could hear of any that complained of hurt done by it. It was somewhat asperous, but pleasing in malignant Ulcers.

But much greater is the Reputation of the *Holy-Wells*, as they call them, on the side of *Melvern-Hills*; which Hills divide *Worcestershire* from *Herefordshire*. The higher Spring is peculiar for the Eyes: About a Furlong lower is the *healing Spring*; this cureth many Maladies and Cancers, if applied before the Strength of Nature be overthrown. I have read in the Monuments belonging to the *Hospital* at *Ledbury*, a Town in the Way from *Hereford* to those Springs, that a Bishop some Ages past endowed that Hospital with Revenues for the Entertainment of distressed Passengers that travelled to those Springs for Relief. Above 50 Years since I heard a panick Story spread all over the City and Country of *Worcester*, that the *Physicians* had poison'd those Wells. But I am persuaded, that the ground of this Fable was only this: After more than ordinary Rain, for 1, 2, or 3 Years together (as it falls sometimes in *England*) some *common Waters*, by a part of the same or some other Channel, do drive to the same Aperture, and drown the Excellency of the *Healing-Water*. In this droughty Year (1669) we find, that many excellent Springs have lost more than half, and some more than 4 Parts of 5 of the Waters which they did usually afford in the same Seasons of the other moister Years; and the remaining *Waters* have the stronger Efficacy. Of this *Expectation* from long Droughts I formerly advertis'd you. And 'tis now remarkable, that the better Springs, which are on the side of the Hills and on the higher Ground, do maintain their *Current* much better than those which

are

are in the lower Vale. 'Tis so in many Places about us here, when the better Springs had lost 4 Parts of their Current, many of the lower Springs were quite dried up. All these Waters are purely limpid, free from all Sediment, very terfive and searching, most effectual at the *Spring-head*.

Vid. inf. §
XLIV. 2.

Vid. sup. §
XXX. 3.

I omit many other *healing Waters*, that I may give you a brief Touch of such *mineral, saline, and medicinal Waters*, as I have found or heard of in our Neighbourhood, namely about *Yeovil* in *Somersetshire*. I lately heard of two more *metalline Springs* in *Dorsetshire*, besides that of *Farrington*; perhaps their Virtues and their Fame are increased by this Drought. The *saline Spring*, mentioned by Dr. *Higmore* to be at *East-Chenock*, is about 3 Miles hence Westward. In a very drougthy Summer I found it *strong Brine*. But there is a *Salt-Spring* of a far greater Worth at *Everich*, about 12 Miles hence towards *Shepton-Mallet*. The Pool, which yieldeth *vitriolate Salt*, is in *Sock-Dennis*, 3 or 4 Miles from hence Westward. 'Tis not a great Pool, nor above ten Foot square. Whether the Salt proceedeth from a Spring, or from a Vein of *vitriolate Earth*, I cannot yet determine; but the Mud and Earth about it is as blue as any *Roman Vitriol*. In a long lasting and hard Frost I sent for a Quart Bottle of the *Water*, and found it very thick and blackish, and it scented intolerably strong, not much unlike Gunpowder newly inflamed. Close adjoining unto this Town of *Yeovil* were two Springs kind for the Eyes; the one in a Pasture, the other within a Bolt-shot in a Field.

The old People prefer that in the Pasture before the other, as they have it from elder Tradition, and their pretended Experience. And at this time the more commended Spring, which is in the Pasture, and on the side of a rising Ground, runs freely; the other is newly dried up. 'Tis not every slight *gravelling* of the *Eyes* that sufficiently indicates an extraordinary *Eye-water*; many good Springs have a degree of *Terfiveness*; but that which is extraordinary hath a Fiction somewhat permanent, and is in the End gratifying. We have also, close by our Town, a Spring called *Rusty-well*; where it breaks out, and where it first falls, it tingeth the Stones of the Colour of *Rusty Iron*, and it hath the Smell strongly, and seemeth to taste of *Rusty Iron*, yet is as clear as any Water; and I tried it for a Month or more in my Study, putting *Cornish-slate* and Pebbles to it in a Glass, and it gave no Tincture at all to the Stones, nor any Sediment; so that I suspect the Tincture to proceed from some Effluvium mingled with the Water at first opening; but I confide not much in the single and short Trial I made. Some old Men boast of many great Cures it hath done.

Our Fore-fathers and very old Men scarce heard of the Name of the *Scorbute*; 'tis a seasonable Providence, if, since that Disease is become so Epidemical, the Remedy should be so obvious and vulgar, as is pretended to be by such ferruginous Springs.

This breaks out near the foot of a lofty Hill, which continues, with some lesser Falls, about 3 Miles Westward to *Hamden-Quarry*, where they dig a hard Free-stone of a dark yellow Colour. At *West-Camel*, 5 Miles hence Northward, is a very foetid black Spring, which tingeth Silver black immediately; and I am told, that about 10 Miles hence, more Eastward, near

Winc-

Wine-Cauntou, not many Years ago, they digged for *Coal*, where the *Coal-Men* were endangered by a *Fætid Damp*: And when they assayed the *Coal* in the *Fire* it proved very noisom, so that they forsook those *Coal-Mines*. Perhaps it may be serviceable to them that know not how to make an honest Use of *Arsenic* and other *Poisons*.

Here again, with some Timorousness, I propose the Inquiry, whether *subterraneous Steams* might not give the *dark yellow Tincture* to the *Hamden-Quarry*, and the Property to this Water of *Rusty-well* for the *Pulvous Coloration*? It cannot be expected, that Materials, differing so much as *Stones* seem to differ from *Water*, when perfectly petrified, should retain the very same Colour, though both received it from the very same *Steams*. The same I propose for the *Blackness* and *Fætidness* of the Spring in *West-Camel*, and of the *Coal* near *Wine-Cauntou*; that both may receive the same *Tincture* and *Odour* from *subterranean Steams*, which may perhaps be of so many Kinds and Mixtures, as to cause much of the great Diversities of *Metals*, *Minerals*, *Earths*, and *Soils*; and of some minute Differences in the *Colour*, *Taste*, *Odour*, and *Dress* of *Vegetables*; yea, and of the *Furrs*, *Hairs*, *Wooll*, and other little Varieties in *Animals* (particularly in *Sheep*) in several Places; more immediately in *Vegetables*, and of *Animals* by remoter Circumstances; I will not except the *Ethiopick Hue*, and *Humours* of Men in *distant Climates*, though *Vegetables* and *Animals* do, for the most part, retain their *seminal Properties* in *distant Climates* for many Generations. And perhaps from these *Terrestrial Steams* the *Vegetables* do imperceptibly draw some of their *Salts*, and much of their *Nutrimment*.

For these *Overtures* I will at present instance no more than thus. The illustrious Mr. *Boyle* hath, methinks, evinced, that the most solid Bodies, we know, have their *Atmosphæres* of *Steams* and *Exhalations*: And whatever the Materials be, which are under our *Terrene-Crust* towards the Center, whether fluid, flaming, or gross Substances, they must needs hold an Intercourse of *Transpirations*, and mutually operate by their perpetual Agitations and Whirlings about: And by the *Vulcano's*, frequent in *Japan*, and in several other Places, and by the *Heats* in deepest Mines, and by many other manifest Arguments, it appears, that there are always strong *Steams* ascending towards the Surface of the Earth: And, if their *generative Power* and other Efficacies were duly examined, and prosecuted to the best Purposes, we might perhaps in time find them to have a greater Virtue, and more useful for us, than many of the *Constellations* and *Celestial Influences*, which make no small Noise amongst *Astrologers*.

XLIII. Visiting the famous *boiling Fountain* at *Peroul*, not far from *Montpelier*, I found the Water to heave, and boil up very furiously in small Bubbles; which manifestly proceeded from a Vapour breaking out of the *Earth*; for upon digging any where near the Ditch, and pouring other *Water* upon the dry place newly dug, I observed in it immediately the same *boiling*, as the exquisite Naturalist Mr. *Ray* has related in his *Travels*. The like bubbling of Water is also found round about *Peroul*, upon the Sea-shore; and in the *Etang* itself. But when I had taken some of the Sand and Earth out

Observations
on boiling
Fountains
and subter-
raneous
Streams; by
Dr. Tancred
Robinson.
n. 169. p. 922
n. 172. p.
1038.

of

of the Fountain and Ditch, and put it into Vessels, pouring the same Water upon it, there did not appear the least *Perturbation* or Alteration thereupon; the Superficies of the *Water* continuing very smooth, equal, and quiet. And for further Satisfaction I sought out, and discovered in several dry Places of the Ground thereabouts, many little *Ventiducts*, Passages or Clefts, where the Steam issued forth; at the Mouths of these Channels or Pipes, placing some light Bodies, as *Feathers*, small thin Pieces of Straws, Leaves, &c. I found them soon removed away. This Vapour, upon the Application of a lighted Candle or Torch, did not flame, or catch the least Fire; as the Fumes running through a boiling Spring near *Wigan* in *Lancashire* do; with which those burning Fountains near *Grenoble* in *Dauphine*, near *Cibinium* or *Hermanstadt* in *Transylvania*, near *Cbermay*, a Village in *Switzerland* in the Canton of *Friburgh*, and that not far from *Cracovia* in *Poland*, do agree in many Particulars. Many *hissing* Springs, bubbling at the Top, I have found in *Switzerland* (the best watered Country that ever I saw) and in many Places near the *Rhine*. The like is related by *Varenus* near *Culina*, and by *Dr. Plot* in *England*. There are other *boiling Waters* of a quite contrary Temper, being actually *Hot* to several Degrees, so as to boil Eggs, and many other Things put into them; as those near the *Solfatara* not far from *Naples*; as also upon the Top of Mount *Zebio* in the Duke of *Modena's* Territories, not far from his *Villa* near *Sassalo*; in the Source of the *Emperor's* Bath at *Aken*, in the Country of *Juliers*; and in *Japonia*, mentioned by *Varenus*.

From the foregoing History we may take occasion to reflect a little upon the manifold Variety of *Exhalations*, prepared in and flying out from the vast *Magazines* and several *Reconditories* below, as to their Qualities and Effects; some being *cold* and *dry*, resembling Air or Wind; as those near *Peroul*, and in the *Caverns* of Mountains, especially those of *Aeolus* and other Hills of *Italy*; as also in Mines upon the meeting of *Water*. Others are *inflammable*, and of a *bituminous* Nature, tho' not actually *warm*; as those near *Wigan* in *Lancashire*. There are also many *Steams* very *Hot*, *Sulphurous*, and *Saline*; more especially those in the natural *Stoves*, *Sweating-vaults*, *Grottos*, *Baths*, and the *Volcanos* near *Naples*, *Baja*, *Cuma*, and *Puzzuolo*; as also in some of the *subterraneous Works* at *Rome*. Others there are of an *Arsenical*, and such like venomous Qualities; as in the *Grotto del Cano* on the Bank of the *Lago Agrano*, in many Mines, in poisonous Springs and Lakes.

Now these various *Steams*, meeting with and running thro' *Waters*, must cause a great Variety of *Phanomena* and Effects in them. Whether this great Diversity proceeds from the various *Breaths* of the *Pyrites*, and the *Lapis Calcarinus*, whilst under their different States and Changes, or from other sorts of *Effluvioms*, I dare not determine: But I am apt to believe that there may be Veins of the *Pyrites* near those Places; the *Inflammability* of which *Mineral* hath already been discoursed of, and made very clear by *Dr. Lister*.

An ingenious Author, relating the History of a burning Fountain in the *Palatinate* of *Cracovia*, affirms that upon *evaporating* the Water a dark, or Pitch-like Substance may be extracted, which cures the most *inveterate Ulcers*

n. 172. p.
1038.

n. 169. p. 923

n. 172. p.
1039.
V. d. Inf.
C. p. III.

cers in a very short Time; and that the Mud itself is very powerful against *Rheumatick* and *Gouty Pains*, *Palsies*, *Scabs*, &c. The Inhabitants of an adjacent Village, who drink much of this Spring, do generally live to 100 or 150 Years, which he attributes to the sanative Virtue of the *Water*.

The *Naptha*, or *Bituminous* Substance floating upon a Spring at *Pitchford* in *Sbropshire*, and upon *St. Catharine's Fountain* near *Edinburgh*, had been successfully used in *Ulcerous* and *Cutaneous* Distempers. Many such like Fountains of *Petroleum*, and *Oily Substances*, are to be met with up and down; as in the Island of *Zant* very plentifully; near *Gabian*, in the Road from *Montpelier* to *Beziers* in *Languedock*; in the *Valceline*, subject to the *Grifons*; at the Foot of Mount *Zebio*, in the Dutchy of *Modena*: Not to mention any of the Places written of already by *Varenius*. The Inhabitants, living near these Fat Oily Springs, take great care to gather and separate the *Bituminous Substance* from the *Water*, making very considerable Advantages of them, for *Mechanical* and *Medicinal* Uses. I have seen them gather it up with Ladles, and put it into large Filtres, or into great Funnels stopp'd at the *Bottom*; or else into Barrels set on one End, which have Spiggots near their Bottoms; when they are full, and have stood a while, they open the Spiggot or Stoppel to let out the *Water*; and, when the Oil or *Bituminous Substance* begins to come, they presently stop it again.

XLIV. 1. The Salt Springs at *Hall* in *Saxony* are Four; called *Galiaar*, the *Dutch Springs*, the *Wettritz*, and the *Hackel-dorn*. The three *First* hold above 7 Parts of *Salt*, 3 of *Marcasites*, and 14 of *Water*. The last holds less, but yields the purest Salt.

Salt-Springs at Hall in Saxony, and at Lunenburg; by... n. 8. p. 136.

They are (besides their *Œconomical* Use) employed medicinally to bath in; and to draw a Spirit out of it, exhibited with good Success against *Venom*, and the *Putrefaction* of the *Lungs*, *Liver*, *Reins*, and *Spleen*.

The Salt-Water at *Lunenburg*, being more greenish than white, and not very *Transparent*, is about the same Nature, and holds with that of *Hall*. It hath a Mixture of *Lead* with it, whence also it will not be sod in *Lead Pans*; and, if it held no *Lead* at all, it would not be so good, that Metal being judged to purify the *Water*; whence all the Salt of *Lunenburg*, is preferred before all others that are made of *Salt Springs*.

2. I made *Trial* of that Salt-Spring at *East-Chenock* in *Somersetshire* (above 20 Miles from the Sea) which tho' not so salt, by reason of the late *Rains*, as in *Summer*, yet from a *Wine-Quart*, by *Evaporation*, yielded near 80 *Grains*.

In Somersetshire, by Dr. Highmore; n. 56. p. 1130.

3. At *Salt-Water-Haugh* near *Butterby*, about a Mile and a half from *Durham*, in the middle of the River *Weare*, rises a Salt-Spring. It is good to be seen and tasted only in the *Summer-time*, when the *Water* is discharged all on one side of the Channel; for in *Winter*, when the River is high, it loses its *Salt* in the fresh Streams, so that they are not perceivable. The *Water* seems to bubble up equally in all Parts in the Channel, for the Space of 40 Yards in Length, and about 10 in Breadth. The saltiest of all the Springs issues out of the middle of a *Rock*, the Surface of which was manifestly saltish; and which, in a hot Day, as I was told, would be all covered over with a perfect *Salt*. I had all the *Water* laved out of the Place where

In the Bishoprick of Durham, by Mr. Hugh Tod, n. 163. p. 726.

where it seemed to stagnate, and immediately out of the Body of the Rock there bubbled up Water as salt as the former. It was as high as any Brine can be, and tho' but little in Quantity, in Comparison of the fresh River, yet of that Force to give a Brackishness to the Streams a hundred Yards below. Those that have boil'd this Brine say, that it affords a great Quantity of Bay Salt, not so palatable, yet as useful as ordinary Salt is. It *tinges* all the Stones with a red Colour. The Sea is eight Miles off, where nearest.

Salt-springs
and Salt-
Making at
Nantwich in
Cheshire, by
Dr. Will.
Jackson, n.
53. p. 1060.
n. 55. p. 1122
n. 54. p. 1077

XLV. The Depth of the Salt-springs is in some Places not above 3 or 4 Yards: In *Nantwich* the Pit is full 7 Yards from the footing above the Pit; which is guessed to be the natural Height of the Ground, though the Bank be 6 Foot higher, accidentally raised by Rubbish of long making Salt, or Walling, as they call it. In two Places within our Township the Springs break up so in the Meadows, as to fret away not only the Grass, but part of the *Turf* of the Meadow; and hath a salt Liquor ousing as it were out of the Mud, but very gently.

Our Country is generally a low Ground, witness the Name given to it, the *Vale Royal of England*; yet it is very full of collicular Eminencies and various Risings, to distinguish it from being all Meadow. The nearest Hills (of those worth calling Hills) is about 7 Miles distant from the Springs; it is steeper but not much higher than *Highgate-Hill*.

We have also a peculiar sort of Ground in this County and some adjacent Parts, which we call *Mosses*: And they are a kind of moorish boggy Ground, very stringy and fat; which serveth us very well for *Turfs*, cut out like great Bricks, and dried in the Sun. And this kind of Ground is so much here, that there are few *Townships* but they have their particular *Mosses*. In these is found much of that Wood we call *Firr-Wood*, which serves the Country-People for Candles, Fewel, and sometimes for small *Timber-Uses*; and this the Vulgar concludes to have lain there since the *Flood*. But generally these *Mosses* seem to be Places undermined by some *subterraneous Streams*; or by the Dissolution of some Matter, that made them equal with the rest of the Ground formerly: In which Conjecture I am confirmed by this, that near a Place of my Lord *Cholmondeley's*, called *Bilkely*, about 9 or 10 Years since, not far from one of these *Mosses*, without any Earthquake, a Piece of Ground, of about 30 Yards over, fell in with an huge Noise, and great *Oaks* growing on it fell in with it together; which hung first with Part of their Heads out, afterwards suddenly sunk down into the Grounds, so as to become invisible: Out of which Pit they drew Brine with a Pitcher tied to a Cart-rope, but could then find no *Bottom* with the Ropes they had there: The Pit is since filled up with Water, and now doth not *taste* salt, but a very little brackish, a very small Rivulet passing through it. The nearest Salt-springs to this Place are at *Durtwich* about three Miles from it.

Our Springs are about 30 Miles from the Sea; and generally lie all along the River *Weever*: Yet there is an appearance of the same *Vein* at *Middlewich*, nearer the River *Dane* than *Weever*; which notwithstanding seems not to be out of the Line of the *Weever's Stream*; and these lie all near Brooks and in the meadowish Grounds.

I could observe no Singularity at all in the Plants; for, where the Salt reaches the Surface, it frets away all, as I said before; and upon the *Turf*, near the old decayed Pits, grows the very same that doth in the remotest Place of the Meadow; only I observe, that where the *Turf* was fretted away Rushes maintained their Station longest.

The Water is so very cold at the Bottom of the Pit, that when the Briners sometimes go about to cleanse the Pit, they cannot abide in above half an Hour, and in that time they drink much strong Water. There is not any hot Springs (that I can hear of) nearer us than *Buckston-well*, which is about 30 Miles distant.

Several new Brine Springs have been of late both sought and found; yet none knows of any Shells, but rather a blackish Slutch mixt with the Sand, which infects the whole Spring (like the *Scuttle Fish*) black when 'tis stirred; else the Water runs very clear.

The Springs are rich or poor in a double Sense; for a Spring may be rich in Salt, but poor in the Quantity of Brine it affords. Thus they have a rich Brine in their chief Pit at *Middlewich*, which yields a full 4th Part of Salt; yet is it so thrifty in its Brine, that the Inhabitants are limited to their Proportions out of it, and their Quantity is supplied out of Pits that afford a weaker Brine. Our Pit at *Nantwich* yields about 1 Pound of Salt for 6 Pounds of Brine; but then 'tis always, without any sensible Difference, so plentiful a Spring, that whereas they seldom *Wall*, that *make Salt*, in above 6 Houses at a time, and there are or should be about 50 *Wich-houses* in the *Town*; this Pit is judged sufficient to supply them all, without falling much lower than a Yard or two at most. And this Advantage would accrue over and above, that such quick Use of the Pit extremely strengthens the Brine, perhaps to a Degree little less than that of *Middlewich-Pit*: For, I have tried it my self, that a Quart of Brine, when the Pit had been drawn off 3 or 4 Days to supply 5 or 6 *Wich-houses*, hath yielded an Ounce and an half more of *Salt*, than at any other time when it hath had a Rest of a Week or thereabouts.

March 8. 1668. I weighed 2 Pounds of distill'd Water in a Narrow-mouth'd Glass-bottle, that I might take an exact Mark for a Quart. This Bottle, being filled with our Brine to the very same Mark, weighed (besides the *Tare* of the Bottle) 2 Pounds 3 Ounces and 5 Drachms. This was taken up when the *Wich-houses* began to work, so that the Pit was but little drawn. I filled up the Bottle with the same Brine, and it weighed just 3 Drachms more. This Brine boiled away, without any Addition or Clarification, made 5 Ounces and 4 Drachms of Salt. Five Days after, when the Pit had been drawn all that while for the working of the *Wich-houses*, viz. *March 13.* the same Bottle, fill'd to the Quart Mark aforesaid with Brine then taken up, weighed, besides the Bottle, 2 Pounds 4 Ounces and an half: The same time, the Bottle filled, as in the former Experiment, weighed just 2 Pounds and a half, which is 3 Drachms more than the Quarter Mark before; which boiled into *Salt* made 6 Ounces, 6 Drachms and 2 Scruples: Which exceeds

the former Quantity of *Salt*, 1 Ounce 4 Drachms and 2 Scruples, though the Brine exceeded the former in Weight but 4 Drachms.

By which Trial I confuted also a Tradition which the Briners have amongst them, *viz.* that the Brine is strongest at the time of the *Spring-Tides*, to wit, at the Full and Change of the Moon. For *March 8*, aforesaid was only one Day past the Full, and then the Brine was weaker than it was the 13th Day, when it was 6 Days past the Full. So that I conclude there could be no other Reason, than that the much *drawing* makes way for the *Salt-Springs* to come the quicker, and allows the less time for the Admission of *Fresh-Springs*. But 'tis observed by the Briners, that they make more *Salt* with the same Quantity of Brine in dry than in wet *Seasons*.

Their manner of *working* is this: They have formerly boiled their Brine in 6 *leaden Pans* with Wood-fire; upon which Account they all *claim* their Interest in the Pit by the Name of so many 6 *Leads Walling*; by which they each know their Proportion; but, in the Memory of many alive, they changed their 6 *Leads* into 4 *Iron Pans*, something better than a *Yard square*, and about 6 Inches deep, still fitting the Content of these to that of the 6 *Leads*: And of late many have changed the 4 *Iron Pans* into two greater; and some *Wall* but in one; but still the Rulers gage it to their old Proportions.

They use for their *Fewel* Pit-Coals, brought out of *Staffordshire*. These *Pans* are set upon *Iron Bars*, and made in on all Sides very close (that the *Flame* nor *Smok* break through) with *Clay* and *Bricks*. They first fill their *Pans* with Brine out of the *Pit*, which comes to them in several *wooden Gutters*; then they put into their *Pans*, amongst their Brine, a certain Mixture, made of about 20 Gallons of Brine, and 2 Quarts of *Calves*, *Cows*, or chiefly *Sheep's* Blood, mixt into a *Claret* Colour: Of this Mixture they put about 2 Quarts into a *Pan* that holds about 360 Quarts of Brine; this bloody Brine at the first boiling of the *Pan* brings up a *Scum*, which they are careful to take off with a Skimmer, made with a *wooden Handle* thrust through a long Square of *Wainscot Board*, twice as big as a good square *Trencher*: This they call a *Loot*. Here they continue their Fire, as quick as they can, till half the Brine be wasted; and this they call *Boiling upon the fresh*. But, when 'tis half boiled away, they fill their *Pans* again with new Brine out of the Ship (so they call a great *Cistern* by their *Pan's* Sides, into which their Brine runs through the wooden Gutters from the Pump, that stands in the Pit;) then they put into the *Pan* 2 Quarts of the Mixture following: They take a *Quart of Whites* of *Eggs*, beat them thoroughly with as much Brine, till they are well broken; then mix them with 20 Gallons of Brine, as before was done with the Blood; and thus that which they call the *Whites* is made. As soon as this is in, they boil sharply, till the *second Scum* arise; then they scum it off as before, and boil very gently till it corn; to procure which, when Part of the Brine is wasted, they put into each *Pan*, of the Content aforesaid, about a *Quarter* of a *Pint* of the best and strongest *Ale* they can get; this makes a momentary *Ebullition*, which is soon over; and then they abate their Fires, yet not so, but that they keep it boiling all over, though gently; for the Workmen say, that if they boil fast here (which they call *boiling on the Leach*, because they usually

usually all this time lade in their *Leach-brine*, which is such Brine as runs from their *Salt*, when it is taken up before it hardens) if, I say, they boil fast here, it wastes their *Salt*; after all their *Leach-brine* is in, they boil gently till a kind of Scum comes on it like a thin Ice; which is the first Appearance of the *Salt*: Then that sinks, and the *Brine* every where gathers into *Corns* at the Bottom to it, which they gently rake together with their *Loots*. I say gently, for much stirring breaks the *Corn*. So they continue till there is but very little Brine left in the *Pan*: Then with their *Loots* they take it up, the *Brine* dropping from it, and throw it into their *Barrows*, which are Cases made with flat cleft Wickers in the Shape almost of a Sugar-Loaf, the Bottom uppermost, when the *Barrow* is full, they let it stand so for an Hour and an half in the *Trough*, where it drains out all the *Leach-brine* above said; then they remove it into their *Hot-House* behind their Works, made there by 2 *Tunnels* under their *Pans*, carried back for that Purpose. The *Leach-brine*, that runs from the *Barrows*, they put into the next Boiling; for 'tis to their Advantage, it being *Salt* melted, and wanting only hardning.

Fig. 64.

Fig. 65.

This work is performed in 2 *Hours* in the smaller *Pans*, which are shallower, and generally boil their Brine more away; wherefore their *Salt* will last better, though it does not *granulate* so well, because when the Brine is wasted, the Fire and the Stirring breaks the *Corns*. But this *Salt* weighs heavier, and melts not so soon, and therefore is bought by them that carry it far. But in the greater *Pans*, which are usually deeper, they are about half an Hour longer in boiling; but, because they take their *Salt* out of their Brine, and only harden it in their *Hot-House*, it's apter to melt away in a moist Air. Yet of this Sort of *Salt* the bigger the *Grain* is, the longer it endures; and generally this is the better *granulated* and the clearer, though the other be the whiter. Upon which I rather think, 'tis the taking of the *Salt* out of the Brine before it be wasted, that causes the *granulating* of it, than the Ale, to which the Workmen impute it. This Kind measures profitably well, therefore it is much bought by them who buy to sell again.

They never cover their *Pans* at all, during their whole time of boiling. They have their Houses like Barns open up to the Thatch, with a *Louverbole* or two to vent the Steam of the *Pans*. Possibly Tiles may do better, but no Body is yet so curious as to try; but the Steam is such, that I am confident no Plaster will stick, and the Board will warp, and their Nails will rust so, as quickly to fret in Pieces.

With our *Salt* both *Beef* and *Bacon* is very well preserved sweet and good a whole Year together; and I do apprehend this *Salt* to be rather more searching than *French Salt*, because I have often observed, that Meat kept with this *Salt* shall be more fiery *Salt* to the midst of it, than I have observed when I have eaten powder'd Meat on Ship-board, which was probably done with *French Salt*; I then being on the South-side of *England*, and in a *Dutch Vessel*. 'Tis certain *Cheeshire* sends yearly much *Bacon* to *London*, which yet had never any Mark of Infamy set upon it; and hang'd Beef (which others call *Martimass-beef*) is as good and as frequent in *Cheeshire* as in any Place; so that I conclude that this last is fully effectual for any use, and as good as any other.

The Sweepings of such Salt is constantly shed and scattered about on the Floor, not without taking much of the Dirt (which occasions its *Greyness*) and is called *Grey Salt*. This sells not at half the Rate of *White Salt*, and is only bought up by the poorer sort of People, and serves them in salting *Bacon*, coarse *Cheese*, &c. *Cats of Salt* are only made of the worst of Salt, when yet wettish from the *Pans*; molded and intermixt with interspersed *Cummin-Seed* and *Ashes*, and so baked into a hard Lump in the Mouths of their Ovens. The Use of these is only for *Pigeon-houses*. But *Loaves of Salt* are the finest of all for Trencher Use. There is no Difference in the boiling of these from the common way of the fine Salt; but in the making up some Care is used: For first they cut their Barrows, they intend for *Salt-Loaves*, with a long Slit from Top to Bottom equally on both Sides; then they tie both Sides together with Cords; then they fill this Barrow with Salt boiled as usually, but in the filling are careful to ramm down the Salt with the End of some wooden Bar, continuing this till the Barrow be fill'd to their Minds; then placing it speedily in their *Hot-house*, there let it stand all the time of their *Walling*: Wherefore they prepare for their *Loaves* at the Beginning of their Work, that they may have all the Benefit of their *Hot-houses*; and, when these begin to slack, they take out the *Loaves*, and untie the Cords that fastened the Barrow, that both Sides of the same may easily open without breaking the Loaf. They then take the Loaf and bake it in an Oven where Household-Bread hath been baked, but new drawn forth. This they do twice or thrice, 'till they see it baked firm enough; and this being placed in a Stove or in a Chimney-Corner, and close covered with an Hose of Cloth or Leather, like the Sugar-Loaf-Papers, will keep very white; and when they have occasion to use any, they shave it off with a Knife (as you do Loaf-Sugar) to fill the Salt-seller.

Explication
of the Fi-
gures.

Fig. 63. The Loot.

Fig. 64. *aa*, Two Barrows filled with Salt. *bb*, The Salt heaped above the Top of the Barrows, and patted down hard. *C*, The *Leach-Trough*.

Fig. 65. *aaaaaa*, The *Hot-house* between the Wall and the Chimney. *bb*, two Tunnels. *CC*, The Chimney-back, into which the Tunnels convey the Smoak. *dddd*, The 4 *Pans*. *E*, The Partition-Wall between the *Pans* and the *Hot-house*. *ff*, The *Fire-places*. *gg*, *Ash-holes*. *hh*, The *Hearth* below. *ii*, The *Descent* to the *Hearth*.

A: Droit-
wich in
Worcester-
shire; by Dr.
Tho. Rastel.
n. 142.
p. 1059.

The Country is neither *Plain*, neither hath it any great *Hills*, but many small *Risings*; the greatest *Hills* near us being the *Licbie* within 6 Miles, which some call *Look-bigh*, supposing it to be the highest Ground in these Parts, because the Springs which rise there run into the North and South Seas; near to which are *Clent-Hills*, about the same Distance. On the other Side the River *Severn* are *Aberly Hills*, at about 7 Miles Distance from us. There are many Salt-springs about the Town, which is seated by a Brook-side, called *Salwarp-brook*, which arise both in the *Brook*, and in the Ground near it, tho' there are but 3 Pits that are made use of.

Where the Springs are saltest there grows nothing at all, but by the *Brackish* Ditches there grows *Aster Atticus* with a pale Flower, which I find no where else with us.

Some

Some of the *Salt-springs* rise on the Top of the Ground, which are not so salt as others. The great *Pit*, which is call'd *Upwich-Pit*, is 3 Foot deep, in which are 3 distinct Springs rising in the Bottom; one comes into the *Pit* North-west, another North-east, the 3d South-east, which is the richest both in Quantity and in Quality. They all differ in Saltness, which I can give no exact Account of, it being impossible so to separate them, that there shall be no Mixture; the *Pit* is about 10 Foot square; the Sides are made with square Elms jointed in at the full Length, which I suppose is occasioned by the *Saltness* of the Ground that appears to me to have been a *Bog*; the Surface of it is made of Ashes. That it was originally a *Bog*, I am induced to believe, for not many Years since, digging to try the Foundation of a *Seal*, for so we call our Houses we make Salt in) I thrust a long Staff over Head.

Tho' the *Brine* be colder than the other Water, yet it never freezeth; but the Rain Water, that lies upon the *Brine*, in extream hard Frosts will freeze, but not much.

The *Soil* about the Town, on the lower Side of it, is a black rich Earth, under which 2 or 3 Foot is a stiff gravelly Clay, then Marle. Those that make Wells for fresh Water, if they find Springs in the Marle, they are generally fresh; but if they sink thro' the Marle, they come to a whitish Clay mixed with Gravel, in which the Springs are more or less brackish.

In the great *Pit* at *Upwich* we have at one and the same time 3 Sorts of *Brine*, which we call by the Names of *First-man*, *Middle-man*, and *Last-man*; these Sorts are of different *Strengths*; the *Brine* is drawn by Pump; so that which is in the Bottom is first pumped out, which is that we call *First-man*, &c. That I might make an exact Trial of the Strength, I made me a Quart that contained 24 Ounces Troy of distill'd Water; which Quart being filled with the first *Brine*, besides the Tare of the Quart weighing 29 Ounces, made 7 Ounces and 3 Drachms of Salt without any Addition; the next Day I weighed the same Salt again, and it weighed 7 Ounces and 6 Drachms; so that 4 Tuns of *Brine* make above one Tun of Salt. The same Quart filled with *Middle-man*, which is the second sort of *Brine*, weighed 28 Ounces; I also weighed a Quart of *Brine* as it came immediately out of the Springs, which weighed 28 Ounces, and the 3d sort 27 Ounces; so that what the first gets, the last loseth, which doth precipitate as much in 24 Hours, as if it stood a much longer Time.

The Quantity of *Brine* that this *Pit* yields every 24 Hours is as much as will make 450 Bushels of Salt, which is drawn out twice or three times a Day, for so oft we ordinarily draw, and that as long as the Pump will go.

In the best *Pit* at *Netherwich* a Quart of *Brine* weighs 28 Ounces and an half; this *Pit* is 18 Foot deep, and 4 Foot broad, and yields as much *Brine* every 24 Hours as makes about 40 Bushels of Salt; there is but one Spring in the *Pit*, that comes in 2 Foot and 8 Inches above the Bottom.

The worst *Pit* at *Netherwich* is of the same Breadth and Depth as the former, a Quart of *Brine* out of which weigheth 27 Ounces, and yields as much *Brine* daily as makes about 30 Bushels of Salt. In this *Pit* are 3 Springs;

two in the Bottom, and one about 2 Foot higher. These Pits are within 6 Yards of one another.

These Pits are near the *Brook*; the great Pit on the North Side; and about a Quarter of a Mile lower, the 2 lesser Pits on the South-side.

In the great Pit I found no Variation either in Quality or the Strength of the *Brine*, but the Springs in the other Pits are augmented by much Rain, and yield less Salt.

That every Man may know his own Proportion, the *Brine* is divided into *Pbats Wallings*; a *Pbat Walling* is divided into 12 weaker *Brines*; and every weaker *Brine* is divided into 8 *Burdens*, every *Burden* being a Vessel that contains about 32 Gallons; whereof every one hath 6 *Burdens* of *First-man*, 6 of *Middle-Man*, and 6 of *Last-man*, so that every Man hath not only his just Proportion in Quantity, but in Quality also. This *Brine* is carried in Coolers to every Man's Seal by 8 sworn Men, which we call *Masters* of the *Beachin*, and 4 *Middle-men*, and there put into great Tuns for Use.

The *Fewel* heretofore used was all Wood; but, since the Wood hath been destroyed by the Iron-Works, we use almost all *Pit-coals*, which are brought to us by Land 13 or 14 Miles.

The *Pbats* we boil our *Brine* in are made of *Lead*, cast into a flat Plate at 5 Foot and an half long, and 3 Foot over; and then the Sides and Ends beaten up, and a little raised in the Middle; which are set upon *Brick-work*, which we call *Ovens*; in which is a Grate to make the Fire on, and an *Ash-hole*, which we call a *Trunk*: In some *Seals* are 6 of these *Pans*, in some 5, and some 4, some 3, some 2. In each of these *Pans* is boiled at a time as much *Brine* as makes 3 Pecks of white Salt, which we call a *Lede*, and is laded out of the *Pan* with a *Loot*, and put into Barrows, which are set into *Bastals* over Vessels we call *Leach-combs*, that the *Brine* may run from the Salt; which *Brine* we call *Leach*, with which we dress our *Pbats*, when the cold *Brine* they are first filled with is something boiled away. In these *Bastals* the Salt stands still till it's dry, which is about 4 Hours; then we carry it into *Cribs* which are Houses boarded on the Bottom and Sides, where 'tis kept till sold, which is sometimes half a Year, or 3 Quarters; in which time, if the *Crib* is good, it will not waste a 12th Part, the Salt itself being of so strong a Body: Whereas in *Cheshire* they are forced to keep their Salt in Barrows in Stoves to dry it, and make it no faster than they sell.

For *clarifying* the *Brine* we use nothing but the *Whites* of *Eggs*; of which we take a Quarter of a *White*, and put it into a Gallon or two of *Brine*; which, being beaten with one's Hand, lathers like Soap; a small Quantity of which *Froth* put into each *Pbat* raiseth all the Scum (so that the *White* of an *Egg* will clarify 20 Bushels of Salt;) by which Means our Salt is as white as any thing can be, neither hath it any ill Savour, as that Salt hath that is clarified with Blood.

For *granulating* it we use nothing at all; for the *Brine* is so strong of itself, that, unless it be often stirred, it will make Salt as big grain'd as *Bay-Salt*. I have boil'd *Brine* to a *Candy-height*, and it hath produc'd *Clods* of Salt as clear as the clearest *Allom*; like *Isle of May Salt*; so that we are necessitated to
put

put a small Quantity of *Resin* into the *Brine*, to make the Grain of the *Salt* small.

Besides the *White-Salt* we have another Sort that we call *Clod-Salt*, which grows to the Bottom of the *Phats*; that after the *White-Salt* is laded out, is digged up with a Picker, which is made like a *Mason's Trowel*, pointed with Steel, and put upon a short Staff; this is the strongest Salt I have seen, and is most used for salting *Bacon* and *Neats-Tongues*; it makes the *Bacon* redder than other Salt, and makes the Fat eat firm; if the Swine are fed with *Mast*, it hardens the Fat almost as much as if fed with *Pease*, and salted with *white Salt*. It is very much used by Countrywomen to put into their *Runnet Pots*, and as they say is better for their Cheese. These Clods are used to broil Meat with, being laid on Coals. We account this Salt to be too strong to salt Beef with, it taking away too much of its Sweetness.

A third sort of Salt we have, which we call *Knockings*, which doth candy on the *Stails* of the Barrow, as the Brine runs from the Salt, after it is laded out of the *Phats*; This Salt is much used for the same Uses as the *Clod-Salt*, tho' it is not altogether so strong.

A fourth Sort we have, which we call *Scrapings*, that is, a coarse Sort of Salt that is mixed with Dross and Dust that cleaves to the Tops of the Sides of the *Phats*; this Salt is scraped off the *Phats* when we reach 'em, that is, when we take our *Phats* off the Fires to beat up the Bottom, and is bought by the poor sort of People to salt Meat with.

A fifth Sort is *Pigeon-Salt*, which is nothing but the Brine running out through the Crack of a *Phat*, and hardens to a Clod on the outside over the Fire.

Lastly, The *Salt-loaves* are the finest of white Salt, the Grain of which is made something finer than ordinary, that it may the better adhere together; which is done by adding a little more *Resin*, and is beaten into the Barrows when it is laded out of the *Phat*.

Our Salt is not so apt to dissolve as *Cheshire-Salt*, nor as that Salt that is made by dissolving *Bay-Salt*, and clarifying it, which is called *Salt upon Salt*, which appears by our long keeping it without any Fire.

I believe there cannot be better white *Salt* than ours, for several Reasons.

1. There is none can be whiter, and consequently more free from Dross.
2. It is the weightiest as I have seen my self, and been informed by others; for the Bags of Salt, I have usually seen brought out of *Cheshire* on Horse-back, contain 6 Bushels and a half, or 7 Bushels; whereas the best Horses that carry Salt from hence, if they carry it above 5 Miles, carry not above 3 Strike and 3 Pecks, or 4 Strike. A *Winchester Bushel* of our Salt weighs half a hundred Weight; so that it must necessarily follow, the weightiest and driest must needs be best.

3. In the time of the first *Dutch War* our Salt was carried down into the West, where they had none before but foreign Salt; where, at first using ours, they complained that it made their Meat too salt; which was because they put as much of ours on their Meat as of others: If so, it must be better than *French Salt*.

4. I have been assured by many that have made use both of ours and *Che-
shire-Salt*, that both for *Flesh* and white *Meat* they must lay on more of *Che-
shire-Salt* than of ours.

5. It doth preserve all Sorts of *Flesh* for long *Voyages*, viz. to *Jamaica*,
as well as any, which hath been lately tried.

6. I have seen *Herrings* that have been salted with our *Salt* in *Ireland*, and
brought over to this *Town*, which have been whiter and better tasted than
than those salted with *Bay-salt*.

7. It is an ordinary Way of powdering *Beef* with us to give it but one salt-
ing to keep it the whole *Year*.

We use not *Iron Pans* as they do in *Cheeshire*, and other *Places*; for we have
found upon *Trials*, that the *Strength* of the *Brine* doth so corrode, that it
quickly wears out those of forged *Iron*, and breaks those of cast *Iron*.

The Forma-
tion of Salt
and Sand
from Brine;
by Dr. Rob.
Plot. n. 145.
p. 95.

XLVI. At my Request two curious Observers, Neighbours to the *Brine-
Pits* in *Staffordshire*, to 8 Folds of fine *Holland* added as many more of finer
Cambrick; through both which they strained a competent Quantity of the
Brine, but found nothing left in this very close *Colander* but a little black
Dust, which they imputed only to the *Foulness* of the *Water*, it being no-
thing like *Sand*; for, having examin'd the *Cloth* both with their *Fingers* and
a *Microscope*, they could feel or see no more of *Sand* than if they had per-
colated the clearest *Spring-water*; and yet this *Brine* is found to hold in boil-
ing at least $\frac{1}{4}$ of as much *Sand* as *Salt*.

But, notwithstanding this *Experiment*, it did not seem to their Apprehen-
sions necessary, that the *Sand* should be generated in the boiling, but might
rather be originally there; for, before they strained it, they observed in the
Water, by the Help of a *Microscope*, a great Multitude of very minute
Animals, much smaller than those in *Pepper Water*, swimming about in it,
together with many small transparent *Plates*, some of them a little bigger
than the *Animalcules*, and some less; but all of a rectangular, oblong Fi-
gure, tho' some indeed seemed very near a square, which they found also in
the *Water*, after straining, as thick as before; the *Pores*, or rather *Interstices*,
between the *Threads* of the *Holland* and *Cambrick* appearing in the *Micro-
scope* 20 times greater than either the *Animalcules* or *Plates*. And these they
judged to be the original *Particles* both of the *Salt* and *Sand*; which, as the
Water evaporates in boiling, they thought might gather together till they
made up such a visible coarse *Body*, as we see the greater *Corns* of each are.
Wherein they were confirmed in a little time; for observing with an excel-
lent *Microscope*, some of the strong *Brine*, which drops from the *Baskets* or
Barrows when the *Salt* is first put into them, though at first it looks like
clear *Water*, yet upon a more accurate *Observation* it appear'd exceeding
full of these oblong *Particles*; which, as they look'd on them, they could
sensibly perceive to gather together, and club to make greater *Parts*; and,
as the *Water* dried off from the *Glass*, to grow far larger and larger, till
they appear'd as big, and not much unlike a large-siz'd *Table Diamond*:
Which made them guess that the *Sand* might be also generated (if
I may

I may say so) after the same manner, it appearing to them to be nothing (pardon the Expression) but insipid Salt, composed of Parts not so sharp pointed as the other, but rounder and blunter angled, and consequently not so pungent on the Tongue.

Upon the Suggestion, having some of the *Sand* by me, I endeavour'd to dissolve it in fair Water, to see whether I could reduce it again into its former State, but without Success; its Parts being so inseparably fixed, that they would by no means dissolve. I also tried the *Salt*, which tho' it dissolved, yet would not render itself again into the Plates. Whereof sending an Account to my Friends in *Staffordshire*, they were pleas'd also to make a further Trial of dissolving the *Sand* separated from the *Salt*, and boiling; which though they confess'd they could not do any to a considerable Quantity, yet they found, that after the straining, it was not so heavy by a great deal as before, the Water that came from it being very clear; which made them believe, that it did dissolve in some measure, unless, as is very probable, there were in the *Sand* some Particles of *Salt*, which, upon Dissolution, were separated from it, and rendred it lighter: Nevertheless they did not doubt, but a great Part of the *Sand* might also be dissolved, though perhaps no great Quantity in *Pump-water*, in which it seems they tried it.

One of the aforesaid Gentlemen casually looking upon some of the Salt made at those Pits, before it was dried and beaten small, observed that many of the larger Corns were of the same Shape to the naked Eye, as the minute ones appeared in the Microscope, and that they were visibly made up of a great number of small Plates, shooting up from a quadrangular oblong Base into a very obtuse Pyramid, hollowed within.

XLVII. At *Northwich* in *Cheshire*, upon the *Weever*, in 4 Pits is great Plenty of Brine; it stinks of *Sulphur* apparently in all the Pits; it becomes a-

*Observations
on the Mid-
land Salt-
Spring. By
Dr. Lister.
n. 156. p. 489*

tramentous with Galls. Here are used *Sand-pans*, which are let down in the Corners of the great Iron Boilers, before the Salt shoots into Grains, and these catch the Sand. Besides, there are thick Stone Flakes raised from the Bottom of the said Iron Boilers once a Week.

N. B. Within half a Mile of these *Brine-Pits* at *Marberry*, a Salt-Rock was found by the Augur in boring for Coals.

*Vid. Inf.
cap. 3.*

Here, and at *Middlewich*, also at *Nantwich*, and all along the River *Weever*, which are Places many Miles distant, sink on either Side of the River, and you will scarce miss of Brine, as I was credibly inform'd by the most knowing Men in that particular: But yet it proves a venture, whether the Brine will be strong enough to boil and turn to account; and for this Reason, their Pits sometimes fail them to their great Loss, (as they shew'd me once which had been wrought to very great Profit) by a small sweet Spring breaking into it, and sometimes the River *Weever* itself does them this Mischief.

At *Nantwich*, upon the same River, is one very large Brine-pit: This Water also plainly smells as it were corrupted, or like Sulphur, but notoriously upon a few Days forbearance of the Pit. It becomes atramentous with Galls. It yields a white Sand or Stone, adhering in the manner of thin Scales, to the Bottom of the Iron-Pans, in which the Brine is boiled.

Weston Brine-pit near *Stafford*. This Water in the Pit stinks like rotten Eggs: With Galls it becomes suddenly atramentous. It purges and vomits violently, and that drunk in a small Quantity. Here are used *Sand-pans* to catch the white Sand, and there are Flakes of Stone also raised from the Bottom of the great Iron Boilers.

Mr. J. Collins, S. & Fish.

Droitwich in *Worcestershire*: The upper *Wych* or Brine-pit is very neatly kept, and exceedingly drawn, because there are so many Proprietors, and but a small Pit, comparatively to those which have been named above.

Here the Salt is boiled in small Leaden Pans, and there is not the least Grain of Sand at any time, which either falls before the graining of the Salt, or that adheres to the Pans bottoms, notwithstanding what hath been said to the contrary: And therefore this Brine being naturally without Sand, it must yield the more wholesome Salt.

The lower Pit at the *Netherwich* in the same Town hath but one Proprietor, as I remember, and therefore is less drawn, but yet is constantly and well wrought. Here is also no News or Knowledge of any Sand at all. The Water of those Pits stink like rotten Eggs, especially after *Sunday's* Rest: And (*N. B.*) will, if Flesh be pickled in them, make it stink in 12 Hours. And yet the Salt that is boiled out of these Pits, is accounted the very best Inland Salt of *England*, and I believe as good as any in the World.

I observed in a Ditch over-against the *Nether Wick-house*, the Water standing with a white Scum, as at the *Sulphur Spaws* in *Yorkshire*.

I shall add by way of Corollary.

1. That all our *Yorkshire* Wells call'd *Sulphur Spaws* (which are many) are no other than so many Brine-pits, and if they were well drawn and wrought, would be as little offensive in smell.

Vid. Infr. S. XLVIII.

2. That this Stone-powder is also to be found adhering to the Iron Pans, where the Sea-water is boiled into Salt, as it is at *Skiels*, in the Bishoprick of *Durham*; but I do not remember it to be in the Lead-pans at *Medop* and *Milthrop* in *Lancashire*, where the Sea-sands are lixiviated, and that *Lixivium* of *Sea-salt* by *Insolation*: Nor could I observe it in the least, in distilling of Sea-water in a Glass Still, or in the *Yorkshire* stinking Wells; of which a good Quantity is yearly made for medicinal Use, or rather Curiosity, to vend to Strangers.

N. B. This Sand falls to the Bottom before the Salt-Grains.

This is so also in all other *Mineral Salts*, whose Brines being boiled, ever let go first this stony Part: The *Oker* falls in Powder upon the first boiling, but the *Lapis Calcarius* rises and flakes like Wafers, which yet falls in Powder by Frost, as we have elsewhere observed.

3. This Stone-Powder irrigated with fair Water, and kept moist, does yield in immature Salt of an uncommon Figure: Which I have described at large and figured.

De Font.
Med. Angl.

4. Notwithstanding the great Affinity betwixt the Salt of the Midland Brine-pits, which is common Salt, and the Sea-Salts: I must not omit (amongst others) a specifick Difference, which is by me (that I know off) now first published, and which, in my Opinion, makes the Sea-water a Water of its own kind: And also shews, that none of the Productions of incinerated Plants are truly a Marine-Salt.

The Angles of Chrystals of common Salt, boiled out of the *Midland Brine-pits*; as also of Salt-Gem, or Rock-Salt, which I take to be one and the same, are intire, and so are all those lixiviated marine Salt, so called and described by Dr. *Grew*. But the *Angles* of the *Chrystals* of true Sea-Salt, are ever some of them cut off into *Triangular Planes* at one of the Sides. And this I learnt by suffering a Bottle of *Sea-water*, taken up upon the Coast at *Scarborough*, where no River near enters it, to evaporate leisurely placed in the Shade, after it had been half boiled away; and here all the Chrystals (which are many, and of different Magnitudes) did yet agree in a like Figure, as is described; and I do not doubt but it will succeed with any *Sea-water*.

XLVIII. *AAA*, is the *Sea*.

11, The Entry, by which the Sea-water passes into *BB*.

BB, The first Receptacle; in which the Water maketh 3 Turnings as you see, and is 10 Inches deep.

22, The Opening, by which the first and second Receptacle have communication one with another.

The Way of
making Salt
in France,
by Dr. * * *
p. 51. p. 1425

Fig. 60.

EEF, The 3d Receptacle is properly called the *Marish*.

ddddd, Is a Channel very narrow, through which the Water must pass before it enters out of the 2d Receptacle into the 3d.

33, Is the Opening, by which the Water runs out of the 2d into the 3d Receptacle.

The *Pricks* you see in the Water throughout the whole Scheme do mark the Course and Turnings which the Water is forced to make, it comes to *hbhbh*, which are the Places where the Salt is made.

hhhhh, Are the Bed of the *Marish*, where the Salt is made; and in them the Water must not be above an Inch and an half Deep. Each of these *Beds* is 15 Foot long, and 14 Foot large.

99999, Are the little Channels between the Beds.

88888, Are the Apertures, by which the Beds receive the *Sea-Water* after many Windings and Turnings.

When it rains, the *Openings*, 22, 33, are stopped to hinder the Water from running into the *Marish*. Unless it rain much, the Rain-water doth little hurt to the *Marish*; the *Heat* of the *Sun* sufficiently exhaling it, if it be not above an *Inch* high; only if it have rained very plentifully that Day, no Salt is drawn for the 3 or 4 next Days. But if it Rain 5 or 6 Days, the People



are then necessitated to empty all the Water of the Beds by a peculiar Channel, which cannot be opened but when it is low Water. But 'tis very seldom that it Rains so long as to constrain Men to empty those Beds.

The hottest Years makes the most Salt, and the hottest part of the *Summer* there is Salt made even during Night. Less Salt in calm, than in windy Weather.

The West and North-west Winds are the best for this Purpose.

Our Country People draw the Salt every other Day, and every Time more than an hundred Pound Weight of Salt.

The Instruments used to draw the Salt, have many small Holes to let the Water pass, and to retain nothing but the Salt.

The reddish Earth in *Marishes* make the Salt more grey, the blewish, more white: Besides, if you let run in a little more Water than you ought, the Salt becomes then more white, but then it yields not so much. Generally all the *Marishes* require a fat Earth, neither spungy nor sandy.

The Salt-man who draws the Salt, must be very dextrous. In this *Ile* of *Rbee*, Men there are, that draw very dark Salt, and others that draw it as white as Snow; and so it is in *Xaintonge*. Chiefly, care is to be taken that the *Earth* at the Bottom of the Beds mingle not with the Salt.

The Salt we use at our Tables is perfectly white, being the *Cream* (or that Salt which is formed on the Top of the Water) drawn 4 or 5 Hours before the Salt is to be drawn. The Grains of it are smaller than of the other. Generally the Salt of *Xaintonge* is somewhat whiter than ours. The Bigness of our Salt is of the Size of a Pepper-Grain, and of a cubical Shape.

The *Marishes* are preferred from one Year to another, by overflowing them a Foot high.

The Timber of the *Marishes*, if it be of good *Oak*, keeps near 30 Years, but there is used but little *Wood*, all the *Ditches* and *Apertures* being done with *Stones*.

In Lanca-
shire, by Dr.
J. Beal, n.
103. p. 51.

XLIX. At *Wire-water* in *Lancashire*, Salt is gathered out of Heaps of *Sand* along the *Sea-side* in many Places: Upon which *Sand* (saith *Speed*) the People pour *Water*, until it gets a saltish *Humour*, which they afterwards boil with *Turfs*, till it becomes white Salt.

The Water of the *Brine-pits* in *Summer-time*, when the *Brine* is strongest, being cast into any Place where it may be soon dried by the *Sun*, and where we would have *Pidgeons* resort, does please them well; so will any refuse *Brine* being boiled up to a *Consistence*. But I know not whether such *Brine*, taken from the powder'd *Flesh*, will be kind for *Sheep*.

In Germany,
by
n. 7. p. 128.

X. An observing Gentleman writes out of *Germany*, That no *Salt-water* which contains any *Metal* with it, can well be sodden to salt in a Vessel of the same *Metal* which itself contains, except *Vitriol* in *Copper Vessels*.

He adds, that to separate Salt from *Salt-water* without *Fire*, if you take a Vessel of *Wax*, hollow within and every where tight, and plunge it into the *Sea*, or into other *Salt-water*, there will be made such a Separation; that the Vessel shall be full of sweet *Water*, that Salt staying behind: but though this *Water* have no saltish Taste, yet he saith, there will be found a *Salt* in
the

the Essay which is the *Spirit of Salt*, subtile enough with the Water to penetrate the Wax.

LI. We have seen here (at *Leyden*) a Maid, of 13 Years of Age, which from the Time that she was but 6 Years old, and began to be about her Mother in the Kitchen, would, as often as she was bid to bring her Salt, or could else come at it, fill her Pockets therewith, and eat it, as other Children do Sugar; whence she was so dried up, and grown so stiff, that she could not stir her Limbs, and was thereby starved to Death.

The Joints of a Girl made Stiff by eating Salt.
By
n. 8. p. 138.

LII. *Papers of less general Use, omitted.*

1. **S**OME Objections of the *Fr. Journalist* to the Engines for drawing up Water from the Bottom of the Sea, and for sounding the greatest Depths. n. 13. p. 228.
2. Inquiries concerning the Sea; by Mr. Robert Boyle. n. 18. p. 315.
3. Inquiries and Directions concerning Tides; proposed by Dr. J. Wallis. n. 17. p. 297.
4. Patterns of Tables proposed to be made for observing of Tides; by Sir Robert Moray. n. 18. p. 311.
5. Quæries about Tides in China and the East-Indies; by Mr. Edm. Halley. n. 162. p. 685.
6. Several Engagements for observing of Tides. n. 21. p. 679.
7. A Correct Tide-Table, showing the true Time of High-Water at London-Bridge to every Day in the Year 1682; by Mr. Flamsteed. *Phil. Cal.* n. 4. p. 102.
8. The same, for the Year 1683. n. 143. p. 10.
9. The same, for the Year 1684. n. 153. p. 458.
10. The same, for the Year 1685. n. 166. p. 821.
11. The same, for the Year 1686. n. 177. p. 1226.
12. The same, for the Year 1687. n. 185. p. 132.
13. The same, for the Year 1688. n. 191. p. 428.
14. Objections from *Vossius*, *De Motu Marium & Ventorum*, and from *Gassendus*, *De Æstu Maris*, to Dr. Wallis's Theory of Tides, answer'd; by Dr. Wallis. n. 16. p. 286.
15. Quæries and Conjectures concerning Mineral Waters; by Dr. Dan. Foot. m. 52. p. 1504.
16. An Inquiry concerning the Causes of Mineral Springs; proposed by Dr. J. Beal. n. 56 p. 1131.
17. Some Quæries whereby to examine Mineral Waters; by Sir W. Petty. n. 166. p. 802.
18. Inquiries about the Salt-Springs in *Worcestershire* and *Cheshire*; by Dr. J. Beal. n. 20. p. 359.
19. Inquiries and Suggestions concerning Salt for Domestic Uses; by Dr. J. Beal. n. 103. p. 48.

LIII. *Accounts, Resolutions and Foundations of Books, omitted.*

1. **I**S *Vossius de Motu Marium & Ventorum.* n. 16. p. 286.
2. *Gassendus de Æstu Maris.* ib. p. 287.

3. De

- n. 167. p. 362 3. *De Origine Fontium* Tentamen Philosophicum, in Prælectione habita coram Societate Philosophica nuper Oxoniæ instituta ad Scientiam Naturalem promovendam. Per Rob. Plot, L. L. D. Oxon 1685. in 8vo.
- n. 333. p. 734 4. *De Fontium Mutinensium* admiranda Scaturigine, Tractatus Physico-Hydrostaticus Bernardini Rammazini, in Mutinensi Lyceo Med. Prof. Murinæ 1691. in 4to. Translated into *English* and illustrated with many curious Remarks and Experiments by the Author, and Translator, Dr. Rob. St. Clair, Lond. 1697. in 8vo.
- n. 51. p. 1033 5. Dr. Tobias Whitaker of drinking *Mineral Waters*, 1634.
- n. 42. p. 850 6. *Hydrologia Chymica*, or the Chymical Anatomy of the *Scarborough* and other *Spaws* in *Yorkshire*, &c. by W. Sympson, Lond. 1668. in 8vo.
- n. 49. p. 999. n. 51. p. 1038 7. An Answer to *Hydrologia Chymica* of Will. Sympson, by Rob. Wittie, M.D. Lond. 1669. in 8vo. Besides the Account of this Book, there is a Correction of a Mistake of the Printer in the 3d Page.
- n. 52. p. 1050 Some Reflections made on this Account of Dr. Wittie's Answer to *Hydrologia Chymica*; by Dr. Dan. Foot.
- n. 57. p. 1154 n. 56. p. 1128 Dr. Foot's Reflections consider'd; by Dr. J. Beal.
- n. 56. p. 1128 Some Considerations relating to Dr. Wittie's Defence of the *Scarborough Spaw*, by Dr. Highmore.
- n. 60. p. 1074 A Discourse of Dr. Rob. Wittie, relating to the Notes and Queries of Dr. Foot, and to those of Dr. Highmore, concerning *Mineral Waters*, and Extracts made out of them.
- n. 62. p. 1038 8. A Vindication of *Hydrologia Chymica*, by Will. Sympson, M. D. Lond. 1670.
- n. 85. p. 5019 9. *Scarborough Spaw* spagyrically anatomiz'd. An. 1670. and a *New Year's Gift* for Dr. Wittie, Lond. 1671. both in 12mo. by Geo. Tonstal, M. D.
- n. 144. p. 59. 10. 1. M. Lister, M. D. *De Fontibus Medicatis Angliæ*; Exercitatio Nova & Prior. Eboraci 1682. in 8vo.
- n. 518. p. 579 2. M. Lister, M. D. *De Fontibus Medicatis Angliæ*; Exercitatio altera. Lond. 1684. in 8vo.
- n. 172. p. 1063 11. *Short Memoirs* for the *Natural Experimental History* of *Mineral Waters*, by the Honourable Rob. Boyle, Lond. 1685. in 8vo.
- n. 206. p. 1003 12. Tentamen Philosophicum de *Aquis Mineralibus*, &c. Auth. Carolo Leigh, M. D. Lond. 1694. in 8vo. Dr. Cay here objects many Things to that Author's Observations.
- n. 243. p. 368 n. 251. p. 146 13. *The Natural History* of the *Chalybeat* and *Purging Waters* of *England*, with their particular Essays and Uses, &c. with Observations on the *Bath-waters* in *Somersetshire*, by Benj. Allen, M. D. Lond. 1699.
- n. 125. p. 612 14. Observations sur les *Eaux Minerales* des plusieurs Provinces de *France* faites en l' *Academie Royale des Sciences*, en l' *Anne* 1670 & 1671. par le Sieur de Clos. A *Paris* 1675. in 12mo.
- n. 125. p. 573 15. *Batboniensium* & *Aquisgranensium Thermarum Comparatio*, variis adjunctis illustrata, a R. P. Lond. 1676. in 8vo.

C H A P. III.

Minerology.

I. 1. **T**HE *Mine* or *Adit* is to be made 7 or 8 Foot high, which tho' it seems to make more Work downwards, yet will be found necessary for making the better Dispatch by rendring the *Invention* more effectual.

There is a Tool of Iron well steeled at the End, which cuts the Rock (of the Shape shewed by the *Figure* annexed) 20 or 22 Inches long or more, and some 2 $\frac{1}{2}$ Inches Diameter at the steeled End, the rest being somewhat more slender. The steeled End is so shaped, as makes it most apt to pierce the Rock, the Angles at the End being still to be made the more obtuse, the harder the Rock is. This Tool is to be first held by the Hand in the Middle between the Sides of the Rock that is to be cut, but as near the Bottom as may be. The Tool being placed, is to be struck upon with a Hammer, the heavier the better, either suspended by a Shaft turning upon a Pin, or otherwise, so soon as one Man may manage the Hammer, while another holds the Tool or *Piercer*. If it be hung in a Frame or other convenient way, he that manageth it, hath no more to do but to pull it up at first as high as he can, and let it fall again by its own Weight, the Motion being so directed as to be sure to hit the *Piercer* right. After the Stroke of the Hammer, he that holds the *Piercer*, is to turn it a little on its Point, so that the Edges or Angles at the Point may all strike upon a new Place, and so it must still be shifted after every Stroke, by which means small Chips will at every Stroke be broken off, which must from time to time be taken out, as need requires. And thus the Work must be continued, till the Hole be 18 or 20 Inches deep, the deeper the better. This Hole being made deep as is required, and kept as straight and smooth in the Sides as is possible, there is then a kind of double Wedge to be made, and fitted exactly for it, the Shape whereof is to be seen in the annexed Figure.

This double Wedge being 12 or 13 Inches long, each piece of it, and so made as being placed in their due Position, they may make up a *Cylinder*, cut *Diagonal wise*. The two Flat-sides, that are contiguous, are to be greased or oiled, that the one may slip the more easily upon the other; and one of them, which is to be uppermost, having at the great End a hollow Crease cut into it round about, for fastning a Cartridge full of *Gun-powder* to it with a Thread, the round End of the Wedge being pared as much as the Thickness of the Paper or Past-board that holds the *Powder* needs, to make the Outside thereof even with the rest of the Wedge. This Wedge must have a Hole drilled through the longest Side of it, to be filled with *priming Powder*, for firing of the *Powder* in the *Cartridge*: Which needs have no more than half a Pound of Powder, though upon occasion a greater Quantity may be used, as shall be found requisite.

Then this Wedge being first thrust into the Hole with the Cartridge, the round Side, where the priming Hole is, being uppermost, the other Wedge is to be thrust in, home to the due Position, care being taken that they fit

To break
hard Rocks,
by M. Du-
fons, n. 5.
p. 82.

Fig. 67.

Fig. 68.

the

the Hole in the Rock as exactly as may be. Then the End of the lower Wedge being about an Inch longer than that of the upper, outwardly and flatten'd, *priming Powder* is to be laid upon it, and a Piece of burning *Match* or Thread dipt in Brimstone, or other such prepared combustible Matter, fastened to it, that may burn so long before it fire the *Powder*, as he that orders it may have time enough to retire quite out of the *Pit* or *Adit*, having first placed a piece of Wood or Iron so as one End thereof being set against the End of the lower Wedge, and the other against the Side-Wall, so as it cannot slip. Which being done, and the Man retired, when the *Powder* comes to take Fire, it will first drive out the uppermost Wedge as far as it will go; but the slanting Figure of it being so made, as the farther it goes backward the thicker it grows, till at last it can't go no farther, then the Fire tears the Rock to get forth, and cracks and breaks it all about, that at one Time a vast deal of it will either be quite blown out, or so crack'd and broken as will make it easy to be removed.

By Mr Beau-
mont, n.
167. p. 845.
Fig. 69.

2. A considerable *Adventurer* in the *Lead-Mines* on *Mendip-Hills* acquaints me, that the *Miners* there, within these 12 Months, had got a new way of *Cleaving Rocks* with *Gun-Powder*.

The *Borer* is made of Iron, and is 2 Foot 2 Inches in Length: It is an Inch Square at the steeled End from *a* to *b*, and somewhat less in the other Part. The Use of this Instrument is to make a Hole in the Rock deep enough to receive the *Powder*. The Gun is 6 Inches in length, $1 \frac{1}{4}$ Diameter, and has a Hole drilled through it to receive the *priming Powder*. When a Hole is made with the *Borer* somewhat deeper than the length of the *Gun*, they dry it with a Rag, and put into it about 2 or 3 Ounces of *Powder*, over which they put a thin Paper, and on it place the *Gun*, which they bind firmly into the Hole, by driving in against the flat Side of the upper Part of it a little Iron Wedge 4 Inches in length, by the *Miners* called a *Quinnet*.

Fig. 71.

When this is done, they pass down a Wire through the Hole drilled in the *Gun*, and pierce the Paper which covers the *Powder*, and then they *prime* the *Gun*, and lay a *Train*, and go up out of the Work, before the *Powder* comes to take Fire. The *Paper* is put at first over the *Powder*, lest when the *Gun* and *Quinnet* are driven down, the Tools may strike Fire, and kindle the *Powder*.

These Instruments are of great Advantage to *Miners*; for as soon as a Man has fired his *Powder*, and broken the Rock, he may presently go to Work again; whereas after a Fire is laid in a Shaft, a Man can scarce go to Work in 24 Hours, the Rocks being too hot to suffer him.

Okey Hole,
and some o-
ther Subter-
raneous Ca-
verns in
Mendip-
Hills; by Mr
J. Beau-
mont, Phil.
Col. n. 2. p. 1.

II. 1. On the South-Side of *Mendip-Hills*, within a Mile of *Wells*, is a famous *Grotto*, known by the Name of *Okey-hole*, much resorted to by Travellers: The Entrance of it is in the Fall of those Hills, which is there all beset with Rocks, having near it a precipitous Descent about 10 or 12 Fathom deep; at the Bottom of which there always issues from the Rock a considerable Current of Waters. The naked Rock above the Entrance, shew themselves for about 30 Fathom in Height; though the whole Ascent of the Hill above it is about a Mile, and is very steep.

As you pass into this *Vault* you go upon a Level; but, advancing further into it, you find the Way rocky and uneven, sometimes ascending, and sometimes descending, as generally in all *Caverns*. The Roof of it, in the highest Part, is about 8 Fathoms from the Floor; and in some Places it is so low, that a Man must stoop to pass. The Wideness of it is also various; in some Parts it is about 5 or 6 Fathoms; in others, not above a Fathom or two: It extends itself in Length about 200 Yards. People talk much of several Stones there, resembling Men, and other Things; but they are only Lumps of common *Sparr*, without any *regular Figures*.

At the farthest Part of this *Cavern* there rises a good Stream of *Water*, large enough to drive a Mill, which passes all along one Side of the *Cavern*, and at length glides down about 6 or 8 Fathoms betwixt the Rocks; and then, pressing through the Clefts of them, discharges itself into a Valley.

This *River* within the *Cavern* is well stored with *Eels*, and hath some *Trouts* in it, which must of Necessity have been *engendred* there, and not come from without, there being so great a Fall, as I have mentioned, near the Entrance. It happen'd some few Years since, that many Cattle, which fed in Pastures through which this River passes, died suddenly after a Flood; the Cause of it being supposed to be, that these Waters had a Communication under Ground in *Mendip-Hills* with certain Waters which came from the Washing of *Lead-Ore* in the *Minery-Ponds*, which are two Miles and a Half distant from this *Cavern*, and were convey'd into the Ground by a *Swallow*, near the Place where the *Ore* was wash'd; which *Swallow* has since been caused to be damm'd up.

In a dry Summer I have seen a good Number of *Frogs* all along this *Cavern*, even to the farthest Part of it, and other little *Animals* in some small *Cisterns* of *Water* there.

Before you come to the Middle of this *Vault*, you will find a Bed of very fine Sand, which is much sent for by Artists to cast *Metals* in.

On the Roof of it, at certain Places, hang Multitudes of *Batts*: And indeed we generally find them in all *Caverns*, whose Entrance is upon a Level, or somewhat ascending or descending, so it be not perpendicularly; and even in these, if the Passage into them be not narrow, and of a considerable Height or Depth.

2. About 5 Miles from this, on the South-west Part of *Mendip-Hills*, near a Place called *Chedder*, lies another *Cavern*, into which you must ascend about 15 Fathoms on the Rocks. This *Cavern* is not of so large an Extent as the former; there is no Current of *Water*, nor does *Water* drop so freely from the Roof, as generally in other *Caverns*; wherefore the *Sparrs* appear not of so lively Colours, as commonly elsewhere.

3. These two *Caverns* have no Communication with *Mines*: But we generally observe, that, wheresoever *Mines* of *Lead-Ore* are, there are *Caverns* belonging to them, which are of a various Nature and Situation. The most considerable of these *Vaults*, I have known on *Mendip-Hills*, is on the most Northerly Part of them, in a Hill call'd *Lamb*, lying above the Parish of *Harptrey*. Much *Ore* has been formerly raised on this Hill; and being told,

some Years since, that a very great *Vault* was there discover'd, I took 6 *Miners* with me, and went to see it. First we descended a perpendicular *Shaft* about 10 Fathoms; then we came into a *Leading Vault*, which extends itself in Length about 40 Fathoms; it runs not upon a Level, but descending, so that when you come to the End of it, you are 23 Fathoms deep, by a perpendicular Line. The Floor of it is full of loose Rocks; its Roof is firmly vaulted with Lime-Stone Rocks, having Flowers of all Colours hanging from them, which present a most beautiful Object to the Eye, being always kept moist by the distilling Waters. In some Parts the Roof is about 5 Fathoms in Height, in others so low, that a Man has much ado to pass by creeping. The Wideness of it, for the most Part, is about 3 Fathoms. This *Cavern* crosses many *Veins* of *Ore* in its running, and much *Ore* has been thence raised. About the Middle of this *Cavern*, on the East Side, lies a narrow Passage into another *Cavern*, which runs betwixt 40 and 50 Fathoms in Length. At the End of the first *Cavern* a vast *Cavern* opens itself. I fastened a Cord about me, and ordered the *Miners* to let me down: And upon the Descent of 12 or 14 Fathoms I came to the Bottom. This *Cavern* is about 60 Fathoms in Circumference, above 20 Fathoms in Height, and about 15 in Length; it runs along after the *Rakes*, and not crossing them as the leading *Vault* does. I afterwards caused *Miners* to drive forward in the Breast of this *Cavern*, which terminates it to the West; and, after they had driven about 10 Fathoms, they happened into another *Cavern*, whose Roof is about 8 Fathoms, and in some Parts 10 or 12 in Height, and runs in Length about 100 Fathoms.

The Frequency of these *Caverns* on those Hills may be easily guess'd at, by the Frequency of *Swallow-Pits* which occur there in all Parts, and are made by the falling in of the Roofs of *Caverns*; some of these *Pits* being of a large Extent and very deep; and sometimes our *Miners*, sinking in the Bottom of those *Swallows*, have found *Oaks* 15 Fathoms deep in the Earth.

Elden-Hole
in Derby-
shire, by
Dr. Plot, ib
p. 7. in Col.
n. 2. p. 7.

III. Dr. Plot has learnt by an inquisitive Gentleman, who purposely made Trial of it, that one of those *Caverns* in the *Peak* in *Derbyshire* hath been sounded in Depth, by a perpendicular Plumb-Line, no less than Eight and Twenty Hundred Feet, without meeting with the Bottom, or Water; and yet the Mouth of this *Cavern*, at the Top, is not above 40 Yards over.

Pen-Park-
Hole in
Gloucester-
shire, by
Capt. Stur-
my, n. 143.
p. 2.

IV. 1. Upon the 2d of July, 1699, I descended by Ropes affix'd at the Top of an old *Lead Ore Pit*, 4 Fathoms almost perpendicular; and from thence 3 Fathoms more obliquely, between two great Rocks, where I found the Mouth of this spacious Place; from which a *Mine-Man* and myself lower'd ourselves by Ropes 25 Fathoms perpendicular, into a very large Place, which resembled to us the Form of a Horse-Shoe; for we stuck lighted Candles all the Way we went to discover what we could find remarkable. At length we came to a River or great Water, which I found to be 20 Fathoms broad, and 8 Fathoms deep. The *Mine-Man* would have persuaded me, that this River ebb'd and flow'd; for that some 10 Fathoms above the Place we now were in we found the Water had sometimes been: But I proved the contrary,

rary, by staying there from 3 Hours *Flood* to 2 Hours *Ebb*, in which Time we found no Alteration of this River. Besides, its Waters are fresh, sweet, and cool; and the Surface of this Water, as it is now at 8 Fathoms deep, lies lower than the Bottom of any Part of the *Severn Sea* near us, so that it can have no Community with it. As we were walking by this River, 32 Fathoms under the Ground, we discovered a great Hollowness in a Rock some 3 Foot above us; so that I got a Ladder down to us, and the *Mine-Man* went up the Ladder to that Place, and walk'd into it about 70 Paces, till he just lost a Sight of me, and from thence cheerfully called unto me, and told me he had found what he look'd for, a *Rich Mine*. But his Joy was presently turned into Amazement, and he returned affrighted by the Sight of an *Evil Spirit*, which we cannot persuade him but he saw, and for that Reason will go thither no more.

Here are Abundance of strange Places; the Flooring being a Kind of white Stone enamell'd with *Lead-Ore*, and the pendant Rocks were glazed with *Salt-Petre*, which distilled upon them from above, and Time had petrify'd.

Four Days together after his Return Capt. *Sturmy* was troubled with an unusual and violent Head-ach, which he imputed to his being in that Vault; and, falling from his Head-ach into a Fever, he soon after died.

By Sir Rob. Southwell, ib.

2. 'Tis down the *Tunnel CC*, from the *Superficies* of the *Ear:b AA*, to the Opening of the *Cavity* below, 39 Yards. Then the *Hole EE*, spreading into an irregular oblong Figure, is in the greatest Length 75 Yards, and in the greatest Breadth 41 Yards. From the highest Part of the Roof to the Water was then 19 Yards. The Water *HH* was now in a Pool at the North End, being the deepest Part; it was in Length 27 Yards, in Breadth 12, and only five Yards and an Half deep. Two Rocks *GG* and *LL* appeared above the Water all covered with *Mud*: But the Water was sweet and good. There was a large Circle of *Mud KKK*, round the Pool, and far up towards the South End, which shew'd that the Water has at other Times been 6 Yards higher than at this present.

By Captain Collins, ib. p. 4.

Fig. 1, 72, 73.

Sept. 18 and 19, 1682. The *Tunnel* or Passage down was somewhat oblique, very ragged and rocky; in some Places it was two Yards wide, and in some three or four; but nothing observable therein, save here and there some of that *Sparr* which usually attends the *Mines* of *Lead-Ore*. In the Way, 30 Yards down, there runs in Southward a Passage *DD*, of 29 Yards in Length, parallel to the *Superficies* above; it was two or three Yards high, and commonly as broad and alike rocky as the *Tunnel*, with some Appearances of *Sparr*, but nothing else in it except a few *Batts*.

The *Cavity* below was in like Manner rocky and very irregular; the Candles and Torches burnt clear, so as to discover the whole Extent thereof; nor was the Air any thing offensive.

The Bottom of this *Hole I*, where the *Land-Waters* do gather, is 59 Yards down from the *Superficies* of the Earth; and by good *Calculation* the same Bottom is twenty Yards above the highest Rising of the *Severn*, and lies into the Land about three Miles distant from it, and about as far from *Bristol*.

Air in
Mines; by
Mr. J. Gill.
n. 26. p. 481.

V. One *John Gill* affirms, from 20 Years Experience of his own, that if in digging deep under Ground the Workmen meet with Water, they never want *Air* or *Wind*; but if they miss Water (as sometimes it happens, even at 12 or 16 Fathoms deep) they are destitute of convenient Air, either to breathe in, or to make their Candles burn; and that when they drive up an *Adit* for drawing away a great Quantity of a Winter's standing Water from a deep Mine, as soon as it is brought up so near that any of the standing Water begins to run away, the Men must secure themselves as well as they can from Danger of being dashed in Pieces against the Sides of the *Adit*; for the included Air or Wind, in the standing Water, breaks forth with such a terrible Noise as that of a Piece of *Ordnance*, and with that Violence, as to carry all before it, loosening the very Rocks, though at some Distance, in the Work or *Adit*.

To Work in
Mines with-
out Airshafts;
by Sir Rob.
Moray, n. 5.
p. 97.

VI. At the Mouth or Entry of the *Adit* (to the *Coal-Mines* of *Leige*) there is a Structure raised of Brick like a Chimney, some 28 or 30 Foot high in all; at the Bottom two opposite Sides are, or may be, some $5\frac{1}{2}$ Foot broad, and the other two 5 Foot; the Wall $1\frac{1}{2}$ Brick thick. At the lower Part of it is a Hole some 9 or 10 Inches square, for taking out of the *Ashes*, which when it is done, this *Ash-Hole* is immediately stop't so close, as Air cannot possibly get in at any Part of it. Then some 3 Foot above Ground, or more, there is on that Side that is next to the *Adit*, or Pit, a square Hole, of 8 or 9 Inches every Way, by which the Air enters to make the Fire burn: Into this Hole there is fix'd a square *Tube* or *Pipe* of Wood, whereof the Joints and Chinks are so stop't with Parchment pasted or glewed upon them, that the Air can no where get into the *Pipe* but at the End; and this *Pipe* is still lengthened as the *Adit* or Pit advanced, by fitting new *Pipes* so as one End is always thrust into the other, and the Joints or Chinks still carefully cemented, and stop't as before. So the *Pipe* or *Tube* being still carried on, as near as is necessary to the Wall or Place where fresh Air is requisite, while the Air is drawn by the Fire from thence through the *Tube*, fresh Air must needs come in from without, to supply the Place of the other; which by its Motion doth carry away with it all the ill Vapours that breathe out of the Ground: By which Means the whole *Adit* will be always fill'd with fresh Air, so that Men will there breathe as surely as abroad, and not only Candles burn, but Fire, when upon Occasion there is Use for it for breaking of the Rock.

There must be two of the Iron Grates, that when any Accident befalls the one, the other may be ready to be put into its Place; the *Coal* being first well kindled in it: But when the Fire is near spent, the Grate, being haled up to the Door, is to be supplied with fresh Fuel.

The higher the Shaft of the Chimney is, the Fire draws the Air the better. And this Invention may be made use of in the Pits or Shafts that are perpendicular, or any ways inclining towards it, when there is Want of fresh Air at the Bottom thereof, or any Molestation by unwholesome Fumes or Vapours.

The whole Contrivance of the Fabrick may easily be understood by the annexed Figure. Fig. 74.

A The Hole for taking out the *Ashes*; *B* the square Hole, into which the *Tube* or *Pipe* for conveying the *Air* is to be fitted; *C* the Border or Ledge of *Brick* or *Iron*, upon which the *Iron Grate* or *Cradle*, that holds the burning *Coals*, is to rest; the one being exactly fitted for the other: *D* the Hole where the *Cradle* is set; *E* the wooden *Tube*, thro' which the *Air* is convey'd towards the *Cradle*; *F* the Door, by which the *Grate* or *Cradle* is let in which is to be set 8 or 10 Foot higher than the Hole *D*; and the *Shutter* made of *Iron*, or *Wood* that will not shrink, that it may shut very close; *G* the *Grate* or *Cradle*, which is narrower below than above, that the *Ashes* may the more easily fall, and the *Air* excite the *Fire*, the Bottom and Sides being barred; *H* the *Border* or *Ledge* of the *Cradle*, that rests upon Ledge *C*; *I* four *Chains* of *Iron* fastened to the four Corners of the *Cradle*, for taking it up and letting it down; *K* the *Chain* or *Iron* to which the other *Chains* are fasten'd; *L* the *Pully* of *Iron* or *Brass* through which the *Chain* passeth; *M* a *Hook* on which the *Chain* is fasten'd by a *Ring*, the *Hook* being fixed at the Side of the *Door*; *N* a *Bar* of *Iron* in the *Walls*, to which the *Pully* is fasten'd.

VII. 1. In a *Coal-Pit*, belonging to the Lord *Sinclair* in *Scotland*, where the *Coal* is some 18 or 20 Foot thick, and antiently wasted to a great Depth, the *Colliers*, some Weeks ago, having wrought as deep as they could, and being to remove into new Rooms, as they call them, did, by taking off, as they required, Part of the *Coal* that was left as *Pillars* to support the *Roof* and *Earth* over it, so much weaken them, that, within a short Space after they were gone out of the *Pit*, the *Pillars* falling, the *Earth* above them filled up the whole Space, where the *Colliers* had lately wrought, with its *Pruins*. The *Colliers* being hereby out of Work, some of them adventur'd to work upon old Remains of *Walls* so near the old *Wastes*, that, striking thro' the slender *Partition* of the *Coal-Wall* that separated between them and the Place where they used to work, they quickly perceived their Error; and fearing to be stifled by the bad *Air* that they knew possessed these old *Wastes*, in Regard not only of the *Damps* which such *Wastes* do usually afford, but because there had been, for many Years, a *Fire* in those *Wastes* that filled them with stifling *Fumes* and *Vapours*, retired immediately, and saved themselves from the *Eruptions* of the *Damp*. But next Day some 7 or 8 of them came no sooner so far down the *Stairs*, that led them to the Place where they had been the Day before, as they intended, but, upon their stepping into the Place where the *Air* was infected, they fell down dead, as if they had been shot: And there being amongst them one whose *Wife* being informed he was stifled in that Place, she went down so far without Inconvenience, that, seeing her *Husband* near her, she ventur'd to go to him; but, being choaked by the *Damp* as soon as she came near him, she fell down dead by him.

2. *Damps* happen in most of the *Hungarian Mines*, not only in the *Cuniculi*, or direct *Passages*, where they walk on *Horizontally* (by these *Mine-Men* called *Stollen*)

Damps in Mines, by Sir R. Moray, a. 3. p. 4.

By Dr. Edw. Brown, n. 48. p. 965.

Stollen;) but also in the *Putei*, or perpendicular Cuts or Descents, termed *Schachts* by the same. They are met with not only in Places where the Earth is full of *Clay*, or the like Substances, but also where it is rocky: And one Place they shewed me, in the Copper-Mine at *Hern Groundt*, where there had been a very pernicious Damp, and yet the Rock so hard, that it could not be broken by their Instruments; but the Descent was all made by the Means of Gun-Powder, rammed into long round Holes in the Rock, and so blown up. Another Place they shewed me, where there is sometimes a Damp, and sometimes clear Weather. When there is much Water in the *Mine*, so as to stop up the lower Part of this Passage, then this Damp becomes discoverable, and commonly strong. I procured one to enter it till his Lamp went out 4 or 5 Times, in the same Manner as at *Grotto del Cane* in *Italy*.

Some of these Damps suffocate in a short Space of Time; others only render the Workmen faint, with no further Hurt, except they continue long in the Place. The *Miners* here think themselves no Workmen if they be not able to cure a Damp, or to cure the bad Weather, or make the Weather, as they term it, perform it by Perflation, by letting the Air in and out; and causing, as 'twere, a Circulation of it. In the Mine at *Hern-Groundt* they cured a bad Damp by a great Pair of Bellows, which were blown continually for many Days. The ordinary Remedy is by long Tubes; thro' which the Air continually passing, they are able to dig straight on for a long Way, without Impediment in breathing: For some *Cuniculi* are 500 Fathoms long, which will not seem strange to any one that shall see the Map of the Copper-Mine at *Hern-Groundt*, or the Gold-Mine at *Schemnitz*: And in the Silver *Trinity-Mine* by *Schemnitz* I passed quite under a Hill, and came out on the other Side. At *Windsbach-Mine* by *Schemnitz* they shewed me the Place where 5 Men and a Gentleman of Quality were lost; for which Reason they have now placed a Tube there. The like they place over all *Doors*, and over all *Ways*, where they dig right on for a great Space, and have no Passage thro'. At *Schemnitz* they told me, that 28 Men had been killed at one Time in 4 *Cuniculi*, 7 in each; and in the Sinking of *Leopold's* Pit, which is 150 Fathoms deep, they were much troubled with Damps, which they remedied in the following Manner:

They fixed a Tube to the Side of the *Schacht*, or Pit, from the Top to the Bottom; and, that not proving sufficient, they forced down a broad, flat Board, which covered or stopped the Pit, or couched very near the Sides of it, on all Sides but where the Tube was, and so forced out all the Air in the Pit through the Tube; which Work they were forced often to repeat. And now, they having divers other Passages into it, the Air is good and sufficient, and I was drawn up thro' it without the least Trouble in Breathing.

But, besides this Mischief from poisonous Exhalations, Stagnation of the Air, or Water impregnated with mineral Spirits, they sometimes perish by other Ways: For there being in these Mines an incredible Quantity of Wood to support the Pits, and the Horizontal Passages (the *Putei* and *Cuniculi*) in all Places but where it is rocky, Men are sometimes destroyed by the Wood set on Fire. And in the Gold-Mine at *Schemnitz* the Wood was set

set once on Fire by the Carelessness of a Boy, and 50 Miners smothered thereby; who were all taken out but one, that was afterwards found to be dissolved by the *Vitriol-Water*, nothing escaping either of Flesh or Bones, but only some of his Clothes.

3. There are four Sorts of *Damps*; the first is the ordinary Sort: The external Signs of its Approach are the *Candles* burning orbicular, and the Flames lessening by Degrees, until they quite extinguish; the internal, Shortness of Breath. I never heard of any great Inconvenience which any one suffered by it, who escaped Swooning: Those that swoon away, and escape an absolute Suffocation, are, at their first Recovery, tormented with violent Convulsions; the Pain whereof, when they begin to recover their Senses, causeth them to roar exceedingly. The ordinary Remedy is to dig a Hole in the Earth, and lay them on their Bellies, with their Mouths in it; if that fail, they run them full of good Ale; but if that fail, they conclude them desperate. I have known some who have been recovered after this Manner (when some of their Companions have, at the same Time, died) that told me, they found themselves very well, within a little Time after they had recovered their Senses, and never after found themselves the worse for it.

They call the second Sort the *Pease-Bloom Damp*; because, as they say, it smells like *Pease-Bloom*: They tell me, it always comes in the Summer-time; and those Grooves are not free which are never troubled with any other Sort of *Damps*. I never heard that it was mortal; the Scent perhaps freeing them from the Danger of a Surprise: But, by Reason of it, many good Grooves lie idle at the best and most profitable Time of the Year, when the *subterraneous Waters* are at the lowest. They fancy it proceeds from the Multitude of red Trefoyle Flowers, by them called Honey-Suckles, with which the Lime-Stones Meadows in the *Peak* do much abound.

The third is the strangest and most pestilential of any, if all be true which is said concerning it; those who pretend to have seen it (for it is visible) describe it thus: In the highest Part of the Roof of those Passages which branch out from the main Groove they often see a round thing hanging, about the Bigness of a Foot-Ball, covered with a Skin of the Thickness and Colour of a Cobweb; this, they say, if by any Accident, as the Splinter of a Stone, or the like, it be broken, immediately disperseth itself, and suffocates all the Company. Therefore, to prevent Casualties, as soon as they have espied it, they say, they have a Way, by the Help of a Stick and a long Rope, of breaking it at a Distance; which done, they purify the Place well with Fire, before they dare enter it again. I dare not avouch the Truth of this Story in all its Circumstances, because the Proof of it seems impossible, since, they say, it kills all that are likely to bear Witness to all the Particulars; neither dare I deny but such a Thing may have been seen hanging on the Roof, since I have heard many affirm it. Our *Under-Ground Philosophers* say, The Steam which arises from their Bodies and the Candles, ascends into the highest Part of the Vault, and there condenseth; and, in Time, has a Film grown round about it, which, at length corrupting, becomes pestilential.

By Mr.
Jeslop, n.
117. p. 391.

The

The 4th, which they also call a *Damp* (altho' how proper I will not argue) is that Vapour, which being touch'd by the Candle presently takes Fire; and, giving a Crack like a *Gun*, produceth the like Effects, or rather those of *Lightning*. A Fellow, they commonly call *Dobby Leach*, is, at this Day, a sad Example of the Force of one of those Blasts in *Hasteberg-Hills*, having his Arms and Legs broken, and his Body strangely distorted.

Captain *Wain* told me, he saw one of them in a *Bloomery* near *Peniston*.

This *fulminating Damp* has lately done some Hurt in a Coal-Pit at *Wingerfworth*, two Miles from *Chesterfield*.

N. 119.
p. 450.

The *Shaft* of the *Coal-Pit* is about 15 Yards deep, the Soil a stiff Mire, shaly about the Middle of the *Shaft*, dry at the *Bottom*, as they say, (tho' I observed some Moisture about the Middle) and without any *Quarry* of *Stone*; the Stones in the Field about it are Grit-Stones. It lies almost at the *Bottom* of a rising Ground, being encompassed with Hills on all Sides except towards the East, or rather South-East.

There are 3 Pits which lie almost in a direct Line, the middlemost of which is that we speak of. There is also a fourth, which stands a little higher than the rest.

From the *Bottom* run 4 *Binks*, as they call them, 4 Yards wide, and 40 Yards long; except that in which they meet the fiery *Damp*, which wants 4 or 5 Yards of its due Length.

The *Bink*, in which the *Damp* is, is the farthest from the Air which is communicated from the other *Pits*.

The *Soil* of this *Bink* (as they tell me) is a stiff Clay; neither can they find in it the Sign of any *Mineral*, except *Coal* and *Shale*. The *Coal*, they say, is absolutely free from the *Pyrites*, with which most of our *Coals* are infected.

The *Bink*, in which the *Damp* is, was wrought forward 20 Yards on *Whitson-Monday*, 1675, when *Geo. Mitchell* (one of my Informers) going in to fetch some of his Tools, with a Candle in his Hand, and coming within 4 or 5 Yards of the further End, found himself, on a sudden, he knew not how, environed with Flames. His Face, his Hands, his Hair, and a great Part of his Clothes, were very much burnt. He heard very little Noise, altho' one *Edward Mitchell*, who was working at the same Time in another *Bink*, told me, that both he, and all those that stood above Ground, heard a very great one, like a Clap of Thunder; and that the Earth shook so that he was afraid the Roof would have fallen in and buried him.

This being the first Accident of this Nature, those without ran in a great Amazement, with their Candles in their Hands, to see what the Matter was, which were twice extinguish'd, but held in upon the 3d Lightning: They saw nothing, but met with intolerable Stench of Brimstone, and an Heat as scalding as an Oven half-heated, (for that was their Expression) which forced them very speedily to quit the Place.

Notwithstanding this they wrought forwards for about 3 Weeks, and carried it on till betwixt 30 and 40 Yards, until one *Henry Turnelly* met with the same Accident which had formerly befallen *Mitchell*, and *Mitchell* had also the Misfortune to have his Share in this; for, being by chance under Ground at

at the Mouth of the *Bink*, he was shot forth for about 2 or 3 Yards, and had his Head broken, and his Body bruised against the further Side.

About a Week after *Edward Mitchell*, another of my Informers, adventuring in again, met with the same Misfortune, and was worse scorched than any of the rest.

The things I chiefly took notice of were these :

(1.) That those who were in the *Bink*, whilst it was fired, never heard any more Noise than that which was usually made by a Flash of Gun-powder in the open Air, although those in the other *Binks* and without heard a very great one.

(2.) It shot off the *Turn* at the Mouth of the Pit, and small Coals, with other Rubbish from the Bottom, into the Air to a considerable Height.

(3.) They could perceive no Smell before the Fire, but afterwards a very strong Smell of Brimstone.

(4.) They used to go with their *Candles* low, as near as could be to the Bottom, because they perceived the Vapour to lie towards the Roof; which, if they held their *Candles* higher than ordinary, they could see descend like a black Mist, and catch hold of the Flame, lengthening it to two or three Handfuls; which would nevertheless burn after the usual manner, without any further Mischiefe, if they suddenly held down their Hands close to the Ground.

(5.) The *Flame* would continue in the *Vault* for 2 or 3 Minutes after the *Crack*; the last time, which was the most violent, they thought it continued about *half a Quarter* of an Hour.

(6.) The Colour of the *Flame* was blue, and very bright, something inclining towards green.

(7.) Altho' they told me they were sensible of no Smell before the Kindling of the Vapour, yet the *Colliers Clothes*, that worked in the adjoining Pits, smelt very strong of Brimstone; which makes me suspect all the Pits to be infected, altho' the Air secures them from Mischiefe. Their Insensibility I ascribe to the Custom.

To the Queries suggested by Mr. *Boyle*, I answer as followeth :

[1.] That *Damps* are generally observ'd to come about the latter End of *May*, and continue during the Heat of Summer; and in those Places, which have *Damps* all the Year long, yet they observe them to be most violent at that Season: And I could meet with no other certain Rule for any *periodical Returns*, except this *annual*; altho' it be certain, they do often return in the same Summer.

[2.] I never heard of any *Damps* that kindled of themselves; altho' I have been told, that in some Places they have been kindled by the Motion of the Sled in which they draw their Coals.

[3.] *Damps* generally are held to be heavier than the Air; but this was manifestly lighter, for it lay towards the Top of the *Bink*.

[4.] Upon the breaking of the *fulminating Damp* there proceeded a dark Smoke, of the Smell and Colour of that which proceeds from Gun-powder fired.

5. Many *Damps* are seen, but many also are not seen; which, whether they be visible or no, is hard to tell, but I suppose all would be visible, had we a convenient Light to view them by; because, be they either thicker or thinner than the Air, that Density or Thinness will occasion a Refraction, and that must needs render them visible.

6. Some *Damps* will quite extinguish all those Fires that are let down into them, be they never so many successively, or never so great; and Fire is observed to be so far from *curing*, that it often creates *Damps* in Places not otherwise subject to them. Indeed they are a present Remedy, if you can so order them as, by their Help, to make a Circulation of the Air through the infected Place; otherwise they do Hurt; and those *Grooves* wherein they are forced to break their Rocks by the Help of great Fires, are seldom free from *Damps*.

7. Men usually work in Places infested either by the fulminating or other *Damps*, after they suppose the *Vapour* spent.

8. *Damps* are common both in wet and dry Ground; but I cannot tell in which most.

9. *Damps* are observed to be most pestilential, and to kill the suddenest, that are in *Grooves* not stirred for many Years, especially if such *Grooves* have formerly had great Fires in them.

10. The general Opinion of our Workmen is, that there are some *Damps* which kill by Reason of the noisome *Steam*, and others meerly by Want of *Air*; which latter Opinion I have heard disallowed by the more experienced Sort: For they say, that there is no *Groove* that wants Air, be it never so deep; but the Air *stagnating* in very deep *Grooves* or *Pits*, the grosser Parts must needs, at length, separate themselves by their own Weight, and subsiding to the *Bottom*, there corrupt, and consequently get *malignant Qualities*, especially in the *Summer-time*, when the Sun promotes the *Fermentation*. Besides this, the standing *Air* being in a short Time filled with the *Vapours* arising from Men's Bodies and the *Steams* of *Candles*, and passing so often thro' the Lungs of the *Workmen*, is quickly rendered unfit for that Use (whatsoever it is) to which *Respiration* is accommodated; and this they take to be the most frequent Cause of ordinary *Damps*.

Damps will often follow the *Water*, and particularly this Sort of fiery *Damp*, if I am rightly informed.

By Mr. Rog.
Mostyn, n.
136. P. 895.

4. The *Coal-Work* at *Mostyn* in *Flintshire* lies in a large Parcel of Woodland, which hath a great Fall, directly North, to the Sea-Side; but the Dipping or Fall of the *Coal*, partly crossing the Fall of the Ground, is within a Point of due East, and lies 40, 50, and sometimes 60 Yards under the Level of the Sea. This Work is upon a Coal of five Yards in Thickness, and hath been begun upon about 6 or 8 and thirty Years ago. When it was first found it was extream full of *Water*, so that it could not be wrought down to the *Bottom* of the *Coal*, but a *Witchet* or *Cave* was driven out in the Middle of it upon a *Level*, for gaining Room to work, and drawing down the *Spring* of *Water* that lies in the *Coal* to the Eye of the Pit; in driving of which *Witchet*, after they had gone a considerable Way under Ground, and were
scanted

scanted of *Wind*, the *Fire-Damps* did begin, by little and little, to breed, and to appear in *Crevices* and *Slits* of the *Coal* where *Water* had lain before the Opening of the *Coal*, with a small *bluish Flame*, working and moving continually, but not out of its first *Seat*, unless the *Workmen* came and held their *Candles* to it, and then, being weak, the *Blaze* of the *Candle* would drive it, with a sudden *Fizz*, away to another *Crevise*, where it would soon after appear blazing and moving as formerly. This was the first Knowledge of it in this *Work*, which the *Workmen* made but a *Sport* of, and so partly neglected it, till it had gotten some *Strength*; and then, upon a *Morning*, the first *Collier* that went down, going forwards in the *Witchet* with his *Candle* in his *Hand*, the *Damp* presently darted out so violently at his *Candle*, that it struck the *Man* clear down, singed all his *Hair* and *Cloaths*, and disabled him for working a while after. Some other small *Warnings* it gave them, insomuch that they resolved to employ a *Man* on *Purpose*, that was more resolute than the rest, to go down a while before them every *Morning*, to chase it from *Place* to *Place*, and so weaken it. His usual *Manner* was to put on the worst *Rags* he had, and to wet them all in *Water*, and as soon as he came within the *Danger* of it, then he fell down, grovelling on his *Belly*, and went so forward, holding in one *Hand* a long *Wand* or *Pole*, at the *End* whereof he tied *Candles* burning, and reached them by *Degrees* towards it; then the *Damp* would fly at them, and if it missed of putting them out, it would quench itself with a *Blast*, and leave an ill scented *Smoke* behind it. Thus they dealt with it till they had wrought the *Coal* down to the *Bottom*, and the *Water* following, and not remaining as before in the *Body* of it, among *sulphureous* and *brassy Metal* that is in some *Veins* of the *Coal*, the *Fire-Damp* was not seen nor heard of till the latter *End* of the *Year* 1675, which happen'd as followeth.

After long *Working* of this *Coal*, it was found upon the rising *Grounds*, that there lay another *Roach* of *Coal*, at the *Depth* of 14 *Yards* under it, which proved to be $3\frac{1}{2}$ *Yards* thick, and something more *sulphureous*. This encouraged us to sink in one of the *Pits* we had formerly used on the 5 *Yards* *Coal*; and we sunk down 20 *Yards* before we came to the said *Roach*, in *Regard* it was at the *Sea-side*, and upon the lowest of the *Dipp*, where the *Rocks* successively thicken as they fall. As we sunk the lower *Part* of it, we had many *Appearances* of the *Fire-Damp* in *watry Crevices* of the *Rocks* we sunk thro', *flashing* and *darting* from *Side* to *Side* of the *Pit*, and shewing *Rainbow-colour-like* on the *Surface* of the *Water* in the *Bottom*; but upon drawing up of the *Water* with *Buckets*, which stirr'd the *Air* in the *Pit*, it would leave burning, till the *Colliers* at *Work*, with their *Breath* and *Sweat*, and the *Smoke* of their *Candles* thickened the *Air* in the *Pit*, and then it would appear again; they lighted their *Candles* in it sometimes when they went out, and so in this *Pit* it did no further *Harm*.

But being desirous to get the *Work* in some *Forwardness* before *Summer*, (when the *Heat* of the *Weather* at some *Times*, and the *Clofeness* of the *Air* in foggy *Weather* at others, occasions the *smothering Damp*) it was resolved, for *Expedition-sake*, and saving of some *Charges*, to sink a *Pit* within the *Hollows*

or *Deads* upon the *upper Work*, at 16 or 17 Yards Distance from the *first Pit*. This we proceeded in, 'till we came 6 or 7 Yards deep; then the *Fire-damp* began to appear as formerly, accompanying the *Workmen* still as they sunk: and they using the same Means as before, sometimes blowing it out with a *Blast* of their *Mouth*, at other times with their *Candles*, or letting it blaze without *Interruption*. As we sunk down, and the *Damp* got still more and more Strength, we found that our Want of *Air* perpendicular from the *Day* was the great *Cause* and *Nourisher* of this *Damp*; for the *Air*, that followed down into this *Pit*, came down at the first-sunk *Pit*, at the fore-mention'd Distance, after it had been disperfed over all the old *Hollows* and *Deads* of the former *Work*, that were filled up with *noisome Vapours*, thick smothering *Fogs*, and in some Places with the smothering *Damp* itself. Nevertheless, we held on sinking till we came down to 15 Yards, plying the *Work* Night and *Day* (except *Sundays* and *Holidays*) upon which *Intermission*, the *Pit* being left alone for 48 Hours and more, and the *Damp* gaining great Strength in the *interim*, by that time the *Workmen* went down, they could see it flashing and shooting from side to side, like *Sword-Blades* cross one another, that none durst adventure to go down into the *Pit*. Upon this they took a *Pole*, and bound *Candles*, several times to the End of it; which they no sooner set over the *Eye* of the *Pit*, but the *Damp* would fly up with a long sharp *Flame*, and put out the *Candles*, leaving a foul *Smoke* each time behind it. Finding that these things would not allay it, they adventur'd to bind some *Candles* at a *Hook*, hanging at a *Rope's* End, that was used up and down in the *Pit*: when they had lower'd down these a little way into the *Shaft* of the *Pit*, up comes the *Damp* in a full body, blows out the *Candles*, disperfeth itself about the *Eye* of the *Pit*, and burneth a great Part of the *Men's* Hair, *Beards*, and *Clothes*, and strikes down one of them, in the mean time making a *Noise* like the *Lowing* or *Roaring* of a *Bull*, but louder; and in the end leaving a *Smoke* and *Smell* behind it, worse than that of a *Carrion*. Upon this *Discouragement* these *Men* came up, and made no further *Trial*; after this the *Water* that came from it, being drawn up at the other *Pit*, was found to be blood-warm, if not warmer.

In this *Juncture* there was a *Cessation* of the *Work* for 3 *Days*; and then the *Steward*, thinking to fetch a *Compass* about from the *Eye* of the *Pit* that came from the *Day*, and to bring *Wind* by a secure way along with him, that if it burst again it might be done without *Danger* of *Men's* Lives, went down, and took two *Men* along with him, which served his turn for this Purpose. He was no sooner down, but the rest of the *Workmen* that had wrought there disdainig to be left behind in such a time of *Danger* hasted down after them; and one of them, more indilcreet than the rest, went headlong with his *Candle* over the *Eye* of the *Damp-pit*, at which the *Damp* immediately catch'd, and flew to and fro over all the *Hollows* of the *Work*, with a great *Wind*, and a continual *Fire*; and, as it went, keeping a mighty great roaring *Noise* on all Sides.

The *Men*, at first Appearance of it, had most of them fallen upon their *Faces*, and hid themselves as well as they could, in the loose *Sleck*, or *Small-coal*, and under

under the Shelter of Posts; yet nevertheless the *Damp* returning out of the Hollows, and drawing towards the Eye of the Pit, it came up with incredible Force; the Wind and Fire tore most of their Clothes off their Backs, and singed what was left, burning their Hair, Faces, and Hands; the Blast falling so sharp on their Skin, as if they had been whipt with Cords; some, that had least Shelter, were carried 15 or 16 Yards from their first Station, and beaten against the Roof of the Coal and Sides of the Post, and lay afterwards a good while senseless, so that it was long before they could hear or find one another. As it drew up to the Day Pit it caught one of the Men along with it, that was next the Eye, and up it comes with such a terrible Crack, not unlike, but more shrill than a Cannon, that it was heard 15 Miles off, with the Wind; and such a Pillar of Smoak, as darken'd all the Sky over head for a good while. The Brow of the Hill above the Pit was 18 Yards high, and on it grew Trees 14 or 15 Yards long; yet the Man's Body, and other Things from the Pit, were seen above the Tops of the highest Trees, at least 100 Yards. On this Pit stood a Horse-Engine of substantial Timber, and strong Iron Work; on which lay a Trunk, or Barrel, for winding the Rope up and down, of above 1000 Pounds Weight; it was then in Motion, one Bucket going down, and the other coming up full of Water: This Trunk was fastened to that Frame with Locks and Bolts of Iron; yet it was thrown up, and carried a good way from the *Pit*; and Pieces of it, tho' bound with Iron Hoop and strong Nails, blown into the Woods about; so likewise were the two Buckets; and the Ends of the Rope, after the Buckets were blown from them, stood a while upright in the Air like Pikes, and then came leisurely drilling down. The whole Frame of the Engine was stirr'd and mov'd out of its Place; and those Men's Clothes, Caps, and Hats, that escaped, were afterwards found shatter'd to pieces, and thrown amongst the Woods a great way from the Pit. This happened the 3d of *Feb.* 1675, being a Season when other Damps are scarce felt or heard of.

5. About 2 Miles on the South-East of *Stony Easton*, at a Place nearly bordering to *Mendipp-Hills*, begins a Running of Coal consisting of several Veins, which extends itself towards the East about 4 Miles. There is much Working in this *Running*, and Fire-Damps continually there happen; so that many Men of late Years have been there kill'd, many others maimed, and a Multitude burnt; some have been blown up at the Work's Mouth; the *Turn-Beans* (which hangs over the *Shaft*) has been thrown off its Frame by the Force of it; and those other Effects, whereof you had an Account from other Places, are generally found. The Middle and more Easterly Parts of this *Running* are so very subject to those fiery Damps, that scarce a Pit fails of them; notwithstanding which our Colliers still pursue their Work; but, to prevent Mischief, they keep their Air very quick, and use no Candles in their Works but a single Wick, and those of 60 or 70 to the Pound, which nevertheless give as great a Light there, as others of 10 or 12 to the Pound in other Places; and they always place them behind them, and never present them to the Breast of the Work.

When

By Mr. J. Beaumont
Phil. Col.
n. 1. p. 6.

When any are burnt, the usual Method they observe in their Cure is thus: They presently betake themselves to a good Fire, and sending for some Cow's hot Milk, they first bathe the burnt Places with that; when they have done this a while, they make use of an Ointment proper for Burnings, which the Masters of the Works have always in a Readiness for such Chances, being furnished therewith, at the cheap Rate of 12 Pence the Pound, by a good old Woman living near the Works.

The Colliers assure me, that these Works are apt to take Fire all the Year, which it will freely do at any Time if a Candle be carry'd within Air: But most, and with most Violence, in the Winter, and chiefly in a *black Frost*, when the Air runs best: That the Danger of Firing is alike both in wet and dry Grounds: And that there are no Fumes coming out of the Mouth of any Shaft which will be lighted by a Candle or Torch.

I have heard of one Damp here which took Fire of itself, and kindled the Vein of Coal, which burnt a considerable Time before it went out.

Our *Damps* lie as well towards the Bottom or Seal of the Work as towards the Roof, it being nothing but an invisible *sulphureous Breath* expanded through the whole Work.

I cannot perceive at the Mouth of any Shaft, or understand by any Workman, of any unusual Wind or Current of Vapours coming from beneath. In wet Works there are many Times Bubbles on the Surface of Water there standing, which will presently take Fire if a Candle be held to them: But I cannot find that those Bubbles are caused by any *subterraneous Breath*, but rise from the Falling of Coal into the Water, or from Dropping of Water from the Roof, as we see they do in Ponds from Drops of Rain in the Summer.

I may here further acquaint you, as a Novelty, that this last Summer, 1679, two *Fire-Damps* happened in our *Lead-Mines* on *Mendipp-Hills*; but they were of so small a Force that the Workmen received no Prejudice by them.

A Well and Earth in Lancashire, taking Fire at a Candle, by Mr. Tho. Shiely, n. 26. p. 482.

VIII. About the latter End of *Feb.* 1659, returning from a Journey to my House in *Wigan*, I was entertained with the Relation of an odd Spring, situated in one *Mr. Hawkley's* Ground (if I mistake not) about a Mile from the Town, in that Road which leads to *Warrington* and *Chester*; the People of this Town did confidently affirm, that the Water of this Spring did burn like Oil.

When we came to the said Spring (being 5 or 6 in Company together) and applied a lighted Candle to the Surface of the Water, 'tis true, there was suddenly a large Flame produced, which burnt vigorously: But observing that this Spring had its Eruption at the Foot of a Tree, growing on the Top of a neighbouring Bank, the Water of which Spring filled a Ditch that was there, and covered the burning Place, I applied the lighted Candle to divers Parts of the Water contained in the said Ditch, and found, as I expected, that, upon the Touch of the Candle and the Water, the Flame was extinct.

Again, having taken up a Dish full of Water at the *flaming Place*, and held the lighted Candle to it, it went out. Yet I observed that the *Water* at the burning

burning Place did boil and heave like Water in a Pot upon the Fire, though my Hand put into it perceived it not so much as warm.

This Boiling I conceived to proceed from the Eruption of some *bituminous* or *sulphureous Fumes*, considering this Place was not above 30 or 40 Yards distant from the Mouth of a *Coal-Pit* there: And indeed *Wigan, Ashton*, and the whole Country for many Miles Compass, is underlaid with *Coal*. Then applying my Hand to the Surface of the *burning Place* of the *Water*, I found a strong *Breath*, as it were a Wind, to bear against my Hand.

When the *Water* was drained away, I applied the Candle to the Surface of the dry *Earth*, at the same Point where the *Water* burned before; the *Fumes* took *Fire* and burned very bright and vigorous. The *Cone* of the *Flame* ascended a Foot and an Half from the Superficies of the *Earth*: And the *Base* of it was of the Compass of a Man's Hat about the Brim. I then caused a Bucket full of *Water* to be poured on the *Fire*, by which it was presently quenched. I did not perceive the *Flame* to be *discoloured* like that of *sulphureous Bodies*, nor to have any manifest *Scent* with it. The *Fumes*, when they broke out of the *Earth* and press'd against my Hand, were not, to my best Remembrance, at all hot.

IX. This *subterranean Fire* keeps no Analogy with other *Vulcano's*: It increaseth or decreaseth according to the Subject it feedeth on; which is, for the most Part, a *Day-Coal* (as they call it, for the *upper Seam* of the *Coal* next exposed to the *Air*) so that you may light a Candle at it in some Places; in other Places it is some Fathoms deep, according as the *Day-Coal* heightens or deepens.

A subterranean Fire in a Coal Mine at Newcastle, by Dr. Lucas Hodgeson, n. 130. p. 762.

No *Sal-Armoniack*, nor any thing like it, to be found, except where an actual *Fire* hath come. There being a Mixture of the *Steams* of *Sal-Armoniack* and *Sulphur* rising together in most Places, it is hard to distinguish them; for though the *Flowers* of *Brimstone* seem to rise first, yet there is commonly a Crust of *Sal-Armoniack* under them.

There is a *milky Substance*, which is found no where but where the *Sal-Armoniack* and *Sulphur* are totally gone; and the *acid Part*, or *aluminous Spirit*, of that white Mass will also take Wing by the Increase of the *Fire*, leaving a *Caput. Mort.* dry, stiptick, and as hard as Stone; yet I account that a Pound of this Mass, before the *Fire* press too much upon it, will go near to afford by *Solution*, &c. Half a Pound of tolerable *chrystalline Alum*.

The neighbouring Soil differs little from other Grounds with us, having neither *common Salt* nor *Nitre* in it; for though there be a *Salt-Well* with us, yet it is both on the other Side of *Tyne* and a considerable Distance from the *Fire*.

I have industriously observed the *Springs* that are near the *Fire*, and find none of them that give the least Suspicion of *Sal-Armoniack*. The *Water* that runs from the adjacent *Collieries* is *vitrioline*, giving as deep a Tincture with *Galls* as *Scarborough-Spaw*. In a Word, it differs nothing from the *Waters* that ordinarily

ordinarily drown our *Collieries*, and cost our *Coal Owners* so much to be quit of them. The other *Springs*, most of which are dry this Year (1676) are of ordinary Use, containing no *Mineral Salts* in them. But I hope you will cease to wonder, that *Coal* should produce a *volatile Salt* by the Action of the *Fire*, seeing I have gathered *Sal-Armoniack* from a burning *Brick-Kiln*, where nothing but *Clay* and *Coal* are burnt together, and I hope none will expect the *volatile Salt* in the *Sal-Armoniack* from ordinary *Clay*. The Reason which first prompted me to seek this Salt there, was that the Smell of the *Kiln* did somewhat resemble that of the *subterranean Fire*. There is also a Sort of *Mineral* we call a *Slate*, which is partly *Coal*, partly *Alum Stone*, partly *Marcasite*, which, being laid up in Heaps and burnt, are used for hardening the *Coal-Ways*; upon these Heaps, whilst burning, I have often gathered both *Brimstone* and *Sal-Armoniack*.

When I poured cold Water upon the powder'd *Marcasite*, it produced a *vitrioline Water*, but no Heat.

As to the Resemblance betwixt this *Sal-Armoniack* and that which comes from Mount *Ætna*, where no Coals are supposed to be, whence it seems to follow, that our *volatile Salt* may proceed from somewhat else than *Coal*; to which Difficulty I answer, that when I deduced ours from *Coal*, I did not exclude other *bituminous* Substances that are analogous to it, of which I suppose the Country where Mount *Ætna* is affordeth no inconsiderable Quantity; neither will it follow that no Coals have been wrought, therefore there are none; and if Trial hath been made, and no Coals found, yet it will be a Doubt still whether those Trials have been sufficient. However it be, yet I think it were not impertinent (by the Way) to enquire, whether the the sagacious *Venetians* may not be beholden to Mount *Ætna*, or some other *subterranean Fires*, for the great Quantity of *Sal-Armoniack* they sell to our Merchants; for this *Fire* affordeth no inconsiderable Quantity thereof, especially in dry Weather.

Though it may seem incredible to some that black *Coal* should yield a *white, snowy, volatile Salt*, yet they that know that all *volatile Salts* whatever may be freed from their *Fætor* and intense Colour, by transmuting them into a *Sal-Armoniack* by the Mediation of an *Acid*, as Spirit of Salt, Spirit of *Vitriol*, *Alum*, &c. and then subliming them till they be white, will cease to doubt of this Matter. The Reason of which Change, I presume, is, because, though these *volatile Salts* carry over always some of the *fætid Oil* with them while in a State of *Volatility*, yet being thus, in a Manner, fixed, the *fætid Oil* must necessarily, by Force of *Fire*, rise first, leaving the subsequent *compound Salt*, or *Sal-Armoniack*, without Smell; though it is still a Doubt whether the *volatile Salt* is better or worse for this Labour.

We have no *petrescent Springs* near us; but there is a *Cave* some Miles off, at the farthest End of which few have been, from the Roof of which hang large Lumps of *petrified Water*, like *Icicles*, some of them reaching down to the Ground like Pillars; these *Icicles* are good *Limestone*, as I have tried.

X. I have lately received an Account from my Brother, that on a Side of one of the *Appennine Mountains*, half way betwixt *Bologna* and *Florence*, near a Place called *Petra Mala*, about 5 Miles from *Fierenzola*, there is a Spot of Ground about 3 or 4 Miles Diameter, which incessantly sends up a Flame rising very high, without Noise, Smoak, or Smell; yet it gives a very great Heat, and it has been observed to be thus in all times, except of great Rains, which put it out for a time; but, when that is over, it burns with greater Vigour and Heat than before. The Sand about it, when turned up, sends up a Flame; but within 3 or 4 Yards of it there grows Corn all round about; for it continues always in the same Spot.

*An Eruption
of Fire near
Fierenzola;
By Dr. Rob.
St. Clair. n.
245. p. 378.*

This Flame seems to proceed from a Vein of *Bitumen* or *Naphta*, that *Crops* (as the *Miners* call it) only here; which, when by Plowing or some other Accident the upper Crust has been turned up, was kindled into a Flame by the Heat and Agitation of the Air, as other *Salino-Sulphureous* Bodies are, of which 'Squire *Boyle's Phosphorus* is a particular Instance. The like *Spontaneous Ascension* is seen in many *Mineral* Substances; but none, that I know of, so quick in its Production, or so lasting, as this is; the whole Wood and Fields having been destroyed by them. The Neighbours there have been so little curious to observe it, that they believed there was a great Hole in the Flame-Place; but he found it to be firm Ground. Neither does any there remember when and upon what Occasion it first began. The *Flaming Well* near *Wigan* seems to proceed from a Cause much like this, in which you may boil an Egg, and upon the approaching of a lighted Candle, it takes Fire; both seem to proceed from a *Naphta* or *Subtile Bitumen*; only that in a hotter Country, and being in a dryer Soil, is more subtile and inflammable; just as the *Petroleum* which is to be found in *Italy* is a White like *Spirit of Turpentine*, and is more penetrating than the *Petroleum* which is to be found in the Northern Countries; an Instance of which we have in a *Well* two Miles distant from *Edinburgh*, called the *Baume-Well*, of a black red Colour and very thick; but, being distilled, does in Colour, Taste and Smell, resemble that of *Italy*.

The *Spontaneous Ascension* of the *Naphta* seems to be made out by the Smell that our *Bitumen* near *Edinburgh* yields, being most like *Coal-Smoak*. There are three such Fires on the same Hills that are extinguish'd in the Summer, but burn in the Winter; the Reason of which I judge to be, that the Bowels of the Earth, being cooler in the Summer than in Winter, do not send forth that Quantity of those *Subtile Exhalations*, as may be sufficient to maintain a Flame in Summer; but in Winter the Bowels of the Earth being hotter (which is made evident by the smoaking of Springs in Winter, and not in Summer, and the Experience of *Miners*) greater Plenty of Steams are sent forth, which in the Air are agitated into a Flame, the brisk Motion of the Parts one against another being promoted by the Subtilty and brisk Motion of the *Aerial Particles*, *que mutuas dant operas*.

An historical
Account of
the Eruptions
of Mount
Ætna; by
Mr. Olden-
burgh. n. 48
p. 967.

Lib. 3.
Æneid.

XI. To pass by what is related by *Berosus*, *Orpheus*, and other less credible Authors, about the Eruptions of this Mountain, both at the time of the Ingress of the *Ionian Colonies* into *Sicily*, and that of the *Argonauts* (which latter was in the 12th Age before the *Christian Account*;) we shall first take notice of that which happen'd at the time of the Expedition of *Æneas*; who, being terrify'd with the Fire of this then burning Mountain, left that Island; whereof *Virgil* gives a notable Description.

After this, we find in *Thucydides*, that in the 76 *Olympiad*, which is about 476 before *Christ*, there was another Fire; and about 50 Years after that another.

Then, in the time of the *Roman Consuls*, there happen'd 4 Eruptions of *Ætna*, recorded by *Diodorus Siculus*, and *Polybius*.

The next was in the time of *Julius Cæsar*, related by the said *Diodorus*, to have been so fierce, that the Sea about *Lipara* (an Island near *Sicily*, by its fervent Heat burnt the Ships, and killed all the Fishes thereabout.

Another we read of in the Reign of *Caligula*, about 40 Years after *Christ*; which was so dreadful, that it made that Emperor, then being in *Sicily*, to fly for it.

About the Martyrdom of the *Romish S. Agatha* it burned again very fiercely; though some say, that by virtue of her Intercession it was stay'd from reaching *Catanea*.

Again it burnt *A. C.* 812, in the Reign of *Charles M.*

Then from the Year 1160 to 1169, all *Sicily* was shaken with many terrible Earthquakes; and the Eruptions of the same Mountain destroy'd a vast Tract of inhabited Land round about it, and reach'd as far as *Catanea*; the Cathedral of which it destroyed, and the religious Men living in it.

Again, in the Year 1284, there happened another terrible Fire about the time of the Death of *Charles*, King of *Sicily* and *Aragon*.

A. 1329, until 1333, there was another.

A. 1408, another.

A. 1444, another, which lasted till 1447.

A. 1536, another, which lasted a Year.

A. 1633, another, continuing several Years.

A. 1650, it burnt on the North-East Side, and vomited so much Fire, that by the fiery Torrents caused thereby, great Devastation was made; as *Kircher* relates in his *Mundus subterraneus*; whose Assistance we have also made use of, in the foregoing *Chronology*, together with that of *Philothæus*.

The same Author, having been in *Sicily* himself, observeth, that the People of *Catanea*, digging for *Pumice-Stones*, do find at the Depth of 100 *Palmes* (which is about 68 Feet) Streets paved with Marble, and many Footsteps of Antiquity; an Argument, that Towns have stood there in former Ages, which have been overwhelmed by the Matter cast out of this Mountain. They have also found several Bridges of *Pumice-Stones*

Stones, doubtless made by the Flux of fiery Torrents, the Earth being very much raised since.

XII. There was for the Space of 18 Days before this Fire broke out a very thick dark Sky in those Parts, with Thunder and Lightning, and frequent Concussions of the Earth; which the People make terrible Reports of, tho' I never saw nor heard of any Buildings cast down thereby, save a small Town, or Village called *Nicolesi*, about half a Mile distant from the new Mouth, and some such other slight Buildings among those Towns, that were after over-run by the Fire. Besides, it was observ'd, that the old Top or Mouth of *Ætna* did, for 2 or 3 Months before, rage more than usual; the like of which did *Volcan* and *Strombolo*, two burning Islands to the Westward: And the Top of *Ætna*, much about the same time, has sunk down into its old *Vorago* or Hole, in that 'tis agreed by all that had seen this Mountain before, that it was very much lower'd.

It first broke out on the 11th of *March*, 1669, about two Hours before Night, and that on the South-East side, or Skirt of the Mountains, about 20 Miles between the *Old-Mouth*, and 10 Miles from *Catanea*. At first it was reported to advance 3 Miles in 24 Hours; but at our being there (*viz.* *April* 5.) when we were come within a short Mile of *Catanea*, it scarce moved after the rate of a Furlong a Day; and after this Degree of Progress it continued for 15 or 20 Days after, passing under the Walls of *Catanea*, a good way into the Sea: But about the latter end of this Month, and the beginning of *May*, (whether it was, that the Sea could not receive this Matter fast enough, or rather that the Mouth above did cast out a larger Quantity) it bent all its Force against the City; and having wrought itself up even with the Walls thereof, over it passed in divers Places: but its chief Fury fell upon a very pretty Convent, which was that of the *Benedictines*, having large Gardens and other Grounds betwixt them and the Wall; which, when it had filled up, it fell with all its Force on this Convent, where it met with strong Resistance; which made it swell (as usually it did, where it met with any Obstruction) almost as high as the higher Shops in the old *London-Exchange*; this Convent being built much after that Fashion, though considerably bigger. Some Parts of this Wall were driven in, whole and entire, almost a Foot; as appeared by the rising of the Tiles in the midst of the Floor, and bending of the Iron-Bars that went cross above. And 'tis certain, had this Torrent fallen in some other Part of the Town, it would have made great Havock amongst their ordinary Buildings; but here its Fury ceased upon the 4th of *May*, running henceforward in little Channels or Streams, and that chiefly into the Sea. It had overwhelmed in the up-land Country, some 14 Towns and Villages, whereof some were of good Note, containing 3 or 4 thousand Inhabitants, and stood in a very fruitful and pleasant Country, where the Fire had never made any Devastation before: But now there is not so much as any Sign where such Towns have stood; only the Church and Steeple of one of them, which stood alone upon an high Ground, does still appear.

An Eruption
of M. Ætna
in 1669, by
some English
Merchants.
n. 51. p. 1028

As to the Matter which thus ran it was nothing else but divers kinds of *Metals* and *Minerals*, render'd liquid by the Fierceness of the *Fire* in the *Bowels* of the Earth, boiling up, and gushing forth, as the Water doth at the Head of some great River; and having run in a full Body, for a Stone's Cast, or more, the Extremity thereof began to crust and curdle, becoming, when cold, those hard porous Stones, which the People call *Sciarri*, having the nearest resemblance to huge Cakes of Sea-Coal, full of a fierce Fire. These came rolling and tumbling over one another; and, where they meet with a Bank, would fill up and swell over, by their Weight bearing down any common Building, and burning up what was combustible. The chief Motion of this Matter was forward; but it was also dilating itself, as a Flood of Water would do on even Ground, thrusting out several Arms, or Tongues, as they call them.

About 2 or 3 a-clock in the Night we mounted an high Tower in *Catanea*, whence we had a full View of the *Mouth*, which was a terrible Sight; viz. to see so great a Mass, or Body of meer Fire. Next Morning we would have gone up to the *Mouth* itself, but durst not come nearer than a Furlong off, for fear of being overwhelmed by a sudden Turn of the Wind, which carried up into the Air, some of that vast Pillar of Ashes, which, to our Apprehension, exceeded twice the Bigness of *Paul's Steeple* in *London*, and went up in a strait Body to a far greater Height than that; the whole Air being thereabout all covered with the lightest of those *Ashes*, blown off from the Top of this Pillar: And from the first breaking forth of the *Fire*, until its Fury ceased (being 54 Days) neither Sun nor Star were seen in all that Part.

From the outside of this Pillar fell off great Quantity of Stones, but none very big; neither could we discern any *Fire* in them, nor come to see where the fiery Stuff broke out, there being a great Bank, or Hill of *Ashes* betwixt it and us. At the Mouth, whence issued the *Fire*, or *Ashes*, or both, was a continual Noise, like the beating of great Waves of the Sea against Rocks, or like Thunder afar off; which, sometimes, I have heard here in *Messina*, though situated at the Foot of high Hills, and 60 Miles off. It hath also been heard 100 Miles Northward of this Place in *Calabria* (as I have been credibly inform'd) whither the Ashes have been also carried: And some of our Seamen have also reported, that their Decks were covered therewith at *Zant*, though it is likely not very thick.

Vide Cap. I.
§ 39.

About the middle of *May* we made another Journey thither, where we found the Face of things much alter'd; the City of *Catanea* being 3 Quarters of it compassed round with these *Sciarri*, as high as the Top of the Walls, and in many Places it had broken over. The first Night of our Arrival, a new Stream or Gutter of *Fire* broke forth among some *Sciarri*, which we were walking upon an Hour or two before, and they were as high as to be even with the Top of the Wall. It poured itself down into the City in a small Gutter of about 3 Foot broad, and nine Foot long, of meer Fire, the Extremities still falling off into those *Sciarri*; but this Stream was extinct by the next Morning, though it had filled up a great void Place with its *Sciarri*. The next Night was a much bigger Channel discovered, pouring itself over another Part of the Wall into the *Castle-Ditch*, which continued (as we were inform'd) some Days

Days after our Departure. Divers of those small Rivulets did run at the same time into the Sea.

It was observed, that those Streams of Fire never grew broader, nor visibly longer, nor moved out of the Place they were seen in, which puts us a little more to examine their working; and we did conclude, that not only then, but in the Fury also of its running, it made itself certain crusted Gutters to run in, to keep itself, as it were, from the Air, which by degrees did cool and fix it; as more plainly appeared above at the Mouth, where, the first time of our going thither, we found the *Sciarri* generally thus cold and fix'd. And hence also it might proceed, that these live *Sciarri*, meeting with any Bank or high Ground, would puff and swell up, till they had overcome it: so that in many places, especially under the Walls of *Catanea*, were Valleys of those *Sciarri*, and the Fire never broke forth, or discovered itself in those Streams, until it had gained its Height; for those Rivulets ever went declining.

Having spent 2 Days about *Catanea*, we again went up to the Mouth, where now, without any Danger of *Fire* or *Ashes*, we could take a free View both of the old and new *Channel* of the *Fire*, and of that great Mountain of *Ashes* cast up. That, which we guess to be the old *Bed* or *Channel*, was a three-corner'd Spot of about 2 *Acres*, with a Crust or *Sciarri* at the *Bottom*, and upon that a small Crust or Surface of *Brimstone*. It was hedged in on each Side with a great Bank, or Hill of *Ashes*; and behind, and at the upper End, rose up that huge Mountain of the same Matter. Between those two Banks the *Fire* seems to have had its Passage. At the upper End in the Nook, upon a little Hillock or crusted *Sciarri*, was a *Hole* about 10 Foot wide, whence it is probable the *Fire* issued, and it might have had several other such *Holes* since, either crusted over, or covered with *Ashes*. At the Bottom of this *Hole* the *Fire* was seen to flow along, and below it was a *Channel* of *Fire*, beneath that Surface of *Sciarri*, which being cleft a-top for some Space, we had an easy and leisureable View of the *Metal* flowing along, whose *Superficies* might be a Yard broad, tho' possibly it carried a great Breadth underneath, the Gutter going sloping. What Depth it had we could not guess; it was impenetrable by Iron Hooks, and other Instruments we had. We were very desirous to have got some of this Matter at the *Spring-Head*, but we could penetrate no more into it, than with one's Finger into the Palm of the Hand. 'Tis likely that some Running may have been more yielding than we found this. From *Channel*, but especially from that *Hole* above it, issued great Store of a strong sulphurous *Smoak*, wherewith some of our Company were, at first, almost stifled, thro' Inadvertency. About once in a Quarter of an Hour there would rise a Pillar of *Smoak*, or *Ashes*, but nothing comparable to the former, which seemed to come from the middle Top of that new-made Mountain.

At this our last being at *Catanea* we found the People busy in barricading the Ends of some Streets and Passages, where they thought the *Fire* might break in; and this they did by pulling down the old Houses thereabouts, and laying up the loose Stones in manner of a Wall, which, they said, would resist the *Fire*, as not being mixt with *Lime*; though it was the great Weight and
Force

Force of that fiery Matter in pressing forward, and not its burning, that overthrew the Buildings, as plainly appeared in the Convent of the *Benedictines*, and in the *Town-walls*, where the great Deluge of Fire did pour itself; it not breaking into the City, but pouring itself over the *Walls*, as hath been said.

Unto this very time 'tis said to have run a Mile into the Sea, and as much in Front, tho' it was much less when we were there, The Shore goes gently declining; having at the Extremity of the *Sciarrri* about 5 Fathoms, and about half as much they are above Water. The Superficies of the Water, for 20 Foot or more of those Rivulets of Fire, was hotter than to endure one's Hand in it, tho' deeper it was more temperate; and those live *Sciarrri* still retained their Fire under Water, as we saw, when the Surges of the Sea retreated back in their ordinary Reverberations.

The general Face of these *Sciarrri* is, in some respect, not much unlike, from the Beginning to the End, to the River of *Thames* in a great Frost, at the Top of the Ice above Bridge; I mean, lying after such a rugged manner in great Flakes: but its Colour is quite different, being most of a dark dusky Blue, and some Stones, or Rocks, of a vast Bigness, close and solid.

But notwithstanding their *Ruggedness*, and Store of *Fire*, which we could see glowing in the Clefts and Cavities, we made shift to ramble over a good part of them; as 'tis said also, that People would do the same in its greatest Violence of Burning: For as those live *Sciarrri*, and those *Rivers of Fire* themselves, were so tough and impenetrable as to bear any Weight; so the Superficies of the *Sciarrri* might be touched and handled, the *Fire* being inward, and not to be discerned but near-hand, especially in the Day-time. And 'twas somewhat a strange Sight, to see so great a River come so tamely forward; for, as it approached unto any Houle, they not only, at good leisure, removed their Goods, but the very Tiles and Beams, and what else was moveable.

I shall add, That the whole Country, from the very *Walls* of *Catanea* to 20 Miles on this side, is full of those old *Sciarrri*, which former *Eruptions* have cast forth, tho' the People remember none so big as this last, or that burst out so low. This Country is, notwithstanding, well cultivated and inhabited; for length of time hath either mollified much of those old *Sciarrri*, or new Moulds or Ashes have overgrown them; tho' there still remains much Country, which, it may be, will never be made serviceable.

What is the perpendicular Height of this Mountain I cannot learn. It cannot, perhaps, be rightly taken, being so subject to alter its Height and Shape: But it is a very goodly Mountain to look upon, as one passes by Sea to the Eastward, standing alone by itself, rising from the very Shore, and, at shortest Passage, is reckoned twenty Miles up to the Top, tho' from *Catanea* it hath thirty Miles as before.

2.52.p.1041 A good Quantity of *Ashes* being taken up in divers Parts of and about *Aetna*, some at the Top or the Mouth of the new made Mountain, some a Mile off, some four, some ten Miles, some but half a Mile distant, and others on the Skirts of the said Mountain; the four first were found very

very dry like Dust; but the two latter were very moist, though in *Sicily* (as we are inform'd) they have lain a good while exposed to the Heat of the Sun; besides that the two last differ from one another, in that one sort of them consists of hard and small Lumps, the other of very soft dirty Grains; yet both moist, and of a very vitriolate Taste.

Some of the *Sciarri* are coarser, taken up at some Distance from the Mouth; and of these some black, with a Crust of *Brimstone*; some of a red Hue; others are finer; and said to be got out of the Gutters of Fire at the very Mouth. Both these kinds are light; but then there is a third sort of Stone, very solid and ponderous, which seems to be made up of a Conflux of divers Minerals melted together.

The Fire spread about three Miles in breadth, and seventeen Miles in length.

XIII. 1. When the Easterly Wind had blown about 6 or 7 Weeks, till, as I guess, about the fourth of *June*, 1693, the Mountain in the Island *Sorea* began early in the Morning, about Day-break, to cast out more Fire than ordinary, which continued for 5 or 6 Days; during which it was dark and cloudy Weather: till at last it brought forth, not only a most prodigious Flame, but also such a black and sulphurous Vapour, that the Inhabitants of *Hiso* (being a Village in the western Part of the Island, and nearest to the Opening of the Mountain) were wholly covered by it; and afterwards followed a whole Stream of burning *Brimstone*, which consumed many that could not escape. Afterward the Inhabitants perceived, that a Part of the said Mountain was sunk down; and three or four Days after another Part; and so from time to time, until the burning Lake was become almost as great as half of the Island: Wherefore the Inhabitants went on board of their Vessels and Boats, from whence they perceived that huge great Pieces of the Mountain fell into this fiery Lake, as into a bottomless Pit, with a most prodigious Noise, as if a whole Cannon were discharged. But the most remarkable thing was, that the more vehement the Fire was, the lesser the Island was shaken. The Inhabitants of another Town called *Woroc*, upon the East-side of the Island, not thinking themselves in so great Danger, (the Opening, or fiery Lake being yet at some Distance) remained a Month longer, until they saw the same continually approaching them. They observed that when great Pieces fell down, and that the Lake became wider, the Noise was so much the greater: So that they saw no likelihood, but that all the Island would be swallow'd up. Wherefore they unanimously transported themselves to *Banda*, leaving all their Moveables for want of Vessels, and arrived at *Amboyna* this 18th of *July*, 1693.

Several burning Mountains have now been filled up and quenched; others have begun to open themselves, and cast out Fire, as in the Isle *Cbiaus*.

There is likewise a burning Mountain upon the Island *Celebes*: And in an infinite Number of Places there is hot Water found, if you dig but 10 Foot deep.

*An Account
of several
Burning
Mountains
in the Mo-
lucca Islands,
sent to M.
Nich. Wit-
sen; by ---
n. 206. p. 49.*

In the Mountains of *Ternata* is always heard a terrible Noise, as of the crying of a great many People, caused by the Fires. It often casteth out Stones, and is probably exceeding deep; and the rather, because it is likely that the several burning Mountains of the *Molucca* Islands are beneath consumed by the same Fire, which joineth the spacious Openings together.

The Burning Mountain upon *Banda* casteth forth a prodigious Quantity of Smoak and Ashes, oftentimes much Fire; and makes a Noise as if a great many of the greatest Cannon were heard all at once. This Mountain hath cast out so many Stones (and some near six Foot long) that the adjacent Sea, which has been forty or fifty Fathom deep, is not only fill'd up there, but they become many Fathoms higher than the Water; whereby it may be conjectur'd, how large the inward Cavities of this Mountain are.

By.....
n. 216. p. 42.

2. After several vain Attempts to search and examine the Constitution of the Opening of the Burning-Mountain, in the Isle of *Ternata*, at last, having passed thro' great Difficulties, and mounted very dangerous Precipices, we arrived at the Top, *Octob.* 12. 1693. When I first approached this terrible *fire-vomiting Opening*, wherein there is an inexpressible Noise, I could see nothing of the inward Parts, by reason of the Smoak: Wherefore I went back a little, tarrying for a better Opportunity. After some time I found the Smoak very much diminish'd; and making haste to the Mouth of it, I saw the Opening which is underneath the North-side, from whence the Cavity extended itself towards the South, till the Edges, on both Sides, came to terminate at the North-side of that which was fallen in: Wherefore we went towards the East-side, to look into the western Cavity; but we saw nothing but a fiery and flaming Substance, and the Conveyances of it. We did not venture to go to the North-side, to see into the South Cavities; not only because of the Southerly Wind, but also because 'tis like, that the most spacious *Antra* are on the South-side, which causeth the Smoak to be driven Northerly; and because we had formerly met with Pieces of burning Matter, that were cast out towards the North-side. Having seen enough, and satisfy'd my Curiosity, we withdrew, and returned to *Malayen*, bringing with us some Pieces of Branches of the fruitful *Clove-trees* that we had passed by.

The Northerly-side of this burning Hole is at the utmost Height of the Mountain to the Northward, or from *Hori*. To the West and Eastward of it there is, on each Side, a Hill higher than the *Brinks* of this *Hole*, both of them grown over with *Reed* or *Cane*, by the Inhabitants call'd *Cannacanna*: The most westerly is situated more Northerly from the *Hole*; on the South-side of this we got up. The most Easterly, on the contrary part, lieth more backwards from it, and to the Southward of it. The Southerly Hill, on the West-side of the *Mountain*, turns about to the Eastward, with a Riff or Ridge, and terminates at the North-side of the *Mountain*. The *Mouth* of this fearful *Hole*, on the West and South-East Sides, is surrounded, as by a Bank; each Bank having a several *Ditch*, and the Brink of the *Mouth* is upon the highest Part,

part descending on the Outside. The three Hillets nearest to the Hole are quite barren, and nothing but Stone; but the most remote is covered with thick *Reeds*.

Round about the *Hole* lies scattered much of the Matter that hath been cast forth; and it is perceivable, that it must be soft when it comes out, because it falls flat, according to the Figure of the Place where it falls. The *Colour* of it is dark-green, not clear, but somewhat grey; and this Matter generally does burst, or separate itself as the Dung of a *Cow*. There are of this both great and small Pieces, now turned into Stone, being inwardly blackish and spongy, mixt with white Spots: And, to give you some further Particulars of this burning Mountain, I have observed, that the extreamest or most southerly round Bank is all covered with *Cannacanna*; and it is the highest also. The *Smoak* of which, in respect of *Malayen*, seemed to come forth out of a higher Place, now in the descending of the Mountain, doth notwithstanding seem to come forth at the same Height.

There is a *barren Hill*, that seems to be situated on the North-side of the *Top*, a little descending towards *Malayen*, but it is about the same Height as the highest *Top* that is seen from *Malayen*. Furthermore, the Reason why the *Smoak* seems to come forth from a higher Place is, because the *Opening* is more Southerly; and then, in regard of only *Malayen*, it seems that the *Smoak* comes forth more towards the midst. Wherefore I do certainly believe, that the right *Opening* formerly has been where the round Banks now lie; that is, to the Southward: For whereas, after a good Space of violent Burning, there groweth a small Bank; any Person that should see the Situation, would be of my Mind. And besides, it being 9 or 10 Years since the last Burning was perceived, there are to be seen round about the *Opening* (besides the Barrenness on both Sides, which is some Distance from the *Opening*, in descending towards the West and North-sides, as also above on the South and East-sides) Trees all about, of an equal Thickness, as all grown since that time, and now newly burst and burnt by the Fire.

Lastly, My Opinion is, that, altho' the *Smoak* of it hath not been seen from below, the Fire nevertheless hath not discontinued; because the *inward Noise* is so terrible, that any Person whosoever hears it, will judge with me, that it is a *bottomless Pit* of the *vehementest Fire*, which cannot be quenched while the World lasts. The Horror and Danger that one undergoes, who will see this, is rather to be conceived by Thoughts, than expressed by Words.

3. Nov. 2. 1694. A very thick *Smoak* was seen about the *Top* of the *Mount Gowong Apy*, which was much augmented on the 21st and 22d, and that Night the *Flame* broke out: On the 23d, 24th, and some following Days, the *Fire* was continually encreasing on the West-side, and with such Blows, as if the greatest Pieces of Cannon had been discharged; so that we were fearing that the whole *Mountain* should have been cast upon us. A Day of *Humiliation* and *Prayer* was proclaimed by the *Government* against the 7th, throughout all *Banda*. Sometimes the *Mount* brought forth such a *Noise*, as the greatest Storms can do about the Rigging of a Ship, or a Building on Shore; and afterwards followed *Stones*, on the *West-side*, as far as the Sea, which was a horrible

By . . .
n. 228. p. 530

rible Spectacle. Fishermen have related to me, that so many Stones have been cast out already, that the Place where they used to fish with Lines at 40 Fathom Water is now dry; and the Fire cometh out of the Water so vehemently, that it is dreadful to see; and the Water is so hot, that we cannot come near it: And now the Mountain burneth most towards the Side of the *Loutoir*. The Trees on the East and West-side are altogether spoil'd, and the West-side is covered with Stones God knoweth how high. The Stink of *Brimstone*, during the *Westerly Monsoon*, is so intolerable, that one could scarce endure it in the Streets of *Neira*, where it causeth a great Sickness. The Water which runneth down is, by reason of the *Brimstone* and *Salt-Petre*, become sour, and without a natural Taste. The Gardens which were on the *Gownong Apy*, and formerly brought forth great Store of Fruits for Man's Livelihood, are partly covered with Stones, and partly Desert. The greatest Fear is, because it is *consum'd inwardly* towards the *old Hole*, which was blown up in the Year 1615; and because the Fire seemeth to take its Course towards the South-West, and that it being quite hollow there will tumble inwardly, or be subverted.

By - - - ib.
p. 531.

4. The Mount *Gownong Apy* casteth out Stones round about the Mountain, and the Fire ascendeth so high, that we can see it above the High-land at *Denter*.

By - - - ib.
p. 532.

5. Mount *Gownong Apy* (burning continually) doth cast out so great a Quantity of Fire and Ashes, that the *Trees* of the Country *Neira*, and part of those on the high Country of *Loutoir*, are so much covered with Ashes, that not one good Fruit is to be expected from them.

By - - - ib.

6. At *Neira* there is neither *Leaf* nor *Herb*. The Ground is cover'd with *Stones* and *Ashes*; one half of the high Country is likewise in a sad Condition; many *Trees* are wholly or partly *dead*, and the rest *lingring*. There is not one House at *Neira* without Damage; several are quite demolished to the Ground by the Weight of the *Dust* and *Ashes*.

Those of *Denter*, *Weyer*, *Celam*, and the inward Coast, as far as *Walking*, have likewise a sad Experience of this Calamity. We are sometimes visited with *Earthquakes*; and especially *May 11th*, 1695, about 2 o'Clock in the Afternoon, we had two hard *Motions*.

By M. Nich.
Witzen, n.
228. p. 529.

7. The Mountain *Kemas*, or *Brothers*, in the Territory of *Manado*, is blown up with a most *dreadful Noise*, as of the hardest Thunder, which caused *Darkness* and an *Earthquake*, with very heavy Blows, and other dismal Signs at *Ternata*: Which Noise hath also been heard at *Amboyna*. The Mountain of *Brimstone* upon *Amboyna*, call'd *Warwamy*, does also burn *dreadfully*.

From all which it seemeth evident, that in those Parts and Seas there are *subterraneous Fires*, having a mutual *Communication* one with another; which God knoweth but may, at some time, cause the sudden *Subversion* of them, and consequently a notable Change or Alteration of the World's Globe. Those who have seen these things with their own Eyes, have told me, that when a Hole is made in the Ground 10 or 12 Foot deep, the Ground is *warm*.

XIV. 1. On the 19th of Jan. 166 $\frac{1}{2}$ at divers Places near Oxford was observed a small *Earthquake* towards Evening. In Oxford itself I do not hear that it was observed to be an *Earthquake*; yet I remember, about that time (whether precisely then or not, I cannot say) I took notice of some kind of odd Shaking or Heaveing, I observed in my Study, but did impute it to the going of Carts, or Coaches, supposed to be not far off; though yet I did take notice of it, as a little differing from what is usual on such Occasions, and wondered the more that I did not hear any: But, not knowing what else to refer it to, I thought no more of it. And the like Account I have had from some others in Oxford, who yet did not think of an *Earthquake*, it being a rare thing with us.

An Earthquake near Oxford, 1665; By Dr. Wallis, n. 10. p. 166.

I find my Notes, concerning my *Thermoscope* and *Baroscope* for that Day to be these.

166 $\frac{1}{2}$. Day.	January. Hour.	Thermo. Inches.	Barosc. Inches.	Weather.
19.	8. Morn.	14 $\frac{1}{6}$	29 $\frac{1}{2}$	Hard Frost. Close.
	4. Even.	14 $\frac{3}{8}$	29 $\frac{1}{2}$	Hard Frost. Cloudy.
	9. Even.	14 $\frac{1}{2}$	29 $\frac{1}{2}$	Rain. Wind.
20.	8. Morn.	15 $\frac{1}{2}$	28 $\frac{1}{2}$	Sunshine. Wind.

I hear, it was observed at *Bleckington*, about 5 Miles to the North of Oxford, and so along by *Bestol*, *Horton*, *Stanton*, *St. John's*, and so towards *Whately*, which is about 4 Miles Eastward from Oxford: Not at all these Places at the same time, but moving forwards from *Bleckington* towards *Whately*: For it was at *Stanton* about 6 of the Clock, or later (as I understood from Mr. *Boyle*, who was there at that time) but had been at *Bleckington* a good while sooner. And I am told, that it was taken notice of by Dr. *Holder* (a Member of our Society) who was then at *Bleckington*, to be observed by those in the farther Part of the Garden, some very discernable time before it was observed by those in the House; creeping forward from the one Place to the other.

2. Riding somewhat late betwixt Oxford and a Lodging I have at a Place 4 Miles distant from it, I found the Cold very piercing, which put me upon galloping at no very lazy rate; and yet, before I could get to my Lodgings, I found the Wind turned, and felt the Rain falling. This Accident, considering the shortness of the time, and that it was preceded by a settled *Frost*, was surprizing to me; being one of the greatest and suddenest Alterations of the Air, I had ever observed. Soon after (by my Guess about an Hour) there was a manifest Trembling in the House where I was, which stands high in Comparison of Oxford: But it was not there so great, that I should have taken any notice of it as an *Earthquake*, if I had not been advertised of it, as being taken notice of by the People of the House. Soon after there happened

By Mr. Rob. Boyle, n. 11. p. 179.

pened a brisk Storm; whereupon I sent to make Inquiry, at a Place called *Brill*, which standing upon a much higher Ground I supposed might be more obnoxious to the Effects of the *Earthquake*. The Person I sent to writ me a Ticket; whose Substance was, that the *Earthquake* there was much more considerable, than where I lodged; and that a Gentleman's House in the Neighbourhood trembled very much, so as to make the Stones manifestly to move to and fro in the Parlour, to the great Amazement and Fright of all the Family. The Hill, whereon this *Brill* stands, I have observed to be very well stored with Mineral Substances of several kinds. I have been informed by others that this *Earthquake* reached a good many Miles.

By Dr. J.
Beale, n.
126. p. 357.

3. I conceive the *subterraneous Steams* might be the Cause of such a *Midland Earthquake*. And I know no surer or better Way to find out the Nature and Properties of those Steams, than by observing the Effects, and all the Alterations of the Air, as Mr. Boyle and Dr. Wallis have done.

An Earth-
quake at
Oxford,
1683; by
Mr. Tho.
Pigott, n.
251. p. 312.

XV. Sept. 17, 1683. An *Earthquake* happen'd here at *Oxford*. The Rarity of such Effects make many People not know what they are; and, by heightning their Surprize, imposes upon their Judgments. One fancied it to be the falling of something about his House; another the tumbling of Wood; a third the rattling of a Cart; one, one thing, and one another; till either a mature Deliberation, or Intelligence from other Hands, convinced them to the contrary, and satisfy'd them it was an *Earthquake*: Besides, the short Continuance of the Trembling would hardly permit them to make any accurate Observation.

I, for my part, perceived the *Sound* and *Motion* very plainly; and though, when I saw the Clearness of the Morning, I judged that to be an *Earthquake*, which otherwise I might have thought to have been only a distant Thunder, yet had I not so clear an Impression of it in my Mind, as to make any considerable Observations of my own: So that what I can afford you will be only some Occasional Reflections upon *Earthquakes* in general, and Remarks upon the Intelligence which I have picked up here and there, concerning this in particular.

1. This *Earthquake* happened at a time, in which such Effects are commonly experienc'd, if we may credit *Aristotle*, who tells us, That they are most frequently, tho' not always, in *Spring* and *Autumn*; in which there is generally a greater Abundance of *Moisture* suck'd up, more *Vapours*, and a larger Quantity of *Nitre* (as Experience doth demonstrate;) all which Ingredients may conspire to the producing of an *Earthquake*: For if we consider how capable they are of a large *Expansion*, how forcible they are when rarefy'd in Vessels, closed and placed over the Fire; in *Æolipyles*, from which they break out with forcible Blasts, or in Winds, which frequently proceed from the *Rarefaction* of such Principles; we may suppose that those *Vapours* which produce such great Commotions in the Air, may cause a considerable Disturbance in the *Earth*, when pent and locked up by Cold, or any such like Accident.

2. The latter part of the first Week in *September* was so rainy, that most People were apprehensive of a Flood; and upon *Sunday*, the 9th of *September*, there fell some very considerable Showers in the Afternoon; but from that time it cleared up, and to the End of the next Week continued very warm and pleasant Weather. The Evening of *Sunday* the 16th was inclinable to Frost, and the next Morning it was found to be a very hard Frost, for the Season; and then about Seven of the Clock, the Day being very Clear and Calm, the *Earthquake* happen'd. The like Observations of Cold preceding that of 1664 were made by *Dr. Wallis* and *Mr. Boyle*.

3. The Quick-silver in the *Barometer* (as I am told by the Operator in *Chymistry* here) stood as high then as at any time these three Years; which, together with a remarkable Calmness of the Air, a matter generally looked upon as one of the Circumstances which accompany *Earthquakes*, and by many reckoned among the Signs which fore-run them, may be sufficient to shew how free the Air was from Vapours at that time; and surely, the fewer there were above, the more may be supposed below.

4. *Ignes Fatui* were frequently seen a few Days before this *Earthquake* happen'd; which may pass for a probable Argument, at least to shew how full the *Earth* was then of *Damps* and *Exhalations*; since a *Stench*, that hath tainted Well-water after an unusual manner, hath upon the same Account been generally reckon'd amongst the Signs of an *Earthquake*, by which it may be predicted: For by this it was that *Pberocydes* is said to have presaged the *Earthquake* of *Lacedæmon*; and *Helmont* mentions another, who pretended to the same Fore-sight by tasting the Water of a very deep Well in the Castle of *Lovain*.

5. The Motion of this *Earthquake* was not of that Sort, which are termed *Pulses* or *Successions*; such as strike the Ground at right Angles with a violent Shock, or intermittent Knocking, so as oftentimes to raise the *Earth* to a considerable Height, or force their Way by a Breach. But it appear'd rather to be such a trembling Motion as vibrates and shakes without altering the Position of the *Earth*, and leaves all things in the same Posture in which it found them. For it shook the *Earth* with a *tremulous* and *vibrating Motion*, whose Reciprocations were repeated with a great deal of Quickness. The *Pulses* were, as I could perceive, a little discontinued, and yet they came so thick that I could not count them, tho' the whole *Earthquake* continued here scarce more than 6 *Seconds* of Time; and, when that ended, the *Motus Restitutionis*, or Settling of the Building in which I was did seem to be with a Crash.

6. Now as *tremulous* and *vibrating Motions* are proper to produce Sounds, so was this *Earthquake* accompanied with a *hollow murmuring Sound*, like distant Thunder, as I have observed before; which Sound kept time so exactly with the Motion, and was so conformable to it in all respects, that it plainly appears there was the same Reason for both. To those that were within doors it appeared to be more considerable, and as it were in the Air above, occasioned chiefly by the Shaking of the Building; as we may guess by a Blow or Stamp in a Room, which, besides the principal Sound from
the

the part which is stricken, causes another obscure one, together with a small Shaking throughout the whole; and in the *Laboratory* it was heard more loud: For all Sounds have a great Advantage there. But those, who were abroad in the Fields and open Air, perceived with a gentle Shaking a hollow Murmur towards the Surface of the *Earth*, not unfitly compared to the Groaning of some Planks of Elm, Ash, or Firr, when the Application of Fire causes both a Trembling and Sound. That there is a considerable Heat within the *Earth* is manifest from the Experience of Mines working in the deeper Grooves; from those hot Springs which break out thence from Fermentations occasioned by Mineral Spirits. Nor is it less commonly observed, that such *Heats* and *Fermentations* within the *Earth* are augmented by Frosty *Weather*; when the Steams being more pent up, and hindered from breaking out, do work more forcibly upon one another. And that Sounds and Tremblings may be produced by such *Heat*, though it did but work upon *Air*, *Watery Vapours*, or *Nitre*, only included in Pores and Cavities, appears by several Experiments; as that of filling Glass-bubbles half full with *Water* and *Nitre*, which being set to the *Heat* of the Fire will tremble with a sort of humming Sound, and after that break with a great deal of Noise and Violence.

7. This Sound as well as Trembling appears to have been the same in most of those places where they were perceived; from whence we may infer, that they were not caused by the falling of the *Earth* or *Rock* from the upper part of some Cavern; nor from any Commotion of Vapours within the Hollows, as Powder works in a Mine, by which Similitudes it is usual to expound some *Earthquakes*: For then it would have been perceived more plainly in places above it, or those that were near adjoining, and not equally considerable in Towns of such various distances, as *Oxford*, *Burford*, *Wallington*, *Benson*, *Brill* and *Ailsbury* in *Bucks*; *Wallingford*, *Radley*, *Appleton*, and some other Places in *Berkshire*; with many more round about.

8. Yet I cannot but say that it was less considerable in some places than in others; the Men of some *Towns* speak dubiously, especially towards the North of *Oxford*; and some talk of a neighbouring *Town* feeling it, tho' their own did not. Yea, even here in *Town*, the *Earthquake* was not perceived so plainly in some places as in others; but that may depend upon Circumstances, as the Position and Form of the Houses; or some Accidents, as Noise and Carts intervening, which might render it less observable. Besides, I do not deny but there may be some *Cuniculi*, little Passages or Hollows here and there under Ground, which might advantage the Trembling; and elsewhere more solid Parts, which might damp and obstruct it.

9. This might occasion some Difference in the Sound too. One perceived it like a Voice under Ground, but he could not tell which Way it passed; perhaps there might be a Cavern there. Another who was travelling over *Shotover* heard the same; and it is very likely that there are considerable Hollows there. One who was fishing in the *Charwel* informs me, that whilst his Boat trembled under him, and the lesser Fishes seemed much affrighted,

frighted, by an unusual skipping, he heard the Murmur, as of a rising Wind, which he fancied just then breaking out, and rumbling upwards, but felt none. The like Relation, as to rumbling in the Air, I have from good Hands, concerning some People that were in *Dourton-Park* in *Buckinghamshire*; which I mention only for the Distance sake; for most hereabouts agree in the same Fancy. I myself heard it like a distant Thunder; a Noise determined to one Place, not fleeting or passing from me; though the Crash, which ended the shaking of the Building, little deceived me in my first Imaginations.

Aristotle (*de Mundo*) calls the *Earthquakes* of this kind by the Name of *Bebbsai*, as if they boiled, because they ply up and down. And I take this that happened here to be no such forcible or irregular Ebullition, raising the *Earth* with intermitting Shocks, as that of *Mecklin* for instance, *Apr.* 4. 1640, described by *Van Helmont*; but a regular *Effervescence* of inclosed Vapours, more evenly dispersed, working up and down the *Earth*, with a trembling of each Part, and a reciprocal Agitation of the whole. For I could never meet with any, who pretended to determine from what this *Earthquake* came, or whither it went.

10. All, who felt this *Earthquake*, say, it happened about 7 a-clock; but I dare make no inference from hence, that the Shaking really was in all Places at the same time, unless the time had been exactly observed to a Minute, at least in several Places. For since all *Tremors* and *Sounds* are found to move about 15 Miles in a Minute, and above 94 in an Hour; and consequently the Trembling of the *Earth*, passing along with a continued *Noise*, may be supposed as quick in its Motion; it might, according to this *Calculation*, in a Minute's time have reach'd the Extremity of its Sphere or Compass: For the Circuit of this *Earthquake* was but 70 Miles, or thereabouts; its largest Extent was from South-East to North-West; the least, from N. to S. For it was perceived a little short of *Kirlington N.* of *Oxford*; at *Blebbington*, and at *Ailsbury S. E.* where it was perceived plainly; as also at *Thame*, which is *E.* and so at *Aston*, *Kingston*, and *Stoken-Church-Hill*; at *Wallington S. E.* (some say at *Reading*, which is more *S.* and then its Compass may be supposed larger;) at *Wallingford S. E.* by *S.* as much as any place; at *Abingdon S.* but not much; not so far as *Farington S. W.* but at *Bampton W.* at *Burford* to the North; at *Lo. Harborough N. W.* not much; at *Woodstock*, which is more *N.* little or none; and at *Glympton*, 2 Miles beyond it, not at all, as I am informed. But this is a very inconsiderable Space, if compared with that which happened in the Southern Parts of *Norway*, *Apr.* 24. 1657. and took up 160 Miles in length, and so much in breadth, saith *Michael Peterson Escholt*, that describes it; and *Kircher* mentions one 200 Miles in length.

11. The Effects too of this *Earthquake* were very inconsiderable; as shaking down some *Pewter*, in a very few Places; casting out a Truckle-Bed *Westward*; which, when I looked upon, I found so very easy to move, and apt to run, as also the Room so smooth, and declining towards that Point, that I could as little infer from thence that the Motion came this or that Way, as from the falling of many Books from the North-side of a Warehouse,

house, when a few only fell from the South. And of whatever Nature the enclosed Vapours were, which caused this *Earthquake*, it seems as if they were not able to force their Passage through the *Earth* (at least but slowly:) For the Air, till the End of the Week, continued fair; tho' Week ensuing was very windy and boisterous.

12. We have *Earthquakes* here very seldom; not one before for almost a Score of Years, except that which is doubtfully reported to have happened about four o'Clock in the same Morning. But seeing the *Earth* abounds with such great Variety of Matter, which may produce them, as also with so many Caverns and Chinks of such various Figures through which they may be agitated with such different Motions, it seems more easy to shew how they may begin, how they may be carried on, how they may produce such different Effects, and how they may continue; than to determine why they should happen so rarely, do no more mischief, or be stopped so soon in their Motion.

An Earthquake in the Midland Counties, 1683. By Mr Tho. Pigott, n. 151. p. 321

XVI. There was another *Earthquake* far more considerable, which happened Oct. 9. about 11 at Night, and was in *Oxfordshire*, Northwards, very much; some say, they felt it here at *Oxford*. It spread all over the *Midland Counties*, and extended into *Derbyshire*; in which, as in the Coal-Countries, it was very violent. They report, that it was in all its several Places at the same time, not determining precisely, and that it produced some remarkable Effects.

An Earthquake in Sicily, 1692-3. By Mr. Martin Hartop. n. 202. p. 827

XVII. 1. It seems highly probable, that these Tremblings of the *Earth* proceed from the same incens'd Matter, which finding a way at other times thro' the *Mongibello* has so furiously broken out in Smoak and Fire. This appears by the Tragedy of *Catanea*.

The *Eruptions* of these *Mountains* are of two Sorts: The one not so very violent, as to disturb much the adjacent Country; and this happens once in 2 or 3 Months, and lasts 3 or 4 Days: The other is more furious, and of longer continuance; and is observed here at *Naples*, to happen to Mount *Vesuvio*, once in about 80 Years, as I heard the ingenious Mr. *Peccacio* say. Of these, the last in 1632 was so very violent, that, by the best of his Observation, it cast the Rocks 3 Miles into the Air. Now, from the burning or not burning of this Hill, *Naples* (and without doubt the same holds in *Sicily*) calculates its Safety or Danger of *Earthquakes*: For without doubt the Matter is continually burning under the Mountain; and those vast Clouds of Smoak which daily issue out of the Top, if the Cavity happen by any Rock or inward Alteration to be stopt, must deviate through other Passages under Ground, heaping up continually Magazines for a future Calamity. Now this combustible Matter seems to me to be nothing but *Nitre*, mixed with some other *Minerals* and *Sulphur*. He, that has seen the Way of making *Salt of Tartar* by *Deflagration*, where you mix an equal Quantity of pulverized *Nitre*, has seen an exact Type of these burning Hills; for, after each Spoonful you put into the burning Crucible, arises first a black thick Smoak,

Smoak, after which the fired Mineral boils up, as if it would over-run the Top of the Crucible.

The Motion of the *Earth* is not from the *Perpendicular*, or *Horizontal*; as appears by the Cracks in the *Earth*, which, they say, are to be found now all over *Sicily*: 'Tis a Vibration so quick, that it cracks the Glass in the Windows; 'tis disputable, whether the *Reciprocations* of a Lute-String are more frequent. Now, when the *Vibrations* are so quick, and the Body moved so great, the Motion must be prodigiously violent. We observe that Thunder, which is the Effect of the Trembling of the Air, caused by the same Vapours dispersed thro' it encountring one the other, has force enough to shake our Houses. And why there mayn't be Lightning and Thunder under Ground, in some vast Repositories there, I see no Reason; especially if we reflect, that the Matter, which composes the noisy Vapour above us, is in much larger Quantities to be found under Ground. I can attribute this *Horizontal Trembling* to nothing else, but the furious Passage of the incens'd Matter from one Grotto to another: For 'tis very probable these are continued, in some Parts of the *Earth*, for several Leagues together; witness your last *Earthquake*, about 4 or 5 Years ago; which was felt (with little Difference as to Time) in *England* and *Ireland*. Another Confirmation of this is, the Manner how these trembling Fits are performed; which is not all of a sudden, like that of *Gun-powder* in a *Mine*; but is small at first, afterwards gradually more terrible, like a growing *Tempest*. A third may be, the Observation of some here in *Naples*; that, when Mount *Vesuvio* ceases to burn, the *Sulfaterra* sends out its Fumes more violently; & vice versa. Now this *Sulfaterra* is a Hill near *Pizzolo*, as distant from *Naples* on the one Hand, as the Hill *Vesuvio* is on the other; so that 'tis more than probable, that *Naples* stands upon a burning Arch, thro' which, as a Pipe, their two furious Neighbours do reciprocally receive the above-said *Exhalation*. This seems to me a growing Evil to this wealthy and populous City; and what may possibly make good the Prediction of *Sauazarius*, who was born here:

Et te, quis putet hæc? Altrix mea, durus Arator

Vertet: & Urbs, dicet hæc quoque clara fuit.

2. The Island of *Sicilia*, of 700 Miles Circuit, and divided into 3 Valleys; began on *Friday* the 19th of *January*, 1693, about half an Hour past 4 o'Clock, to be sensible of the Shake, in the Valley of *Mazara*: But, in the two other Valleys of *Emone* and *Noto*, the *Shakes* were so terrible, as to throw down some Buildings, obliging the Inhabitants to seek Refuge, either in the Fields, or with Prayers and Tears implore the Divine Pity in the Churches. On *Sunday* following, being the 11th of the same Month, at 20 Hours and 3 Quarters, the Hand of God appeared much more terrible, awakening the most lethargick Sinner. The *Shakes* of the *Earthquake* did no damage in the Valley of *Mazara*, only frightening of the People.

By P. Alessandro Bur-
gos, ib. p. 830

Palermo received some Detriment in most of the Buildings, especially the Palace and Hospital of *St. Bartholomew*; the Steeple of *St. Nicholas*, belonging to the *Augustines*, was ruined, and some hurt done to the Church; but little Mischief else done, and no Body hurt.

In *Messina*, all the Buildings of the *Theatre* are shatter'd; the Royal, and Archbishop's *Palace*, with the Seminary, are all cracked: The vast and stately Church of the *Franciscans* broken in many Places, and the Roof of the *Vestry* fallen; the Steeple of the Church of the *Annunciation* thrown down, with the Death of the *Sexton*; the Top of the *Spire* of the *Dome* cleft: Many private Buildings were thrown down, and all the rest shored up; there were but few Persons killed.

Troina, *Randazzo*, *Nicosia*, Cities in the Mountains, suffered in their Buildings. The first, and half of the Mother-Church were destroyed, with the Parish-Church of *St. Lucy*, and was much damaged in its Monasteries; one whereof is not habitable: The last had its *Dome* very much hurt. *Castiglione* had the Castle and many Houses thrown down. In *Franca Villa* and *Lingua-grossa*, the greater Part of the Buildings, and some Churches. *Mascalli* quite ruined, but not many killed; most of the People being abroad, at a Procession with the Reliques of *St. Leonard* their Protector.

Aidone received a considerable Mischief; two whole Quarters, with many of its Inhabitants, being destroyed; in the Quarter of *St. Laurence* there is not one House standing, and the Churches ruined; in that of *St. James*, the Church of the *Annunciation* and its *Oratory* thrown down, with several other sacred Edifices. In the other Part of the City, which stands lower, there were not so many Houses nor Persons lost; yet the Church of *Pope Leo* is quite flat, and the magnificent Church of the *Dominicans* in Ruins, with the Convent of the *Reformati Osservanti*, one of the best in the whole Province.

Abi Aquilea, commonly called *Jaci Reale*, situated at the Foot of *Ætna*, is almost quite destroyed, and its Inhabitants buried in the Ruins, with many Convents; amongst the rest, the famous one of the *Osservanti Reformati*.

Aci St. Antonio, *Aci St. Filippo*, *St. Gregorio*, *Pedara Trecastragni*, *Bonnacorei*, *Nicolosi*, *Motta*, *Mesterbianco*, *Fenicia*, and several other fruitful Villages, situated near *Mongibello*, are destroyed, with all the Habitations of pleasant Hills about *Catanea*, which are now in the Dust.

Paterno, about 12 Miles from *Catanea*, a populous City, at the Foot of *Mongibello*, lost most of its Buildings, all the Convents of Fryars, and a very fine Monastery: In the Ruins were buried 40 Persons. *Adero* had the same Fate.

Cantabiano Piemonte in the Valley of *Emona*, *Francofonte*, *Palagonia* in the Valley of *Noto*, are little less than wholly levell'd, and about 300 Persons destroyed. The Marquis of *Francofonte* was miraculously saved, by leaping out through the Crack in the Wall of the falling Edifice.

Catanea, one of the most ancient and famous Cities of the whole Kingdom, honoured by the Courts of several Monarchs, and an Episcopal See even from the Times of the Apostles, giving place to none in the Beauty of its sacred Edifices; amongst which, the *Dome* was the most sumptuous and large

large in all *Sicily*, adorned with excellent Pictures and richly furnished, blessed with the Reliques of the invincible Martyr *St. Agatha*, and honoured with the Bodies of several Kings; besides it had a very high and curiously built *Steeple*. Here were a great many Nunneries; amongst the rest, the Monastery of the *Trinity*, and that of *St. Benedict*, with that Prodigy of Workmanship the magnificent Monastery of *St. Nicholas*, with its Temple; a Place famous for several Reliques. Next, the *Jesuits* College, the Convent of the *Minorites*, and two of the *Dominicans*; the beautiful one of *Capuchins*, the Imperial Convent of the *Carmelites*, that of the *Reformed Minorites*, that of the *Reformed Augustines*, with several other Friaries, with an infinite Number of the antient and modern Churches, Colleges, and other publick Buildings, inhabited with 23000 Souls.

Its Nobility, many and antient: Learning was here in its Glory; the Citizens were themselves learned, and Lovers of Knowledge, assisted with the many Privileges granted by the King. The University, where the learned Laurel was conferred on the Worthy, made this Place the *Sicilian Athens*. This once so famous, now unhappy *Catanea*, had the greatest Share in this Tragedy. Father *Antonio Serrovita*, who was to preach at *Catanea* the Lent following, was on his way thither on the 11th, at 20 Hours and $\frac{1}{4}$; and at the Distance of a few Miles he observed a black Cloud, like Night, hovering over the City; that there arose from the Mouth of *Mongibello* great Spires of Flame, which spread themselves all round; that the Sea, all of a sudden, began to roar, and rise itself in swelling Billows; that there was a very great and dreadful Blow, as if all the Artillery in the World had been at once discharged; that the Birds flew about astonish'd in the Air; that the Beasts and Cattle in the Fields ran crying about, affrighted; that his and his Companions Horses were so startled, that they stood stock still, trembling so as that they were forced to alight; which they had no sooner done, but they were lifted from the Ground above two *Palms*; and casting his Eyes towards *Catanea* he with Amazement saw nothing but a very thick Cloud of Dust in the Air. This was the Scene of their Calamity. For of the magnificent *Catanea* there is not the least Footstep to be seen. All its Edifices are levelled with the Ground, except the Chapel of *St. Agatha*, the *Rotunda*, the Castle of *Ursino*, the Walls that encompassed it, and a few mean Houses. There was a very great Destruction of the Inhabitants buried in the Ruins of the Bishop's Palace, the *Steeple*, and *Dome*, where most of the City, frighted with *Friday's Earthquake*, were got together to carry the Reliques of *St. Agatha* in Procession. Many of the Nobility were saved under the Chapel of the Saint, and some of the Clergy: The Number of the Dead were about 15000; for though the People had staid in the Fields all the *Saturday*, yet the Solemnity obliged them to be in the City on the *Sunday* to pay their Devotions at the Procession. Of the *Benedictines*, about 25 were killed in the Quire; of the *Jesuits*, 21; of the *Conventuals*, 11; the Number of the *Dominicans* is not known; the *Carmelites* were all buried, except one, as they went in Procession; and so were the greater Part of the other *Religious Orders*; and of the *Nuns*, few were saved. This was the Tragedy of

Catanea; which was accompanied with dreadful Lightning and Thunder from Heaven, with Deluges of Rain; and in the Ruins were heard nothing but Cries, Shrieks, and dying Groans. On the Heaps of Stones we may now write, *Here was Catanea*.

Lemini, a very antient City, honoured with the Births of many illustrious Persons, amongst the rest that Father of Eloquence *Gregorio Leontino*; of a long time an Episcopal See, &c. felt that Shock on the 9th, with such Violence, as threw down and ruined the greater Part of its Buildings: amongst which was the antient Convent of *Minorites*, famous for being the Dwelling-place of *St. Anthony of Padua*; the *Royal Convent*, so called from the Tomb of one of our Queens, buried there; under the Ruins of which four Religious were buried; the rest escaped miraculously. But the last *Earthquake* on the 11th laid in the Dust the Remainder of the City, with the Death of about 4000 People, that return'd thither after the first Shake to take care of their Goods: So that now there is but the Carcase of a City, all shatter'd to Pieces, not one House left standing.

Carlentine, a modern City, being as a Citadel dependent on *Lentini*, had the same Fate. The beautiful Castle of *Licodia* all ruined, with the Marchioness of *Martini* and all her Children buried therein.

Bizrini, a City of rich Inhabitants, is levelled with the Ground.

Sortino and *Cassero* are quite demolished; in the first about 300 perished.

Agosta, a trading Town, built on an Island, in a large Bay which makes a capacious Port, was all blown up into the Air; for, besides the Damage of the *Earthquake*, there was a great Quantity of Powder in the Castle, that took fire and killed several of the Citizens, that had escaped into the Fields, with the Stones of the Buildings. Here perished about 3000. The enraged Sea grew terrible boisterous, and tempestuously beat against the Walls of the *Dominican Convent* with such Fury, that some Gallies, belonging to the *Knights of Malta*, scarcely escaped Shipwreck in the Port. In fine,

Luctus ubique, Pavor, & plurima Mortis Imago.

The Country of *Mililli*, in the Dutchy of *Montalto*, felt the same Fate, with the Destruction of the Inhabitants.

Syracusa, famous in old time, an Episcopal See; in our Time, like the *Phoenix* arising from the Ashes, standing upon a *Peninsula*, by Art made an Island, having a Bridge to the main Land; strengthened with a modern Fortification, sufficiently populous, by Reason of its convenient Situation for Trade; full of Nobility, and beautified with Churches, Convents, Monasteries, and Palaces, now mourns in Ruins. It was sensible of *Friday's*, but shook to Pieces by the *Sunday's Earthquake*, with the Loss of many thousand Persons. Most of the Nobility saved themselves by a timely Flight. Of the Religious, not many perished. Scarce a Village in the whole Diocese is left; Confusion reigns every where; and the Misery is encreased by Want of Food, caused by the Granaries and Mills being destroyed.

Lasera,

Lasera, Palazzuolo, and Busceni lie in Ruins, with many Inhabitants destroyed.

Spacaforno, a populous Place, situated near the Sea, which washes the Foot of the Promontory *Pachino*, has lost all its Buildings, Here they reckon about 2000 dead.

Giarratana with its Fall killed most of its Inhabitants: The Marquis himself, with his Wife and 3 Children, escaping on *Friday*, were on *Sunday* buried in the Ruins; the Marquis and his Children were taken out alive, to bewail the Loss of his Lady.

Melitello, in the Valley of *Noto*, is shaken to Pieces; the Churches and chief Buildings even with the Ground, and the Religious Orders all turned out into the open Air, or under Huts and Cabbins.

Occhiula escaped not the common Calamity.

Mineo, an ancient City, is now no more; and the greater Part of the Citizens and Religious.

Caltagirone, a City conspicuous for its Senate and Nobility, suffer'd in this universal Calamity the total Ruin of its proud Edifices. As the principal Church, with its very high Steeple, or Spire; the famous College of *St. Julian*; the Temple of *St. George*; the Parish-Church of *St. James*; admired for the Pictures of *Epiphanius*, the Chapel only remaining, with the Image and Reliques of the Saint. The Temples of the *Conventuals* thrown down; the famous Bridge that joins the Convent to the Town shatter'd to Pieces, and the Dormitories not to be inhabited; the famous Convent of *St. Bonaventure*, the Fall of whose Temple and Spire, was the Destruction of the lower Buildings; the College of the *Jesuits* and the Steeple of that noble Church are quite ruined. The *Carmelites, Dominicans, Augustines, Crouched-Fryars, &c.* are all without Churches and Convents. The Monasteries of *St. Gregory, St. Chiara, St. Salvator, and St. Stephen*, with a *Conservatory of Orphans*, are all shook down. In fine, the Senate-House, adorned with most curious Statues, and all the other Buildings, are either fallen, or threaten a sudden Ruin. In these Desolations about 1000 People were lost.

Modica, a populous Place, and a Chief of the Seignior of the *Admiral of Castile*, has its Buildings and famous Castle laid in the Dust. Seignior *Abbot Frederick*, the *Procurator-General*, saved himself in the College of the *Jesuits*, from whom we had the Account; and that the Cities of *Ragusa, Sicily, and Chiaramonte* had the same Misfortune.

Comiso suffer'd much in its Buildings, tho' but few were kill'd: The Convent is down, but the Church stands.

Noto, an ancient and ingenious City, full of Nobility and fine Buildings, Convents and Monasteries, as we hear from a Courier from thence, is all ruined: The Convents of the *Dominicans, Conventuals, Reformati, Carmelites, and Capuchins* which was indeed a wondrous Fabrick, are all torn to Pieces. The Church of the *Crucifixion, the Dome, and all the Nunneries* are down, with the Deaths of many Citizens and Nobles.

To conclude, there is not a Corner in all the Valley of *Noto*, that is not ruined wholly, or for the most Part, with a dreadful Slaughter of the People

People. The Southern Coasts, as *Licati*, *Terra Nova*, and *Girenti*, have suffered Damage in their Buildings: And all the Castles of the Valley of *Emone*, near *Mongibello*, are crack'd and broken, or thrown down.

By the Noble
Vincentius
Bonajutus.
n. 207. p. 2.

In Dec. 1. 1.
1. Cap. 4. and
Dec. ult. 1. 10

3. The continual fiery Eruptions of *Aetna* (of which the first that we have any Account of, happened 500 Years before the Destruction of *Troy*, as *Diodorus Siculus* relates) have been taken for the most likely Causes of the horrible Shakes that from time to time have laid waste the Island of *Sicilia*; as is observed by *Fazello*, where he remembers That of the Year 1542, which on the 10th of *December*, at the 23d Hour, shook the whole Island; and especially *Val di Noto*, *Syracusa*, *Lentini*, *Sortini*, *Mililli*, *Catanea*, *Agosta*, *Noto*, *Caltagirone*, *Melitello*; and in short the same Cities and Castles, which were miserably ruined by the two late violent *Earthquakes* of this present Year 1693.

The first of which was at 5 o'Clock, the next Night after the 9th of *January*: Its Motion was of that Sort which *Aristotle* and *Pliny* call the first Species, and is by them likened to the shaking Fit of an *Ague*, causing such a Motion as shakes the *Earth* from Side to Side. In this first almost all the Edifices in the Country were thrown down; whereof some were very high and strong-built Towers. A great Part of the City of *Catanea*, with many others, were demolished, and a great many Buildings in *Val di Noto*; *Syracusa* was also much shatter'd, but not ruined. This was not preceded by any Darknes in the Air, but a pleasing, serene, warm time; which was the more observable, as being unusual at that time of the Year: Yet it was not to any Excess.

Some Persons, which the Evening before were travelling in the Country, observed a great Flame or Light at about an *Italian Mile's* Distance; and so bright, that they took it for a real Fire made by some of the Country People; and though they went directly towards it, yet it seem'd to keep at the same Distance from them. Whilst they were observing this Appearance, the *Earthquake* began, which was sensible even to the Horses they rode upon, that were affrighted thereat, and the Trees were all shaken. Upon this the amazed Travellers, looking for the Light the saw just before, found it quite vanished. We perceiv'd, turning toward the Sea, that the Waves, which before the Shake only beat gently upon the Shore, began now to make a dreadful Noise. The next Day, which was the 10th, the Night and Day following, the Air was over-shadowed with Darknes, and tinged with a deep Yellow; and the obscured *Sun* struck our Minds with a melancholy Preiuge of the approaching *Earthquake*, which was the second, and happen'd on the 11th of the same *January*, about the 21st Hour, and lasted about 4 Minutes. It was much like the 2d Sort, which *Aristotle* and *Pliny* call a *Pulse* or *Stroke*, for its resemblance to the beating of an Artery; and by *Possidonius*, in *Seneca*, is represented by the Name of *Vibrations*, it being a perpendicular lifting up of the *Earth*. Its *Impulse* was so vehement and powerful, that not only many Cities and Countries of the Kingdom of *Naples*, but the Island of *Malta* participated also of its Fury. It was in this Country impossible to keep upon our Legs, or in one Place, on the dancing *Earth*; nay, thok

those, that lay along on the Ground, were tossed from Side to Side, as if on a rolling Billow.

In open Places the *Sea* sunk down considerably; and in the same Proportion in the Ports and inclosed Bays; and the Water bubbled up all along the Shore.

The *Earth* opened in several Places in very long Clefts; some an Hand's Breadth, others half a Palm, others like great Gulphs. From these Openings that were in the Valleys such a Quantity of Water sprung forth, as overflowed a great Space of Ground; which to those that were near it, had a sensible *sulphureous Smell*, though in a low Degree, and without that unpleasant Stifling produced by the Smoak of *Brimstone*.

In the Plain of *Catanea*, an open Place, it is reported, that from one of these Clefts, narrow, but very long, and about 4 Miles off the *Sea*, the Water was thrown forth altogether, as *salt* as that of the *Sea*.

In the City of *Noto* is a Street of half a Mile long, built of Stone, which at present is settled into the Ground, and quite hanging on one Side, like a Wall that inclines; and in another Street, before the *Assent del Durbo*, is an Opening big enough to swallow a Man and Horse.

Great Rocks were loosened, and thrown down from the Mountains every where: And in the Country of *Sotino*, inhabited by about 5000 Persons, a great Number perished in the Houses which were beaten down by them in their way, as they rolled down from the Hills. A great Cistern, or Reservoir of Water, hollowed on the Top of a Rock, was loosened and thrown off from the rest of the Rocks, and slid down to the Bed of the River that runs in the Bottom; where the Cistern remains as it was, full of the same Water it had received before the *Earthquake*.

A very great many *Grotto's*, made by Art or Nature, are now fallen in.

In *Syracusa*, and other Places near the *Sea*, the Waters in many *Wells*, which at first were *salt*, are become *fresh*, and have not as yet lost their Goodness; so they are still fit to drink.

The Fountain *Arctusa*, for the Space of some Months, was so brackish, that the *Syracusans* could make no use of it; and now, that it is grown sweeter, its Spring is increased to near double.

In the City of *Termini*, all the running Waters are dried up; and, amongst the rest, a small River near to it, with which they watered their Gardens and Orchards. It was contrary to the *Hot-Baths*, which are augmented by a 3d Part of what they were before the *Earthquake*.

In many plain and level Places, very high Walls leaped from their Foundations above two Paces, leaving that whole Space perfectly clear and free from Rubbish and Ruins, as if they had been taken up, and carried off. And in *Syracuse*, two Side-Walls of a small House jumped up from each other; the one upright, and stood upon its Bottom, at a great Distance from its former Place; and the other, leaving its Companion, flew away so as to make an Angle with the other, to the Wonder of the Beholders of so extravagant an Accident. Not far from the Country of *Cassaro*, from the Tops of 2 Mountains, between which through a long Valley ran a River, two very great Rocks were loosened; which, tumbling down over against each

each other, met so exactly as to close up the Valley, and stop the Current of the River; which, not finding any *Subterraneous* or Side-Passage, has fill'd up the Valley to the Top of the Rocks that were thrown down, and runs over them, forming a Lake 3 Miles round of a considerable Depth.

In the Territory of *Sortini*, in a Piece of Ground half a Mile long but much narrow, the Ground, at several little Interstices, is sunk from the Level in some Places 2, in other 3 *Palms*, and ends in a very deep circular Gulf or Swallow.

A Fountain, in the very Minute of the *Earthquake*, on the 11th, threw forth its Waters tinged of a Blood-red; which continued for 3 Hours, and then it dried up, leaving many Holes in the Mud at the Bottom, through which real Ashes were thrown out; and the next Day the Waters returned of the former Quality, without the least Alteration.

In the City, encompassed with Caves on three Sides, altho' by the considerable Shakes that were given it there was not much Ruin made, yet a very dreadful Sound and Noise was heard for a great while.

The South Winds have blown very much, which still have been impetuous in the most sensible *Earthquakes*, and the like has happened at other times.

From the 11th of *Jan.* to this 14th of *Sept.* there have been considerable and strong South Winds, preceded by a Noise like Cannon at a great Distance; some of a longer, some of a shorter Continuance: This has been observed in all Parts, but louder in cavernous Places, and in the Valleys between the Mountains; where the Shakes were more violent, in Proportion to the Distance from the Sea.

Darkness and Obscurity in the Air has always been over us, but still inferior to that on the 10th and 11th of *Jan.* and often these Clouds have been thin and light, and of a great Extent; such as Authors call *Rare Nubiculae*. The Sun often, and the Moon always obscured, at the Rising and Setting; and the Horizon all Day long dusty; so that our wonted Prospects are shorten'd; but for some little time past it has grown something clearer.

The Heat, at the Beginning of Summer, was not extreme; but, the Sun entering *Virgo*, it grew very great, and at Noons intolerable.

Since the first of *August*, which was a most tempestuous Day, not only for the excessive Rains for about 4 Hours, but for the Hail and very loud Thunder, the Shakes of the *Earthquake* have been less sensible, and seldomer; and for two Months not so universal; but sometimes in one Place, sometimes in another.

It has been observed, that in less solid Ground, such as Chalk, Sand, or loose Earth, the Mischief was without Comparison greater than in the rocky Places: And in *Syracusa* the Difference was visible in 3 Places; that is, in the middle of the City, in the little Island, and in *Zaracati*, where the ancient *Syracusa* stood; in all which Places the Buildings, being on a rocky Foundation, remain for the most part untouched, or only shaken, or at least not quite demolished: Whereas, on the contrary, in the rest of that Territory, which is not rocky, a very great Number of noble Structures and Towers lie like a horrid Desert, and Heap of vast Ruins.

The Effects it has had on human Bodies, altho' I do not believe they have all been immediately caused by the *Earthquake*, have yet been various; such as *Foolishness*, but not to any great Degree; *Madness*, *Dulness*, *Sottishness*, and *Stolidity* every where; *Hypochondriack*, *Melancholick*, and *Cholerick* Distempers: Every Day *Fevers* have been common, with many *Continual* and *Tertian*; *Malignant*, *Mortal*, and *Dangerous* ones, in a great Number, with *Deliria* and *Letbargies*. Where there has been any Infection caused by the *natural Malignity* of the *Air* infinite *Mortality* has followed. The *Small-Pox* has made great Destruction among young Children; and in short there has been no State nor Condition, which has not had its Share in so universal a Calamity.

The Number of the Inhabitants before the *Earthquake*, and of those that perished therein

The Names of the Cities.	Numb. of Inhab.	Numb. of those kill'd.	The Names of the Cities.	Numb. of Inhab.	Numb. of those kill'd.
<i>Agosta.</i>	6173	2300	<i>Mazzarino.</i>	7696	
<i>S. Agatha.</i>	1402	20	<i>Nicolosi.</i>	844	4
<i>Avola.</i>	6225	800	<i>Nixerni.</i>	1483	
<i>Buscema.</i>	2192	900	<i>Noto.</i>	12043	3000
<i>Bonaccorso.</i>	844	94	<i>Occhiella.</i>	2910	100
<i>Bontello.</i>	172	2	<i>S. Giovanni Lapunta.</i>	1082	15
<i>Butera.</i>	3492		<i>Jaci Reale.</i>	12895	739
<i>Buceberi.</i>	3295	300	<i>Jaci S. Antonio.</i>	6363	1335
<i>Caltagirone.</i>	12339	800	<i>Leontini.</i>	10063	1212
<i>Catanea.</i>	18914	18000	<i>Licodia.</i>	4898	741
<i>Comiso.</i>	5305	269	<i>Mineo.</i>		1355
<i>Castel di Jaci.</i>	331	32	<i>Palagonia.</i>	1862	29
<i>Carleontini.</i>	2751	77	<i>Pedara.</i>	1582	475
<i>Cassaro.</i>	1458	15	<i>Palazzolo.</i>	5571	700
<i>Ciaramonte.</i>	4830	303	<i>Ragusa.</i>	9946	5000
<i>Fioridia.</i>	1037	20	<i>Sortino.</i>	6316	2500
<i>Ferla.</i>	3610	800	<i>Syracusa.</i>	15399	4000
<i>Fenicia Moncada.</i>	1651	14	<i>Scicchi.</i>	9382	2000
<i>Francofonte.</i>	2039	345	<i>Scordia.</i>	907	33
<i>Giarlatana.</i>	2981	541	<i>Spaccafurno.</i>	7987	2200
<i>Mascali.</i>	1300	15	<i>Trezza.</i>		200
<i>Massa Nunziata.</i>	394	55	<i>Trecastagni.</i>	3264	1000
<i>Milistello Val di Noto.</i>	6438	600	<i>Terra Nova.</i>	5289	
<i>S. Michele.</i>	1838	1	<i>Tremisteri.</i>	996	90
<i>Melilli.</i>	5480	900	<i>Vittoria. (Grande.)</i>	3950	200
<i>Monterosso.</i>	234	232	<i>Terra Grande o Vii</i>	1602	200
<i>Modica.</i>	18203	3400	<i>Vizzini.</i>	10678	2000
			Sum	254936	59963

An Earth-
quake at Li-
ma, 1687.
By P. Alva-
rez de Toled-
o. n. 209.
p. 81.

XVIII. On *Monday, Octob. 20. 1687, (N. S.)* at 4 of the Clock in the Morning came a horrible *Earthquake* and *Noise*, with which some Houses fell, and some Persons were killed under the Ruins.

At 5 of the Clock in the same Morning was another Shake, with the same Noise.

At 6 of the Clock in the aforesaid Morning, when we thought we had been all in Safety, came another Shake with great Fury and rushing Noise; the *Sea*, with great bellowing, came beyond its Bounds; the Bells rung of themselves; and the Destruction was so great, that no Building stood. The *Noise* was such, that those in the Fields assure us, that the Cattle were in great Astonishment; *Callao, Canete, Pisco, Cbancoy, and Los Chorillos*, are all ruined. There are more than 5000 dead Bodies found, and they find more daily; so that we know not their Number.

An Earth-
quake in Ja-
maica,
1687-8. By
Dr. Hans
Sloan, n.
209. p. 81.

XIX. The Inhabitants of *Jamaica* expect an *Earthquake* every Year, &c. Some of them are of Opinion, that they follow their great Rains. One of them happened on *Sunday* the 19th of *Feb. 1687*, about 8 in the Morning. I found in a Chamber, one Story high, the Cabinets and several other Moveables on the Floor to reel, as if the Foundations of the House had been raised. I looked out at a Window to see what was the Matter, and found that the Pidgeons and other Birds, in an Aviary hard by, were on their *Wings* in great Astonishment. It came by Shocks; there were three of them with a little Pause between: It lasted about a Minute; of Time in all; and there was a small Noise accompanied it. A Pair of Stairs higher it threw down most Things off the Shelves, and had much more visible Effects than below. This was generally felt all over the Island at the same Time, or near it; some Houses therein being cracked, and very near ruined; others being uncovered of their Tiles: Very few escaped some Injury; and the People in them were generally in a great Consternation, seeing them dance. The Ships in the Harbour at *Port-Royal*, felt it; and one, who was Eastward of the Island, coming thither then from *Europe*, met with, as he said, at the same time, an *Hurricane*. One riding on Horse-back was not sensible of it. A Gentleman being at that Time abroad in his Plantation, told me, he saw the Ground rise like the Sea in a Wave, as the *Earthquake* passed along, and that it went Northward; for that, some small Time after he had felt it, he saw, by the Motion of the Tops of the Trees on Hills, some Miles distant, that it had then reach'd no farther than that Place. The *Spainards*, who inhabited this Island and those neighbouring, built their Houses very low, and they consisted only of Ground-Rooms, their Walls being made of Posts, which were as much buried under Ground as stood above, on purpose to avoid the Danger which attended other manner of Building, from *Earthquakes*. And I have seen in the Mountains afar off bare Spots, which, the Inhabitants told me, were the Effects of *Earthquakes* throwing down Part of the Hills, which continued bare and steep.

XX. 1. The terrible *Earthquake* which happened *June 7. 1692*, between 11 and 12 of the Clock at Noon, shook down and drowned 9 tenths of the Town of *Port-Royal* in two *Minutes* Time; and all by the *Wharf-side* in less than one: Very few escaped there. I lost all my People and Goods, my Wife and two Men, Mrs. B. and her Daughter: One White Maid escaped; who gave me an Account, that her Mistress was in her Closet, two Pair of Stairs high, and she was sent into the Garret, where was Mrs. B. and her Daughter, when she felt the *Earthquake*, and bid her take up her Child, and run down; but turning about, met the Water at the Top of the *Garret Stairs*: for the House sunk downright, and is now near 30 Foot under Water. My Son and I went that Morning to *Liguania*; the *Earthquake* took us in the Mid-way between that and *Port-Royal*, where we were near being overwhelmed by a swift rolling Sea, 6 Foot above the Surface, without any Wind; but it pleased God to save us, being forced back to *Liguania*, where I found all Houses even with the Ground; not a Place to put one's Head in, but in *Negro-Houses*. The *Earth* continues (*June 20.*) to shake 5 or 6 times in 24 Hours, and often trembling. Great Part of the Mountains fell down, and fall daily. I pray God divert those heavy Judgments which still threaten us.

An Earthquake in Jamaica, 1692.
By - - -
n. 209. p. 33.

2. We have had a very great *Mortality* since the *Great Earthquake* (for we have little ones daily;) almost half the People, that escaped at *Port-Royal*, are since dead of a *Malignant Fever*, from Change of Air, Want of dry Houses, warm Lodging, proper Medicines, and other Conveniences. *September 3. 1692.*

By - - - ib.

3. A great Part of *Port-Royal* is sunk; that, where the Wharfs were, is now some Fathoms of Water: All the Street where the Church stood is overflowed, that the Water stands so high as the upper Rooms of those Houses which are standing. The *Earth*, when it opened, swallowed up People, and they rose in other Streets; some in the Middle of the Harbour, and yet were saved; though at the same time I believe there was lost about 2000, Whites and Blacks. At the North above 1000 Acres of Land sunk, and 13 People with it. All our Houses were thrown down all over the Island, that we were forced to live in Huts. The two great Mountains, at the entering into 16 *Mile-Walk*, fell, and met, and stopt the River, that it was dry from that Place to the *Ferry* for a whole Day, and vast Quantities of Fish taken up, which was greatly to the Relief of the Distressed. At *Yellows* a great Mountain split, and fell into the level Land, and covered several Settlements, and destroyed 19 White People. One of the Persons, whose Name was *Hopkins*, had his Plantation removed half a Mile from the Place where it formerly stood, and now good Provisions grow upon it. Of all Wells, from one Fathom to 6 or 7, the Water flew out of the Top, with the great Motion of the *Earth*. Since it has continued shaking, sometimes two or three times in a Day; so at Night, sometimes more, sometimes less; but, God be praised, they are but small. Our People settled a Town at *Liguania-Isle*, and there are about 500 Graves already, and People are every Day a dying still. *Sept. 20. 1692.*

By - - - ib.
p. 85.

By --- ib,
p. 85.

4. Between eleven and twelve a-Clock we felt the Tavern (where I then was) shake, and saw the Bricks begin to rise in the Floor, and at the same Instant heard one in the Street cry, *An Earthquake*. Immediately we ran out of the House, where saw all People with lifted-up Hands begging God's Assistance. We continued running up the Street, whilst on either Side us we saw the Houses, some swallowed up, others thrown on Heaps; the Sand in the Street rose like the Waves in the Sea, lifting up all Persons that stood upon it, and immediately dropping down into Pits, and at the same Instant, a Flood of Water breaking in, and rolling those poor Souls over and over; some catching hold of Beams and Rafter's of Houses, others were found in the Sand that appeared, when the Water was drained away, with their Legs and Arms out; we beholding this dismal Sight: The small Piece of Ground, whereon 16 or 18 of us stood (God be praised) did not sink. As soon as the violent Shake was over every Man was desirous to know if any Part of his Family were left alive. I endeavour'd to go towards my House upon the Ruins of the Houses, that were floating upon the Water, but could not: At length I got a *Canoe*, and row'd up the great Sea-side towards my House, where I saw several Men and Women floating upon the Wreck out to Sea; and as many of them, as I could, I took into the Boat, and still rowed on, till I came where I thought my House had stood, but could hear of neither my Wife nor Family. Next Morning I went from one Ship to another, till at length it pleas'd God that I met with my Wife and two of my Negroes. She told me, when she felt the House shake she ran out, and called all the House to do the same: She was no sooner out, but the Sand lifted up, and her *Negro* Woman grasping about her, they both dropt into the *Earth* together; and at the same instant the Water coming in rolled them over and over, till at length they catch'd hold of a Beam, where they hung till a Boat came from a *Spanish* Vessel and took them up.

The Houses from the *Jews-street* End to the *Breast-work* were all shaken down, save only 8 or 10, that remained from the Balcony upwards above Water: And, as soon as the violent *Earthquake* was over, the Watermen and Sailors did not stick to plunder those Houses; and in the Time of their Plunder one or two of them fell upon their Heads, by a second *Earthquake*, where they were lost.

As soon as the violent Shake was over the Minister desired all People to join with him in Prayer; and amongst them were several *Jews* that knecled, and answered as they did; nay, I heard one say, they were heard to call upon *Jesus Christ*: A Thing worth Observation!

Several Ships and Sloops were overset, and lost in the Harbour: Amongst the rest the *Swan Frigate*, that lay by the Wharf to careen, by the violent Motion of the Sea, and sinking of the Wharf, was forced over the Tops of many Houses; and passing by the House where my Lord *Puke* lived, Part of it fell upon her, and beat in her Round House: She did not overset, but helped some hundreds in saving their Lives.

As to the *Fire-Balls*, which you heard were seen in the Air, it was a great Falshood; but a great and hideous Rumbling was heard in the Mountains, infomuch

infomuch that it frightened many Negroes that had been run away some Months from their Masters, and made them come home.

The *Water*, that issued from the *Salt-Pan-Hills*, forced its Passage in, I believe 20 or 30 several Places, some more forcibly than others: For in 8 or 10 Places it came with that Violence, that had so many Sluices been drawn up at once, they could not have run with greater Force, and most of them 6 or 7 Yards high from the Foot of the Hill: 3 or 4 of the least of them we observed were near 10 or 12 Yards high in the Mountain. We tasted the Water in most of the Places, and found it to be brackish. It continued running that Afternoon, all Night, and till next Morning about Sunrise, at which time the *Salt-Pans* were quite overflowed.

The Mountains betwixt *Spanish-Town* and 16 *Mile-Walk*, as the Way lies along the River, if you remember, about the mid-way they are almost perpendicular, especially on the other Side the River; those two Mountains in the violent Shake of the *Earthquake* joined together, which stopt the Passage of the River, and forced it to seek another, which was a great Way in and out amongst the Woods and *Savana's*; for (as I have heard by several Hands) it was 8 or 9 Days before the Town had any relief from it: Infomuch that, before it came, the People were in thoughts of removing into the Country, concluding it had been sunk as *Port-Royal* was. The Mountains along the River are so thrown on Heaps, that all People are forced to go by *Guanaboa* to the 16 *Mile-Walk*.

Mr. *Bosby* (who with his Wife had a miraculous Escape) told us, that that Afternoon, coming to his Plantations, he found the Ground opened in several Places; and in one, two Cows were dropt in and smothered.

The Weather was much hotter after the *Earthquake* than before; and such an innumerable quantity of *Musquetoes*, that the like was never seen since the Inhabiting of the Island.

The Mountains at *Yellows* far'd no better than those of 16 *Mile-walk*; a great Part of one of them falling down drove all the Trees before it, and at the Foot of the Mountain there was a Plantation that was wholly overthrown and buried in it.

The Mountains in *Liguania* fell in several Places, and in some very steep. ib. p. 82.

The Water in the Streets in *Port-Royal* did not spout up as you have heard, but in the violent Shake the Sand cracking and opening in several Places where People stood, they sinking into it, the Water boiled out of the Sand, that covered many and saved others.

5. The Year 1692 began in *Jamaica* with very dry and hot Weather, which continued till *May*, when there was very blowing Weather and much Rain till the End of the Month; from which Time, till the *Earthquake* happened, 'twas excessive hot, calm and dry; and on *Tuesday* the 7th of *June*, about 40 Minutes past 11 in the Forenoon, it being then a very hot, clear, Sun-shine Day, scarce a Cloud to be seen in the Sky, or a Breath of Air to be felt, happen'd that *Great Shake*, so fatal to this Place, and to the whole Island.

By ———
Communicated by Dr.
Love Mer-
ley. ib. 80.

It began with a small trembling, so as to make People think there was an *Earthquake*, which Thoughts were immediately confirmed by a second *Shake* something stronger, accompanied all the while with a *Hollow Rumbling Noise*, almost like that of Thunder, which made them begin to run out of their Houses. But alas! this was but short Warning for them to provide for their Safety; for at the Heels of this second came the *Third Violent Shake*, which in less than a Minute's Time (it continuing near a Minute) shook the very *Foundation of Port-Royal* in such a Sort, that I believe 3 Parts in 4 of the Houses and the Ground whereon they stood, and most Part of those who inhabited them, all sunk at once quite under Water; and on the Place which was left, and is now standing, shook down and shatter'd the Houses in so violent a Manner, that at our Landing it looked more like a Heap of Rubbish, than any thing else; there being, I believe, scarce one House in ten left standing, and those so crack'd and shatter'd, that few of them were fit, or thought safe to live in, and stand now (*July 3. 1693*) empty. All those Streets which were next the *Water*, towards the *Harbour-side*, where there were excellent *Wharfs*, close to which *Ships* of 700 Tun might lie and deliver their Loading, where were the best Store-Houses and Conveniencies for Merchants, where were brave stately Buildings, where the Chief Men of the Place lived, and which were in all Respects the principal Parts of *Port-Royal*, now lie in 4, 6, or 8 *Fathom Water*. That Part which is now standing is Part of the End of that Neck of Land which runs into the Sea, and makes this *Harbour* (at the Extremity of which stands the *Fort*, not shook down, but much shatter'd by the *Earthquake*) and is now a perfect Island; the whole Neck of Land, from the *Fort of Port-Royal* now standing to the *Pallisadoes*, or other End of *Port-Royal* towards the Land (which is above a Quarter of a Mile) being quite discontinued and lost in the *Earthquake*; and is now also with all the Houses, which stood very thick thereon, quite under *Water*: All which Part or Neck of Land (which is discontinued) as also all the other Parts of this Place which *sunk*, were, for what I can learn, nothing but perfect *Sands*; and, by the People driving down Timber and Wharfing, &c. were by little and little gained in time out of the *Sea*, which now has at once recovered all again.

Capt. *Hals* and some others say, that, when they came hither with *Venables*, the Place, whereon *Port-Royal* was since built, was like one of the Keys or little Islands that lie off this *Harbour* (which by the Way are all standing) but continued by a small Ridge of *Sand*, which then just appear'd above *Water*, with the other Part of the Neck of Land, and I believe there is now as much Ground left standing as then.

And one, who had been there some Years before under one *Jackson* (who took and plundered *St. Jago*, &c.) and returned with *Venables*, told Capt. *Hals* at his coming hither, that the *Point* or Place now standing, when he was here before under the said *Jackson*, was wholly separated from the Land by the *Sea* (as it is at this Time;) and, pointing to the Ridge of *Sand* above-mention'd, said, That did not appear when I was here before. This is very probable; for already, since the *Earthquake*, the *Sandy Ground* at the *Pallisadoes*, or other Side,

Side, hath gained from the *Sea* several Acres. On this *Sandy* Neck of Land did People build great heavy Brick-Houses; whose Weight upon so *Sandy* a Foundation may be supposed to contribute much to their downfall; for the Ground gave way as far as the Houses stood only, and no further; Part of the *Fort* and the *Pallisadoes*, at the other End of the Houses, standing.

This Part of *Port-Royal*, which is now standing, is said to stand upon a Rock: But alas! the strange *Rents* and *Tearings* of the *Mountains* here sufficiently evince, that *Rocks* and *Sands* are equally able to withstand the Force of a *Violent Earthquake*. If this Place be nothing but *Sand* (as some would have it, that are its no Well-Wishers) it seems strange that the Force of the *Earthquake* did not dissipate and dissolve the very Foundation of it, and that it did not fall to Pieces and scatter under *Water*, as the rest of the Place did; for the *Shake* was so violent, that it threw People down on their Knees, and sometimes on their Faces, as they ran about the Streets to provide for their Safety; and it was a very difficult Matter to keep one's Legs. The Ground heaved and swell'd like a rolling swelling *Sea*; ('tis a strange Comparison; but, every Body here using it, I venture to do so likewise) by which means several Houses now standing were shuffled and moved some Yards from their Places. One whole Street (a great many Houses whereof are now also standing) is said to be twice as broad now as before the *Earthquake*; and in many Places the Ground would crack, and open and shut, quick and fast: Of which small Openings I have heard Major *Kelly* and others say, they have seen 2 or 3 Hundred at one Time; in some whereof many People were swallowed up; some the *Earth* caught by the Middle, and squeezed to death; the Heads of others only appeared above Ground; some were swallowed quite down, and cast up again with great Quantities of *Water*; others went down, and never were more seen: These were the smallest Openings. Others, that were more large, swallowed up great Houses; and out of some Gapings would issue forth whole Rivers of *Water*, spouted up a great Height into the Air, which seemed to threaten a Deluge to that Part of *Port-Royal* which the *Earth* seemed to favour, accompanied with ill Stenches and offensive Smells: By means of which Openings, and the Vapours at that Time belch'd forth from the *Earth* into the *Air*, the Sky, which before was clear and blue, was in a Minute's Time become dull and reddish (as I have heard it compared often) like a red-hot Oven. All these dreadful Circumstances occurring at once, accompanied all the while with prodigious loud *Noises* from the *Mountains*, occasioned by their Falling, &c. and also a hollow *Noise* under Ground, and People running from one Place to another, with Fear looking like so many Ghosts, and more resembling the Dead than the Living, made the whole so terrible, that People thought the Dissolution of the whole Frame of the World was at hand. Indeed 'tis enough to raise melancholy Thoughts in a Man now, to see the *Chimneys* and *Tops* of some Houses, and the *Masts* of *Ships* and *Sloops*, which partook of the same Fate, appear above *Water*; and, when one comes first ashore, to see so many Heaps of Ruins, many whereof by their largeness shew, that once there had stood a brave House; to see so many Houses shatter'd, some half

half fallen down, the rest desolate and without Inhabitants; to see where Houses have been swallowed up, some appearing half above Ground, and of others the Chimneys only; but above all to stand on the Sea-shore, and to look over that Part of the Neck of Land, which for above a Quarter of a Mile was swallowed up; there, where once brave Streets of stately Houses stood, appearing now nothing but Water, except here and there a Chimney, and some Parts and Pieces of Houses, serving only to mind us of their sad Misfortune.

And tho' *Port-Royal* was so great a Sufferer by the *Earthquake*, yet it left more Houses standing there, than in all the Island besides. It was so violent in other Places, that People could not keep their Legs, but were violently thrown down on the Ground, where they lay on their Faces with their Arms and Legs spread out, to prevent being tumbled and thrown about by the incredible Motion of the *Earth*, like that as is the general Comparison of a great Sea. It scarce left a Planter's House or Sugar-Work standing all over the Island. I think it left not a House standing at *Passage-Fort*, and but one in all *Liguania*, and none in *St. Jago*, except a few low Houses built by the wary *Spaniards*. And 'tis not to be doubted, but that, had there been 500 or 5000 Towns in *Jamaica*, the *Earthquake* would have ruin'd every one. In several Places in the Country the *Earth* gaped prodigiously: On the North-side the Planters Houses, with the greatest Part of their Plantations (and the Planters Houses are not very near to one another) were *swallowed*, Houses, People, Trees, all up in one Gape; instead of which appeared for some time after a great Pool or Lake of Water, covering above 1000 Acres, which is since dried up, and now is nothing but a loose *Sand* or *Gravel*, without any the least Mark or Sign left, whereby one may judge that there ever had stood a Tree, House, or any thing else. In *Clarendon* Precinct the *Earth* gaped and spouted up with a prodigious Force great Quantities of *Water* into the Air, about 12 Miles from the *Sea*; and all over the Island there were abundance of Gapings or Openings of the *Earth*, many thousands; Marks of many whereof, which upon their closing they left behind them, any one cannot chuse but see that goes into the Country; and I have seen several. But in the *Mountains* are said to be the most violent Shakes of all; and 'tis a generally received Opinion, that the nearer to the *Mountains* the greater the *Shake*; and that the Cause thereof, whatever it is, lies there. Indeed they are strangely torn and rent, infomuch that they seem to be of quite different Shapes now from what they were; especially the *Blue*, and other *Highest Mountains*, which seem to be the greatest Sufferers; which, during the Time of the first great *Shake*, and as long as the great *Shakes* continued, which was above two Months after the first *Shake*, (during which Time the *Shakes* came very strong and thick, sometimes 2 or 3 in an Hour) bellowed out prodigious loud *Noises* and *Ecchoings*.

Not far from *Yellows*, Part of a *Mountain*, after having made several *Leaps* or *Moves*, overwhelmed a whole Family, and a great Part of a Plantation, lying a Mile off: and a large *High Mountain*, near *Portmorant*, near a Day's Journey over, is said to be quite *swallowed* up; and, in the Place where it stood, there is now a great *Lake* of 4 or 5 *Leagues* over.

In the *Blue Mountain*, and its high Neighbours, from whence came those dreadful Roarings, terrible and amazing to all that heard them, may be reasonably supposed to be many strange Alterations of the like Nature: But those wild, desert Places, being very rarely or never visited by any body, not by Negro's themselves, we are yet ignorant of what happened there. But whereas they used to afford a fine green Prospect, now one half Part of them at least seemed to be wholly deprived of their natural *Verdure*. There one may see, where the Tops of great Mountains have fallen, sweeping down all the Trees, and every Thing in their Way, and making a Path quite from Top to Bottom; and other Places, which seemed to be peeled, and bare, a Mile together: which vast Pieces of *Mountains*, with all the Trees thereon, falling together in a huddled and confused Manner, stopped up most of the Rivers for about 24 Hours, which afterwards having found out new Passages, brought down into the Sea, and this Harbour, several hundred thousand Tun of Timber, as I have heard computed from the most knowing People there, which would sometimes float into the Sea in such prodigious Quantities, that they looked like moving Islands. I have seen several of those large Trees on this Shore, all deprived of their Barks and Branches, and generally very much torn by the Rocky Passages, through which, by the force of a falling Stream and their own Weight, they might be supposed to be driven. One great Trunk of a Tree particularly, I have seen amongst the rest so squeezed as a Sugar-Cane after it had passed the Mill. Some are of Opinion that the *Mountains* are *sunk* a little, and are not so high as they were; others think the whole Island is *sunk* something by the *Earthquake*. *Port-Royal* is said to be *sunk* a Foot, and in many Places in *Liguania*, I have been told, are Wells which require not so long a Rope to draw Water out of them now, as before the *Earthquake*, by 2 or 3 Foot.

In this Harbour in *Port-Royal* at the Time of the *Great Shake* (though the Seas were very calm) was suddenly raised such a strange *Emotion* in the Water, that immediately it swelled, as in a Storm, great large Waves appearing on a sudden rolling with such a Force, that they drove most Ships (if not all) in the Harbour from their Anchors, breaking their Cables in an Instant; but this was soon over, and in a little Time all was smooth again. One Capt. *Phips* told me, that he and another Gentleman happened at the Time of the *Earthquake*, to be in *Liguania* by the Sea-side; and that at the Time of the *Great Shake*, the Sea retired from the Land in such Sort, that for 2 or 3 hundred Yards the Bottom of the Sea appeared dry, whereon they saw lie several Fish, some whereof the Gentleman who was with him ran and took up, and in a Minute or two's Time the Sea returned again, and overflow'd great Part of the Shore. At *Tallbouse* the Sea is said to retire above a Mile.

'Tis thought there were lost in all Parts of the Island 2000 People, and had the *Shake* happened in the Night, very few would have escaped alive.

Since my Arrival here I have felt several *Shakes*, the first and greatest whereof was on *Good Friday*, 1693, it lifted me compleatly off my Chair, and set me on my Legs, and was said to be a small *Shake*: But I did not then

hear the Noise (minding something else) which always immediately foreruns or rather accompanies it ; but I have since felt several less *Shakes*, and heard the *Noise* often, which is very loud, and may be easily taken, by those not used to hear it for a ruffling Wind, or for a hollow rumbling Thunder ; but hath some puffing Blasts peculiar to itself, and are most like those of a Match made of *Brimstone*, when lighted, but in a much greater Degree, and such as a large Magazine of *Brimstone* may be supposed to make, when on fire. It is observable, that every small *Shake* is felt on Ship-board as sensibly as on Shore, the *Water* shaking as well as the Land.

It is likewise observed, that in windy Weather there never comes a *Shake*, but in very calm Weather it is always expected. This Observation hath held true in every *Shake*, that hath happened since the first great one.

'Tis observed, that after Rain, they are generally smarter than at other times ; which may be from the shutting up of the Pores of the *Earth*, whereby the Force is more pent in, and hath not so free a Passage as to perspire and spend itself, &c.

Shakes often happen in the Country, not felt at *Port-Royal* ; and sometimes are felt by those that live in and at the Foot of the *Mountains*, and by no body else.

'Tis observed, that since the *Earthquake*, the *Land-Breezes* often fail us, and instead thereof, the *Sea-Breezes* often blow all Night ; a Thing rarely known before, but since common.

In *Port-Royal*, and in many Places all over the Island, much *Sulphureous* Combustible Matter hath been found, supposed to have been thrown out, upon the opening of the *Earth*, which upon the first touch of Fire would flame and burn like a Candle.

St. Christophers, one of the *Caribee-Islands*, was heretofore much troubled with *Earthquakes*, which upon the *Eruption* of a great Mountain there of Combustible Matter, which still continues, wholly ceased, and have never been felt there since : Wherefore many expect some such *Eruption* in some of the *Mountains* here, though we hope there is no Necessity for it ; the *Shakes* having been observed to lose their Force, and to become weaker and weaker ever since the first fatal one ; and 'tis now so long since we have heard any, except now and then one so weak as scarce to be felt, that we have great hopes they will now quite cease.

After the great *Shake*, those People that escaped, (as many as could) got on board the Ships in the Harbour, where many continued above 2 Months after ; the *Shakes* all that time being so violent, and coming so thick, sometimes two or three in an Hour's time, accompanied with frightful Noises, both from under the *Earth*, and from the continual falling and breaking of the *Mountains*, that they dared not come ashore. Others went to the Place call'd *Kingstown* (or by others *Killkown*) where, from the first clearing of the Ground, and from bad Accomodations, the Huts built with Boughs, and not sufficient to keep out Rain, which in a great and an unusual Manner followed the *Earthquake*, lying wet, and wanting Medicines, and all Conveniences, &c. they died miserably in Heaps. Indeed there was a general

neral *Sickness*, supposed to proceed from the hurtful Vapours belched from the many Openings of the *Earth* all over the Island, so general that few escaped being Sick; and 'tis thought it swept away in many Parts of the Island, 3000 Souls; the greatest Part from *Kingstown* only, yet an unhealthy Place. Besides the great Quantities of dead People floating from one Side of the Harbour to the other, as the *Sea* and *Land-Breezes* blew them, sometimes 100 or 200 in a Heap, may be thought to add something to the *Unhealthfulness* of that Place. *July 3. 1693.*

6. Most of the *Ships* lost their Anchors and Cables which were towards the Wharfs or Town, which I suppose came from the Sands and Houses falling on them; and they, after the *Earthquake*, rode in fewer Fathoms Water than before: And one may believe that some of the *Phænomena* may be accounted for from that.

By Dr. Sloan
ib. p. 80.

XXI. The *Earthquake* which happen'd between the 4th and 5th of *Jan. 1699.* hath had strange Effects about the *Tungarouse* and *Batavian Rivers.* The great *Batavian River* from above *Tangala Warna*, being a Place from whence the said River received the greatest Part of its Water, is stopt up, or covered with *Earth* from the *Faln Hills*, till beyond the River *Tsyouspokitsyl*; so that the Place where the River had its Course formerly, was not to be seen. But far beyond that Hill, towards *Batavia*, the Water comes forth again from under the *Earth*, which is sunk down, but thick and muddy; passing over and thorough the Trees wherewith the River was formerly stopt up. The Trees lying in the River are of a special Bigness, and so close packt together, that it is impossible to conceive how they came so.

An Earth-
quake in
1699. at Ba-
tavia; sent
to M. Nich.
Witzen, By
• • • •
n. 264 p. 595.

From the Mountains situated near the Beginning of the *Batavian River*, called by the *Javanians* *Soufy-tsiatwong*, seven Hills are sunk down, viz. 5 on this Side, and 2 on the other. But the *Mount* from whence the River hath also its Source, above *Tangel Warna*, within the Mountain *Terbackti*, is not sunk down, nor hath received any Damage.

The *Tangarang River*, call'd by the Natives *Sengbi Sedani*, is also stopt up, and covered with *Earth*, from the Hill and Branch *Salack*, to the River *Antum*, and from thence to *Tangarang*, being fill'd up with Trees; but not in so much a Quantity, nor so close together, as in the *Batavian River.* On this Side the *Tangarang River*, 9 are sunk down by the *Earthquake*; and seven Branches, that had formerly their Issue in the River *Tangarang*, are also covered with the *Earth*, but three other Hills, lying also on this Side of the same River, and call'd *Minjan*, *Dauw*, and *Halsibi*, had not sustained any Damage, whereby the Branches *Autan*, and *Kaniki*, (the latter into the first Branch, and the first into the River *Tangarang*) have kept their Course. And the Hill *Oudjong-teboc*, being call'd also *Sedani*, from whence the *Tangarang River* had its Source, is not sunk down nor hurted. It is also observed, in the *Tangarang River*, at the Place where it is stopt up with Trees, that the descending Water being thick and muddy, went backward with a Motion not unlike the Waves of the Sea; when moved by a Tempest.

The High-Land between the *Batavian* and *Tangarang* Rivers, behind the old Court of the *Jacatra* Kings, called *Pakowang*, having been a great Wood, is changed since the *Earthquake*, into a great and open Field, wholly destitute of Trees, the Surface of the Ground being covered with a red Clay, such as the *Masons* use here; which in some Places was so hard, that it could endure treading and going upon it, and in other Places Men did sink above a Foot in it. And in the Place of the old Court called *Pakowang* situated between the *Batavian* and *Tangarang* Rivers, no other Damage hath been seen, than that the Land thereabouts hath been rent and divided asunder with great Clefts more than a Foot wide. The River *Tscome*, proceeding from a Pit or Well in the aforesaid Court of *Pakowang*, and running a great Way under Ground, and then coming forth again, taking its Course towards *Anke*, had not received any harm: But kept its Course uninterrupted.

The *Tommagon Porbo Nata* in his going towards the Mountains, heard a Noise like unto Thunder, and fearing that a sinking down of the Ground, or an Eruption of Water would follow, he stood still with those that were about him, and saw afterwards that the *Earth* from the Top of the Mountains sunk down; and hearing no further Noise, he went on his Journey, having in going and coming back spent 19 Days by the Way, and felt 40 Times an *Earthquake*: And since his return from the Mountains, he hath felt the like *Shaking* 208 Times.

The Cause of Earthquakes and Volcanos; By Dr. Mart. Lister. n. 157. p. 512. De Foss. Med. Angl.

XXII. I have elsewhere shewn, that the *Breath* of the *Pyrites* is *Sulphur ex tota Substantia*; also that it naturally takes fire of itself: Again that the material Cause of *Thunder* and *Lightning*, and of *Earthquakes*, is one and the same; viz. the *inflammable Breath* of the *Pyrites*. The Difference is, that one is fired in the Air, the other under Ground: Of which last, these (I think) are sufficient Arguments; A Thing burnt with *Lightning* smells of very *Brimstone*: again the Subtilty and Thinness of the Flame; also the Manner of its burning, which is often observed to be *Particulatim*, or in small Spots, Vapour like. And of *Earthquakes*, the *Sulphureous* Stink of Waters smelt before, and of the very Air itself after them: Of which innumerable Instances occur in the Relations of them.

They also agree in the Manner of the Noise, which is to be carried on, as in a Train fir'd, the one rolling and rattling through the Air, taking fire as the Vapours chance to drive, as the other fired under Ground in like Manner moves with a desultory Noise, as it shall chance to be continued.

That the *Earth* is more or less hollow, is made probable, by what is found every where in the Mountains, viz. Natural Cavities or Chambers, which the Miners of the *North* call *Self-Opens*. These they meet with frequently, some vastly great, and others less, running away with small *Sinus's*: And I doubt not, but upon diligent Enquiry, a great Catalogue of such might be had, discovered in the Memory of Man. Besides, many there are, which are known to open to the Day, and to discover themselves without Digging, as *Pool's-Hole*, *Okey-Hole*, &c. Again, the great and small Streams, which do
arise

arise from under the Mountains, do evidence the *Hollowness*, and *Sinousness* of them. Add to these, that many *Sinus's* are made in that Instant, and are continued by the Explosion and rending of the first Matter fired; which may, and do very probably, close again, when the Force of that *Explosion* is over, but are sufficiently open to continue the *Earthquake*.

That these *subterraneous Cavities* are at certain Times and in certain Seasons full of *inflammable Vapours*, the *Damps* in our *Mines* sufficiently witness, which fire do every Thing as in an *Earthquake*, save in a lesser Degree.

Now, that the *Pyrites* alone which is our present Task) of all the known Minerals, yields this *inflammable Vapour*, I think highly probable, for these Reasons.

1. Because no Mineral or Ore whatsoever is *Sulphureous*, but as it is wholly, or in Part, a *Pyrites*: I have carefully made the Experiment in very many of the Fossils of *England*, and I do find them all to contain Iron, wherever there is *Brimstone*.

2. Because there is but one Species of *Brimstone*, that I know of, at least with us in *England*: And since the *Pyrites* naturally and only yields it, it is but reasonable wherever *Brimstone* is found, though in the Air or under Ground in Vapour, to think that also proceeds from it. The *Sulphur Vive* or *Natural Brimstone*, which is found in and about the *Burning Mountains*, is certainly the Effects of *Sublimation*, and those great Quantities of it said to be found about the Skirts of *Vulcano's*, is only an Argument of the long Duration, and Vehemency of those Fires. And though the *Sulphur Vive* or *Rough Brimstone*, as they call it, had from *Hæcla* and *Italy* is *Opakue*, and agrees not with the Transparent and Amber-like *Sulphur Vive* of the Ancients; yet it does not follow, that that also was not produc'd by *Sublimation*, no more, than that the *Stalactites*, or Water-wrought Stone, is not so made, for that some of it is *Opake*, and some *Chrystalline*.

But possibly the *Pyrites* of the *Vulcano's* or *Burning Mountains*, may be more *Sulphureous* than ours. And indeed it is plain, that some of ours in *England* are very lean, and hold but little *Sulphur*; others again very much. And this may be one Reason, why *England* is so little troubled with *Earthquakes*, and *Italy*, and almost round the *Mediterranean-Sea*, so very much. Another Reason is the Paucity of *Pyrites* in *England*; where they are, indeed, some little in all Places, but mostly *sparsim*; and if perchance in *Beds*, these are comparatively thin, to what probably they are in the *Burning Mountains*, as the vast Quantity of *Sulphur* thence *sublim'd* doth seem reasonably to imply. Also, if we compare our *Earthquakes*, and our *Thunder* and *Lightning* with theirs; there it *lightens* almost daily, especially in Summer Time, here seldom; their *Thunder* and *Lightning* is of long Duration, here soon over; there the *Earthquakes* are frequent, long, and terrible, with many *Paroxisms* in a Day, and that for many Days; here very short, a few Minutes, and scarce perceptible. To this Purpose the *Subterraneous Cavities* in *England* are small, and few compared to the vast Vaults in those Parts of the World; which is evident, from the sudden Disappearance of whole Mountains and Islands.

There

There are indeed other *inflammable* Minerals besides the *Pyrites*: But by the Providence of God, not to be found in *England*, that I know of, and not in any Quantity in any Place of the World, that I can learn; which is well for Mankind, because they are very *Poisons*, as the *Orpiments*: But they are specifically distinct from *Brimstone*, which no *Ore* yields but Iron; so the *Orpiments* are all *Gold Ore*. And by the Bye, some Authors have assign'd this as a good Reason, against any Medicine that shall be made out of *Gold*, (as fond as we are of an *Aurum Potabile*) as having naturally a deleterious Quality.

It may be objected, that no Body is *kindled by itself*: But it seems to me apparently otherwise; for that *Vegetables* will heat, and take fire of themselves, as in the frequent Instance of wet Clay; and *Animals* are naturally on Fire, and Man doth then sufficiently demonstrate it, when in a Fever: And amongst *Minerals*, the *Pyrites*, both in Gross and in Vapour, is actually of its own accord fir'd. Dr. *Power* has recorded at large, in his *Micrographia* a famous Instance of it; and the like not very rarely happens. And that *Damps* naturally fire of themselves, we have the general Testimony of *Miners* and the same *Author*.

Again, the *Vulcano's*, all the World over, argue as much; for we, with great Probability, believe them to be Mountains made up in great Part of *Pyrites*, by the Quantities of *Sulphur* thence *sublim'd*, and the Application of the *Loadstone* to the *ejected Cinder*. I go further:

That these *Vulcano's* were *naturally kindled* of themselves, at or near the Creation, is probable: Because there is but a certain known Number of them which have all continued burning beyond the Memoirs of any History; few or none of them that I know of, have ever totally decay'd or been extinct [unless possibly by the *Submersion* of the Whole, being absorb'd in the Sea. Though they, indeed, do burn more fiercely sometimes than at others, for other Reasons. So that it seems to me as natural, to have *actual Fire* in the *Terrestrial* World from the Creation, as to have Sea and Water.

Again, if these *Vulcano's* did not *kindle of themselves*, what Cause can we imagine to have done it; If the Sun; we answer, *Hæcla* placed in so extreme cold a Climate was *kindled*, for ought I can see by the natural History of both, as soon as *Ætna* or *Fuegos*, or the most Southerly.

Not the Accidents happening from Man; for, if Man was (as we must believe) created Solitary and Topical, they were none of his Kindling, because they seem to be fired before the World could be all over peopled: Besides they are mostly the very Tops of vast high Mountains, and therefore the most unfit for the Habitation of Man.

If we say *Lightning*, and *Thunder*, or *Earthquakes*; we beg the Question: For the Cause of the one is the Cause of the other; and they are one and the same. It remains therefore (very probable) that they were *kindled of themselves*.

I for my Part know no Subject in the whole Mineral Kingdom so general and lasting for the Fuel of these Mountains, as the *Pyrites*; which I have

have said alone does yield *Sulphur*, and naturally resolves itself into it, by a kind of Vegetation.

About the *Durable Burning* of the *Pyrites* these are Instances: *Scotch Coal* hath less of the *Pyrites* in it, being mostly made up of *Coal Bitumen*, and therefore it burns and consumes quickly, and leaves a white Cinder. *Sea-Coal*, or that *Coal* which comes from *Newcastle* by Sea to us, and for that Reason so called, burns slowly; and the *Sunderland Sea-Coal* so slowly, that it is said, by Proverb, to make three Fires; this hath much *Pyrites* mixt with it, and burns to a heavy reddish Cinder, which is Iron, by the *Magnet*. But I have seen, and have a Specimen by me of a *Coal* from *Ireland*, (the Proprietor of the Pits is Sir *Christopher Wandsford*) which is said to be so lasting, that it will continue 24 Hours red-hot, and almost keep its Figure: This seems to be in great Part *Pyrites* by the Weight and Colour.

XXIII. In the *Moores* from *Yeovil* towards *Bridgewater*, in the extreme Drought we have endured this Summer 1666, some Lengths of Pasture grew much sooner withered and parched than the other Pasture. And this parched Part seemed to bear the Length and Shape (in gross) of Trees. They digg'd and found in the Place Oaks indeed, as black as *Ebony*. And hence they have been instructed to find and take up many Hundreds of Oaks.

Subterraneous Cakes in Somersetshire; By Dr. J. Beal. n. 18. p. 323.

XXIV. In that *Fenny Tract*, called the *Isle of Acholme*, lying Part in *Lincolnshire*, and Part in *Yorkshire*, has been Abundance of Oak, Firr, and other Trees, of late frequently found in the *Moore*; whereof some Oaks are 5 Yards in compass, and 16 Yards long; others smaller and longer, with good Quantities of *Acorns* near them, lying somewhat above 3 Foot in depth, and near their Roots, which do still stand as they grew, viz. in firm *Earth* below the *Moore*. The *Firrs* lie a Foot or 18 Inches deeper, more in Number than Oak, and many of them 30 Yards long, one of them being, not many Years since, taken up of 36 Yards long, besides the Top, lying also near the Root, which stood likewise as it grew, having been burnt and not cut down; as the Oak had been also. Mr. *Dugdale* concludeth, that this *Moore* hath been so for divers hundreds of Years, and that the Cause thereof has been the Muddiness of the *Tides*, which flowing up *Humber* into *Trent*, left in Time so much Filth, as to obstruct the Currents of *Idle*, *Dun*, and other Rivers, which thence flowed back and over-whelmed that flat Country.

Wood found under Ground in Lincolnshire, By n. 67. p. 2050.

Of Draining the Fenny.

XXV. At *Youle* about 12 Miles below *York*, near the Place where the *Dun* empties itself into the *Humber*, there are several Persons which are call'd *Tryers*, who, with a long Piece of Iron, search in the soft and boggy Ground for *Subterraneous Trees*; and by this Way of Tryal, can in a great Measure discover the Length and Thickness of these Trees, and get a Livelihood by it. Some are so large that they are used for Timber in building Houses, which is said to be more durable than *Oak* itself; others are split into *Laths*; others are

Fossil Wood near York; By Dr. Richardson. n. 223. p. 526.

are cut into long *Chips*, and tied up in Bundles, and sent to the Market Towns several Miles off, to light Tobacco. Those that I viewed were all broken off from the Roots; I suppose by Violence of Storm or Water, or both; and upon Enquiry do find, that they are all after the same Manner. These *Tryers* do affirm, that at three or four Yards deep they find *Stumps* of *Trees* broken off; some two, three or four Foot from the Ground, and to be exactly the same Wood with the *Subterraneous Trees*. The *Bate* or Texture of this Wood is the same with *Firr*, easily *splitting*: If burnt it sends out the same *Resinous Smell*, and it affords the same Coal. The Branches generally grow in Circles, as the Knots do testify: The Knots do easily part from the rest of the Wood, as is usual in *Firr-Wood*. The Straightness and Length of these *Trees*, are also a Presumption, that they must be such; if one consider that some of these are nigh a hundred Foot long, and at the Bottom not much above a Foot in Diameter. They affirm'd to me, that their Tops lay all one Way, (*viz.*) with the Current of the Water. There are also *Oaks* found there, though not in so great a Quantity. The *Vitriolick* Parts of the *Earth*, in which they have lain, hath given them a black Tincture quite through, which (when wrought and polished fine) is not much inferior to *Ebony*. This Wood doth not emit the same Smell when burnt, with that call'd *Firr-Wood*; therefore I hope the Smell of that Wood will not be attributed to the *Bituminous* Parts of the *Earth* in which it hath lain. About 60 or 70 Years ago, several *Dutchmen* undertook to drain a large Marsh in that Place; and in cutting a Channel in the dry Ground betwixt the *Fen* and the River, at the first they threw up a *Rich* and *Firm Soil*, afterwards they met with a Stratum of *Sand*, under that a Stratum of *Boggy* Ground, in which they found of these *Subterraneous Trees*, and under that *Firm* Ground; and a Gentleman attested unto me, who had it from several Persons then living, that were Eye-Witnesses, that the *Firm* Ground in some Places lay *Ridge* and *Furrow*. There are several of these *Roots* of *Trees* to be seen in the Channel at Low-Water to this Day, and yet there are neither *Firr* nor *Pine* growing naturally here, nor have been in the Memory of any Man; neither doth there remain any Tradition of the Growth of any such.

Fossil Wood
in Craven;
By Dr. M.
Lifter, n.
224. p. 381.

XXVI. *Pimco* is one of the highest Mountains in *Craven* in *Yorkshire*, lying on the South-side of that Country, some two Miles above *Carleton*. On the South-side of the *Pike*, (as they call the very Top of that Mountain) is a Place where the *Water* stands; this is called a *Moss*, and is some Fathoms perhaps deep in black Mud. Here are dug up, if we will believe the Inhabitants, not only *Roots*, but whole *Trees* of *Firr*.

I saw there no small Marks of a Wood in former Ages; as the *Roots* or *Stumps* of *Trees* appearing above Ground; which upon due Examination of the Grain and Bark, I found to be the *Roots* of *Birch*. These *Roots* split easily, and some dry; and when dried, they burn with a *lasting Flame*: and for this Purpose they use them upon any sudden Occasion about their Houses. And altho' the *Flame* be great, yet it is without any *Resinous Smell*: However, it seems, that their having lain so long under Ground, has prepared the Juice for

for burning. There have been Oaks, as I have been told, dug up hereabouts also, but I saw none.

XXVII. On the South-side of the *Mendip-Hills*, at a Place call'd *Doulton*, there are great Quarries of *Free-stone*, where the Workmen at five or six Fathom deep, sawing Stones of four or five Tun Weight, have often found large Pieces of cleft and fair Oak in the midst of them.

Wood found in Stone, by Mr. J. Beaumont, Ph. Col. n. 2. p. 6.

XXVIII. *S. Septali*, in a Voyage he made a few Years since over some Mountains to *Genoa*, met with some Peasants, who digging on the Sides of an Hill, had found and gathered very many *Cockle-Shells* of divers Kinds, which he wonder'd at, and therefore went to the very Place; where he was satisfied of the Truth of the Relation, finding great Store of different Shells, as the *Turbinets*, *Echini*, and some *Pearl-Shells*, whereof one had a fair Pearl in it.

Fossil Shells in Italy; By S. Manfredus Septalius. n. 27. p. 493.

XXIX. Upon the Way of *Beziers* to *Narbonne*, in a Place pretty large, raised by Estimation above the Level of the Sea, (which is two Leagues distant from it) about 15 or 16 Fathoms, I saw Rocks which inclosed a good number of big *Oysters petrified*: And upon the same Way above the Place, which is called *Nice*, at the highest Place of the Descent, very cragged, where the Rock is cut to make a Passage, is seen a Bed two Foot large of many *Cockle-Shells petrified*, heaped up, as ordinarily they are on the Seashore; which notes sufficiently, that the Sea formerly covered this Place.

Fossil Shells in France; By M. de Martel, n. 58. p. 1183.

XXX. We will easily believe (what I have read in *Steno's Prodrumus*) that all along the Shores of the *Mediterranean Sea*, there may all Manner of *Sea-Shells* be found promiscuously included in *Rocks* or *Earth*, and at good Distances too from the Sea. But for our *English* inland Quarries, I am apt to think, there is no such Matter as petrifying of Shells in the Business: But that these *Cockle-like Stones* every where, as they are at present, *Lapides sui Generis*, and never any Part of an *Animal*. It is most certain that our *English Quarry Shells* (to continue that abusive Name) have no Parts of a different Texture from the *Rock* or *Quarry* where they are taken, that is, that there is no such Thing as *Shell* in these Resemblances of Shells, but that *Iron-Stone Cockles* are all *Iron-stone*; *Lime* or *Marble*, all *Lime-stone* or *Marble*; *Sparre* or *Christalline-Shells*, all *Sparre*, &c. and that they were never any Part of an *Animal*. My Reason is, that Quarries of different Stone yield us quite different Sorts of Species of *Shell*, not only one from another (as those *Cockle-stone* of the *Iron-stone Quarries* of *Allerton* in *Yorkshire*, differ from those found in the *Lead-Mines* of the neighbouring Mountains, and both these from that *Cockle-Quarry* of *Wansford-Bridge* in *Northamptonshire*, and all three from those to be found in the Quarries about *Gwithrop* and *Beavour Castle*, &c.) but, I dare boldly say, from any Thing in Nature besides, that either the *Land* or *Salt*, or *fresh Water* doth yield us. 'Tis true that I have pick'd out of that one *Quarry* of *Wansford* very Resemblances of

Fossil Shells in several Places of England; By Dr. M. Lister, n. 76. p. 2282.

Murices, Telinae, Turbines, Cochleae, &c. and yet I am not convinced, when I particularly examin'd some of our *English Shores* for *Shells*, also the *fresh Waters* and the *Fields*, that I did ever meet with any one of those *Species* of *Shells* any where else but in their respective *Quarries*; whence I conclude them *Lapides sui Generis*, and that they were not cast in any *Animal Mold*, whose *Species* or *Race* is yet to be found in being at this Day. I have two or three *Sorts* of our *English Cockle-stones* of different *Quarries*, nearly resembling one another, and all of them very like a common *Sort* of *Sea-shell*; and yet there is enough in them specifically to distinguish them, and hinder them from being sampled by any Thing of the *Spoils* of the *Sea* or *fresh Waters*, or the *Land-Snails*.

Fossil Shells
in Kent, By
Dr. Griff.
Hatley. n.
155. P. 463.

XXXI. At *Hunton*, 5 Miles from *Maidstone* in *Kent*, and about a Quarter of a Mile from the River *Medway*, after the Copping of a Piece of Ground was taken off, (which was of a Clay about 3 Foot deep) we came to a very good *Blue Marle*, which continued such 3 Feet and $\frac{1}{2}$ deep more; and then there appeared a hard Floor or Pavement composed of Shells, or Shell-like Stones, crowded closely together; the Interstices whereof were filled up with the same *Marle*. This Layer (which runs as the Veins of Flints do in chalky *Earth*) was about an Inch deep, and several Yards over, and we could walk on it as on a Bench; under this Layer we came to *Marle* again. I cannot, upon Inquiry, find, that in the Memory of any Man thereabouts, any Floods from the River have reached so far as this Place.

The Stones (for I take them to be *Lapides sui Generis*) are of that Sort which is call'd *Conchites*, and resemble *Sea-Fish* of the *Testaceous* kind; most of them are *Turbinated*, or wreathed, the rest are of the *Bivalvular* Sort, but I have not found any of them with *Valves* closed together, but single.

The Bigness of the *Turbinated*, is from a *Vetch* to a *Hazle-Nut*, they are filled with a *Terra Lapidosa*, like the *Marle*, and are of that Colour till you have washed and rubbed them, and then they appear of the Colour of *Bezoar*, and of the same Politure. After they have been boiled in Water, they are whitish, and leave a Chalkiness upon your Fingers, which, when it is rubbed off, gives you a View of very fine black *Striae*, thick set on the outside. These *Wreathed Stones* are all perfectly formed, they differ not in Figure one from another, but that some have their Sides a little depressed; upon a few of them there adhered a little Proportion of a glittering Mineral like Iron. In *Vinegar*, they made a strong and a boiling *Efferescence*.

The *Bivalvular* are most of them no bigger than a *Kidney Bean*, some lesser, a few as broad as the largest Sort of Beans, but the *Valve* much thinner than any of that kind, which had been the *Exuviae* of an *Animal*; the gibbous Part of the *Valve* is smooth, and of the same Colour with that of the *Turbinated*. In a few there are some oblong Lineations bent circularly to the Commissure of the *Valve*: I have a Piece of such an one by me, consisting of several *Lamellae*, which hath this further observable in it, that the gibbous Part is of a most beautiful black shining Colour, and the inner Part of a shining Pearl-colour'd Substance.

Of this *Bivalvular* Sort, many of them seem to be *in fieri*, not as to their Shape, but as to their Hardness and Thickness, there being in some only the *prima Stamina*, and in others the several Steps and Progresses towards a perfect *Figuration*; which seems to me an unanswerable Argument, for their never having been the *Spoils of Animals*. Some of these appeared in the Inner-side white, and it came off upon the Fingers like Chalk, and seemed as if a Depression had been first made in the Bed of the Shape of a *Valve*, and then the Convex Side rubbed with Chalk or painted white,

Those Pieces of this odd *Concretion*, which I keep by me (now the *Marle*, which is in the Interstices, is grown hard) appear much like that coarse Sort of *Marble-stone*, which is dug about *Pluckley* in the *Wild of Kent*. Which *Marble* seems to be a *Coagmentation* of such *Shell-like Stones*, the *Marle* betwixt them having acquired firm Solidity and Hardness. With this *Stone* they make their *Causeys* in that Part of the Country; and they are apt to be worn into little Cavities, or Holes, where they have lain long exposed to the Air; the Rains, in Length of Time, washing away the Portions of *Marle* (which is less hard than the rest) from the Orifices and Interstices of those *Shell-like Stones*. I am much confirmed in this Opinion by a Piece of *Marble*, inlaid, as it were, with such *Stones*, which was dug out of the *Marle-Pit*, at a little Distance from, and on the same Level with that at *Hinton*.

The imperfect, as well as the complete Formation of some of the *Bivalvular* kind (the *Valves* being only found single, and both Sorts in a Ground never heretofore disturbed) are no light Arguments for their being *Stones*. Perhaps the Salts of Plants or Animal Bodies, washed down with Rains, and lodged under Ground, may be there disposed into such like Figures, as well as above it.

*Vid. Mus.
Reg. Societ.
part 3.
cap. 1.*

XXXII. Near *Reading* in *Berkshire*, for many succeeding Generations, a continued Body of *Oyster-shells* has been found through the whole Circumference of 5 or 6 Acres of Ground. The Foundation of these Shells is a hard rocky Chalk, and above this Chalk the *Oyster-shells* lie in a Bed of green Sand upon a Level, as high as can possibly be judged; this *Stratum* of green Sand *Oyster-shells* is (as I measured) high two Foot deep. Now immediately above this Layer, or *Stratum* of green Sand and *Shells*, is a Bed of a blueish Sort of Clay, very hard, brittle and rugged, they call it a pinny Clay, and this is of no use. This Bed, or Layer of Clay, I found to be high a Yard deep; and immediately above it is a *Stratum* of *Fuller's Earth*, which is high two Foot and a half deep; this *Earth* is often made use of by our Clothiers: And above this *Earth* is a Bed, or Layer, of a clear fine white Sand without the least Mixture of any *Earth, Clay, &c.* which is high 7 Foot deep: Then immediately above this is a stiff red Clay, (which is the uppermost *Stratum*) of which we make our Tiles. The Depth of this cannot be conveniently taken, it being so high a Hill, on the Top of which hath been, and is dug up a little common *Earth* about 2 Foot deep.

*Fossile Shells
in Berk-
shire; By Dr.
Ja. Brewster.
n. 26. p.
464.*

I have, with a Mattock, dug out several whole *Oysters* with both their *Valves* or *Shells* lying together, as *Oysters* before opened: In their Cavity there

there is got in some of the fore-mentioned green Sand. These Shells are so very brittle, that in digging for them, one of the *Valves* will frequently drop from its Fellow; but 'tis plainly to be seen that they were united together, by placing the Shell that drops off to its *Fellow Valve*, which exactly corresponds: But I dug out several that were *Entire*; nay, some *double Oysters* with all their *Valves* united.

*Profile Shells
and Fishes in
Lincoln-
shire; By
Mr. Abr. de
la Pryme, n.
266. p. 678.*

XXXIII. In a *Quarry* at the East-end of *Broughton* in *Lincolnshire*, they get a clayey Substance or *Earth*, that lies under the Stone in which are innumerable Fragments of the Shells of Shell-Fish of various Sorts, of *Pectinites*, *Echini*, *Conchites*, and others, with some Bits and Pieces of *Cornel*; and there are sometimes found whole Shell-Fish, with their natural Shells on, in their natural Colours, most miserably crack'd, bruised and broken, and some totally squeez'd flat by the great Weight of the *Earth* that yet lies, and that was cast upon them in the *Noachian Deluge*.

There is another *Quarry* in the Field on the South Side of the Town, of a hard blue Stone, which was most certainly a pure fine blue Clay, in some *Antediluvian Lake*, in the Stones of most of which are innumerable petrified Shell-Fish of various Sorts, but so united to the Stone, that it is very difficult to get them whole out; and I have always found that they lie in the Superficies of the *Quarry*, within a Foot of the Top thereof, and few or none deeper therein. In many Places of the Surface of the *Quarry*, (which looks rugged and drifted, as Snow does after a Storm, and by which one may find what Quarter the Storm or Wind was then in) there are many Shell-Fish half in the Stone, half out. That Part which is within the *Quarry* is entire and whole, but a hard Stone; and that Part which is without, which the petrific *Effluvioms* did not touch, is consumed and gone, all but a little of the Edges which are plain Shell, and have all the *Radii* and *Striae* on them, that the common Shells of those Sorts of Fishes have.

All these Fishes have their Shells on, some of which Shells are exceeding thin, to what other some are. Sometimes the Shells of some of them are in their petrification so thoroughly united unto and incorporated with the Stone, that they are scarce visible. Others in the same *Quarry* have a thick white Shell on them petrified, but not incorporated and turned into the Substance of the Bed in which they lie. As you get that Fish out, all the Shell sticks so fast to the Rock, that most commonly it is left behind, but sometimes the Shell cleaves in two, one half of the Shell on both Sides of the Fish sticks thereto, and the other half to both Sides of the Bed, but others come out by lying in the Air in frosty Nights, with the whole natural Shell on them, and the *Radii* or *Striae* very exact. Other Fish there are here, that have a black smooth Shell on them, with several *Striae*, but no *Radii*, very like, if not the same with the *Concha Nigra Rondel*.

I have also seen in this *Quarry* some Shell-Fish half open and fill'd with the Matter of the Bed in which they lie, and petrify'd with it. Others being in heaps together, I have found some of them broken, others bruised, and the Edges of one Fish thrust into the Sides of another, some with the one

Shell

Shell thrust half Way over the other, &c. and so petrified in the Bed together. Others in the same Bed have been so close, that the Manner of the Bed could not insinuate itself into them. These, that are thus found, are some of them totally empty, others are filled with *Christalline Fluors*, others I have seen half full of the said blueish Clay of the Bed, and half full of the said *Christallizations*, which have struck therein, from nothing but *subterraneous Heats* and *Effluviiums*.

Amongst these Fish in this *Quarry*, I have seen several great *Horse-Muscles*, such as breed in *Fresh-Water-Rivers* and *Ponds*, which are exactly like the *Concha Longa Rondel*, but are more thick, full, and pubble, than ours commonly are at this Day; which Greatness and Largeness proceeds from nothing but the Fertility and Fatness of the Bed on which they bred; and at this Day in an old Pond beyond *Broughton-Hall*, there are some of the largest of this Sort of *Shell-Fish* that ever I saw, as if this Soil agreed better to the breeding of this Sort of Fish than any else; just as the *Cornu Ammonis*, *Nautili*, and others breed best upon *Alum Soils*: And that is the Reason that they are found so much at *Whitby*, *Rochel*, *Lunenburgh* Rome, and other Places, where are famous *Alum-Mines*. And if any one would find any of those Sorts of Fishes (which some learned Men have ridiculously thought to be Species totally lost) they ought in all probability to seek for them upon *Alum Soils* in the Sea, and there they would undoubtedly find them.

Others have an *Ouzey Soil*, a Sort of a confused Mixture of several Soils together, as Part of the Country about *Fordingham*, *Bramber*, *Ajabee*, *Botsworth*, &c. seems to be; in the Fields and Stones of which Towns, is one particular Sort of Fish, which I knew not what *Genus* or *Species* to compare to, bending somewhat like a *Ram's-Horn*, and exactly creased like one on the out-side with an *Opusculum* thereon, which the Fish opened and shut as it had Occasion. The Bed whereon the said *Shell-Fish* bred in the *Antediluvian Sea*, is not over a Foot thick (to the best of my Memory) in all which, but for the most Part in the Superficies thereof, are Millions of the said Fish sticking half within the Stone, half without; which *Shell-Fish* having a most durable Shell, that Part which sticks out of the Stone, is consumed, as in the *Shell-Fish* of *Broughton*, but remains whole and entire. And yet I have seen and found whole Lumps of them, that by some huge Weight cast or fallen upon them, in the *Noachian Deluge*, have been miserably broken and shattered in Pieces, and so petrified in the Bed as they lay.

In the Parish of *Broughton* aforesaid, in the loose *Earth* above the aforesaid blue *Quarry*, and elsewhere, I have found in a whitish Stone, the *Belemnites Punctulati Lloydi*, the *Turbinites Major. Lloydi. Tab. 7. N. 341.* the *Coelites Lewis Vulgarior. Lloydi T. 7. N. 322*; in blue Stone, the *Concha altera Longa Rondeletii*, exactly agreeing to the Picture and Bigness thereof in *Gesner de Piscibus*, p. 231. only the *Neb* is much longer: I have found also Multitudes of *Belemnites*, great and little, perforated and flat at the Root, by which they grew in the *Antediluvian Sea*, unto some of which I have found little *Shell-Fish* sticking.

There

There have been many Contests and Disputes amongst the Learned concerning these Appearances; but my Notion of them is, that the *Antediluvian World* had an external Sea as well as Land, and Mountains, Hills, Rivers, and fruitful Fields and Plants; that it was about the Bigness that our Earth is at present of, and that when God had a mind, for the Wickedness of the Inhabitants that dwelt thereon, to destroy the same by Water, he broke the Foundations and subterraneous Caverns and Pillars thereof with most dreadful *Earthquakes*, and caused the same to be for the most Part, if not wholly, *absorbed* and swallowed up, and covered by the Seas that we now have; and that this Earth of ours rise then out of the Bottom of the *Antediluvian Sea* in its Room: just as many Islands are swallowed up, and others thrust up in their stead.

From this happy System of the *Deluge*, which is the most concordant to the Scriptures of all others, all those Things are easily solved that were hard and difficult before. It is no longer a Wonder that Shells, and Shell-Fish, and the Bones of other Fishes and Four-footed Creatures, and Fruits, &c. are found (as they commonly are) in Beds and *Quarries*, in Hills and Mountains, and in the Bowels of the Earth; for here they bred in the *Antediluvian Sea*, thither they were elevated with the Hills and Mountains in the Time of the *Deluge*, there they fell into, were absorbed and buried in Chasms, and Holes, and Clefts, that would necessarily happen in the thrusting up of the Earth, and are found in the Soil that was flung and carried with wonderful Violence and Confusion from one Place to another, by the Working of the Waters, and the Ferment and Hurry that they were put into.

And as all Countries were thus raised out of the Bottom of the *Antediluvian Sea* and *Lakes*, so that Part of the Country, about *Broughton* aforesaid, appears manifestly, in the *Antediluvian World*, to have been the Bottom of some *Fresh-water Lake*, because that those are Fresh-water Shell-Fish which are found there; and the Bed, upon which they bred, was a fine blue Clay, which is the Colour of the Stone to this Day: Which Bed being *elevated* and lifted up (and dashed over with other Earth in the Workings of the Waters, and the great Hurry and Confusion that then happened) the said Bed, by the Power of the *subterraneous elevating Heats, Steams, and Effluvioms*, was turned by Degrees into Stone, with all the Fishes therein.

I have before told you, that some of the Shell-Fish, in the same Bed, are not only full of the Matter of the Bed, but of *Flours*, tho' such are not very common. Some might wonder, seeing that the Shells are closed, that the Matter of the Bed could insinuate itself into them; but that is nothing but what is common in like Cases: For I have frequently seen, in the Bottoms of Ponds and Rivers, where such Shell-Fish in Plenty are, that when the Fish is dead and consumed, and the Shell in the Mud, with the Edges as close as if the Fish was alive, that nevertheless the Mud or Clay will, by Degrees, insinuate and fill the same. And now if the Bottom of any one of the said Rivers or Ponds was raised by *Earthquakes*, and turned into Stone by *Petrifick Effluvioms*, they would exactly be found as these are.

That many *Shell-Fish* suffered such wonderful great Violence and Force in the said great Flood, insomuch as to be crush'd, and bruis'd, and squeez'd flat, as some of those manifestly are; is likewise nothing strange or wonderful, if we do but consider the great Pieces of rising Rocks, and Hills, and Mountains, that must needs roll down, and fall in such a general Hurry and Confusion as that must needs have been in the *Quarry*, at the East End of this Town of *Broughton*: where Fragments of innumerable Shells are found, and some *Shell-Fish* squeez'd flat, all which are natural, and not petrify'd. There was in the *Deluge* flung upon the same a huge Bed of a mix'd confused Substance, now turn'd into a whitish soft canker'd Stone, and upon that were cast vast Quantities of *Earth*, all which weigh'd and pressed the tender Shells so much, that they squeezed some flat, and broke others to Pieces, as we find them to be at this Day.

I have a hard Stone, Part of the aforesaid blue *Quarry*, with little Bits of *Wood-Coals* therein, and whole *Leaves of Vaccinia*, or *Whortle-Berries*, such as grow upon Heaths very exact: And Mr. *Lloyd* and others have given us several large Accounts of whole *Leaves* and *Plants* found in Stones and Rocks, and deep in the Bowels of the *Earth*, some folded, some plain, some imperfect; all which is very easily solvable, having in that general Confusion and Hurry been seized upon and embody'd in Lumps of Clay and other Matters, and others caught and intercepted in Rolling Beds of *Earth*, as they tumbled down from rising Hills and Mountains, and so lodg'd deep in Chasms of the Ground and petrify'd, and so preserv'd unto this Day.

XXXIV. I have had out of the Isle of *Sheppey* in the River of *Thames*, very *Sharks Teeth* dug up there; which could not be said to be petrified. They were somewhat gilded with a *Vitriolick Tarnish* at our first receiving them; but they were white, and in a short Time came to their natural Colour.

Glossopetrae,
By Dr. Lister.
n. 110. p. 223.

In the *Stone Quarries* in *Hinderskelf-Park* near *Malton* in *Yorkshire*, I took out of the Rock myself a fair *Glossopetra* with three Points of a black Liver-Colour, and smooth; its Edges are not *Serrate*; its Basis is (like the *true Teeth*) of a rugged Substance; it is carved round the Basis with Imbossed Work: It hath certain eminent Ridges, or Lines like Rays, drawn from the Basis to each Point.

XXXV. Dr. *Tancred Robinson* received lately from *Maryland* a considerable Number of *Fossile Bones* and *Shells* of several Sorts. Some of them had received little Alteration in the *Earth*, others more, and some were so changed as to be stony: But all of them retained their ancient Shape. One of these *Fossiles* I compared with the Tongue of a Fish I had observed in *Jamaica*, and with another of the same Tongues in Pieces, which I saw in Mr. *Charleton's* most useful and admirable Collection of *natural Curiosities*, and found a perfect Agreement. Another of these *Fossiles* I suppose

The Fossile
Tongue of a
Pastinaca
Marina; By
Dr. Hans
Sloane. n.
232. p. 674.

suppose is the upper *Mandible*, or *Palate* of this *Fish*, which is opposite to, or answers this *Tongue*: The Agreement of this in all Parts with the *Tongue*, making it very likely to belong, if not to this same, yet to this kind of *Fish*.

A Part of one of the *Joints* of this *Tongue* was dug up in *England*, and given to Mr. *Charleton*, by Mr. *Lloyd* of *Oxford*, by the Name of *Siliquastrum Subnigrum Pectinatum Maximum*.

Fig. 87, 88.

Dr. *Robinson* thinks the *Fossile Palate* or *Mandible*, Fig. 87. and 88. may be of the same kind with that taken notice of by *Lachmund*, in this *Book de Lapidibus*, p. 17. where 'tis call'd *Pentacrinous*.

Fig. 75.

Fig. 75. Is the whole *Tongue* of a *Flat-Fish* a-kin to a *Thornback*, which I call *Pastinaca Marina*, *Lavis*, *Livida*, *Albis Maculis notata*. It is made up of many *Bones* (about 19 in this) which are each of them crooked, their two *Sides* making an obtuse *Angle*, such as the *Sides* of the *Under-Mandible* of a *Man* does: The uppermost *Sides* of these several *Bones* have *Furrows* and *Pieces* standing together after the Manner of the *Teeth* of a *Short small-toothed Comb*, the extant *Ends* of which answer the like *Parts* in the *Bones* of the upper *Jaw* of this *Fish*, between which and this *Tongue* the *Food* of this *Fish* is cut, torn, or ground to *Pieces*.

Fig. 76.

Fig. 76. Is the *underside* of the same divided into several *Pieces* also, but having no *Furrows* or *Teeth*, as those of the upper *Side* have.

Fig. 77, 78,
79, 80.

Fig. 77, 78, 79, 80. Shew the *Joints* or *Pieces* of the same *Tongue*, separated in several *Positions* of their upper and under *Sides*, to shew the perfect Agreement between the *Pieces* of the *Tongue* of the *Fish* taken lately from it, and those taken out of the *Earth*, which are figur'd in the like *Positions*. Fig. 81, 82, 83, 84, 85, 86.

Fig. 81, 82,
83, 84, 85,
86.

Fig. 87, 88.

Fig. 87, 88. Are the upper and under *Sides* of what, I suppose, is the *Upper-Mandible* or *Palate* of this *Fish*, which is opposite to, and answers this *Tongue*.

Mr. *Willoughby* and Mr. *Ray* call this *Fish* *Nari-Nari*; and I am apt to believe the *Anonymous Portuguese*, whose *Description* of *Brazil* is published in *Purchas*, *Lib. 7. Cap. 1. p. 1313.* means this, when he says there were *Rays*, having in their *Mouth* two *Bones* breaking *Wilks* with them.

Horns of American
Leer found
under
Ground in
Ireland; by
Dr. Tho.
Molineux, n.
227. p. 489.

XXXVI. I had lately an Opportunity of particularly examining a complete *Head*, with both its *Horns* entirely perfect, not long since dug up in *Ireland*, and given to my Brother *Will. Molineux*, as a *Natural Curiosity*, by Mr. *Henry Oston*, that lives at a Place call'd *Dardistown*, in the *County of Meath*, about 2 *Miles* from *Drogheda*. This is the *third Head* which hath been found by casual *trenching* in his *Orchard*; they were all dug up within the *Compass* of an *Acre* of *Land*, and lay about 4 or 5 *Foot* under *ground*, in a Sort of a *boggy Soil*. The first *Pitch* was of *Earth*, the next 2 or 3 of *Turf*, and then followed a Sort of *white Marl*, whereby they were found.

I took the *Dimensions* of this *Head* carefully, as follows, from the extreme Tip of the right *Horn*, to the extreme Tip of the left *AB*, was 10 Foot 10 Inches; from the Tip of the right *Horn*, to the Root where it was fastened to the *Head CD*, 5 Feet 2 Inches; from the Tip of the highest Branch (measuring one of the *Horns* transverse, or directly across the *Palm*) to the Tip of the lowest Branch *GF*, 3 Foot 7½ Inches. The Length of one of the *Palms*, within the Branches *GH*, 2 Feet 6 Inches; the Breadth of the same *Palm*, still within the Branches *IK*, 1 Foot 10½ Inches; the Branches that shot forth round the Edge of each *Palm*, were 9 in Number, besides the *Brow-Antlers*, of which the right *Antler DL*, was 1 Foot 2 Inches in Length, the other was much shorter; the *Beam* of each *Horn M*, at some distance from the *Head*, was about 8 Inches in Circumference; at the Root where it was fastened to the *Head*, about 11 Inches in Circumference; the Length of the *Head* from the back of the *Skull* to the tip of the *Nose*, or rather the Extremity of the upper *Jaw-bone NO*, 2 Feet; the Breadth of the *Skull* where largest *PQ*, was a Foot. There were 2 *Holes* near the Roots of the *Horns* that look'd like *Eyes*, but were indeed large open Passages, near an Inch in Diameter, in the *Forehead-bone*, to give way to great *Blood-Vessels*, that here issue forth from the *Head*, and pass between the Surface of the *Horn*, and the smooth hairy *Skin* that covers them whilst they are growing (which is commonly called the *Velvet*) to supply the *Horns* with sufficient Nourishment, while they are soft, and till they arrive at their full Magnitude, so as to become perfectly hard and solid.

These *Vessels*, by reason of their Largeness and great Turgency of the Humour in them, whilst the *Horn* is sprouting and pliant, make deep and conspicuous Furrows all along the outside of it where they pass, which may plainly be seen after the *Horn* is bare and come to its full Growth, at which time all these *Veins* and *Arteries*, with the outward *Velvet Skin*, drying by the Course of Nature, shrivel up and separate from the *Horn*, and the Beast affects tearing them off in great Stripes against the Boughs of Trees, exposing his *Horns* naked when they are thoroughly hardened, without any covering at all.

Such then were the vast *Dimensions*, according to which the lofty *Fabrick* of the *Head* and *Horns* of this stately Creature was built: And yet it is not to be questioned but these spacious *Horns* as large as they were, like others of the *Deer-kind*, were naturally cast every Year, and grew again to their full Size in about the space of 4 Months. For all Species of *Deer* yet known certainly drop their *Horns* Yearly, which I conceive to proceed from the same Cause, that *Trees* annually cast their ripe Fruit, or let fall their withering *Leaves* in *Autumn*; that is, because the nourishing *Juice*, say it is *Sap* or *Blood*, is stopped and flows no longer, either on the account it is now deficient, being all spent, or that the cavous Passages which convey it, dry up and cool, so as the *Part* having no longer any *Communication* with, must of necessity by degrees sever from the *Whole*; but with this Difference, that *Horns* by reason of their hard, material, and strong Composition, stick fast to the *Head* by their Root 7 or 8 Months after all their Nourishment perfectly retires, whereas

whereas *Leaves* and *Fruit*, consisting of a much more tender Substance, and a finer Texture of Parts, drop sooner from their native Beds where they grew, when once the Supply of usual Nourishment is stopt. This Analogy that *Nature* observes in casting the *Horns* of Beasts, and dropping the *Fruit* of Trees, will appear much more evident to any one that will observe the End of a Stalk, from which a ripe *Orange*, or any large *Fruit*, has been lately sever'd, and the But-end of a cast Horn, where it is fallen'd to the *Os-frontis*; for by comparing them together, he shall find so great a Congruity in the Shape of both, that 'twill be apparent, *Nature* works according to the same *Mechanism* in one as in the other.

Such another *Head*, with both the *Horns* entire, was found some Years since by one Mr. *Van Delure*, in the County of *Clare*, buried 10 Feet under Ground in a sort of *Marle*, and was presented by him to the late D. of *Ormond*. In the Year 1691, Major *Folliot* told me, that digging for *Marle* near Town *Ballymackward* near *Ballyshannon* in the County of *Fermanagh*, he found, buried 10 Feet under plain solid Ground, a pair of these sort of *Horns*. In the Year 1684, there were two of these *Heads* dug up near *Turvy*, within 8 Miles of *Dublin*.

Not long since a *Head* of this kind, with its *Horns*, was found near *Portumny*, seated on the River *Shannon*, in the County of *Galloway*. Such a *Forehead* with two extraordinary *Beams* of these kind of *Horns*, may be now seen fastened against one side of the *Common-Hall* of his Grace *Michael* Lord Archbishop of *Armagh*'s House here in *Dublin*; they are both imperfect, and want their *Palms*, yet by the vast Thickness and Length of the *Beams*, I judge, when entire, they much exceed the Size of those I have given the Dimensions of above. The *Primate* told me, they were found somewhere in the Province of *Ulster*.

To these I might add many more Instances of the like; as those found by the late Lord *Mountjoy*, near his House at *Newton-Stewart*, and those kept at *Stockallen* in the County of *Meath*; for to my Knowledge, within less than 20 Years, above 20, I might safely say, 30 Pair of these sort of *Horns* have been dug up in several Places of this County, all found by accident; and we may well suppose vast Numbers still remain undiscovered: But these may suffice plainly to shew, this Creature was formerly common with us in *Ireland*, and an *indigenous Animal*, not peculiar to any Territory or Province, but universally met with in all Parts of the Kingdom. We may also reasonably gather, that they were a *gregarious Animal*, as the *Naturalists* call them; or such a sort of Creature as affect naturally keeping together in *Herds*; as we see the *Fallow Deer* with us, and as 'tis reported of the *Elches* in *Sweden*, and the *Rain Deer* in the Northern Countries of *Europe*; for otherwise we cannot easily fancy it should happen, that three of their *Heads* should be all found within the narrow Compass of one Acre of Ground.

That these and several others, and indeed I think I may say all that I have been particularly inform'd of, though dug up in far distant Places of *Ireland*, should be constantly found buried in a sort of *Marle*, seems to me

me to intimate, as if *Marle* was only a Soil that had been formerly the outward Surface of the Earth, but in Process of Time, being covered by Degrees with many Layers of adventitious Earth, has by laying under Ground a certain Number of Ages acquired a peculiar Texture, Consistence, Richness or Maturity, that gives it the Name of *Marle*. For of Necessity we must allow the Place where these *Heads* are now found, was certainly once the external Superfice of the Ground, otherwise it is hardly possible to suppose how they should come there.

And that they should be so deep buried as we at present find them, appears to have happened by their accidentally falling where it was soft low Ground; so that the Horns by their own considerable Gravity might easily make a Bed where they settled in the yielding Earth, and in a very long course of Time, the higher Lands being by Degrees dissolved by repeated Rains, and washed and brought down by Floods, covered those Places that were situated lower, with many Layers of Earth: For all high Grounds and Hills, unless they consist of a Rock, by this means naturally lose a little every Year of their Height, and sometimes sensibly become lower even in one Age; of which we may see several satisfactory Instances related by Dr. Plot in his *Natural History of Staffordshire*, Chap. 3. Page 113. As for all such Heads that might chance to fall on high or hard Grounds, where they could not possibly be covered or defended, these must of Necessity rot, perish, and be destroyed by the Weather.

By what means this kind of Animal, formerly so common and numerous in this Country, should now become utterly lost and extinct, deserves our Consideration.

Some have been apt to imagine this, like all other Animals, might have been destroyed from off the Face of this Country, by the Deluge in the Time of *Noah*: But if we consider what a fragil, slight, and porous Substance these and the Horns of all *Deer* are, we cannot well suppose they could by any means be preserved entire and uncorrupt from that *Flood*, now above 4000 Years since; and I have by me some of the Teeth, and one of the lower Jaw-bones of this Creature so perfect, solid, ponderous and fresh, that no one that sees them can possibly suspect they could have been in Nature so many Ages past: And therefore it seems more likely to me, this kind of Animal might become extinct here, from a certain ill Constitution of Air in some of the past Seasons long since the Flood, which might occasion an *Epidemick Distemper*, if we may so call it, or *Pestilential Murrain*, peculiarly to affect this Sort of Creature, so as to destroy at once great Numbers of them, if not quite ruin the Species. For this Island may very well be thought neither a Country nor Climate so truly proper and natural to this Animal as to be perfectly agreeable to its Temper, since for aught I can yet learn, it neither is, nor ever has been an Inhabitant of any of the adjacent Kingdoms round about us. And besides the three Heads above-mentioned, found so close to one another in the County of *Meath*, and the two near

Jurvy, seems not a little to countenance this Opinion, as if these Animals died together in Numbers, as they had lived together in *Herd*s. To this Purpose, *Scheffer* in his *Laponia* speaking of the *Rain Deer*, an Animal that agrees in Kind with ours, tho' it be a quite different Sort of *Deer*, says, that whole Herds of them are often destroyed by a raging Distemper like a Plague, common among them; and that sometimes they all die, so that the *Laplander* is forced to supply himself with new.

'Tis probable, however, that some of them might have escaped this common Calamity; but these being few in Number, I imagine as the Country became peopled, and thickly inhabited, they were soon destroyed and killed like other *Venison*, as well for the Sake of Food as Maltery and Diversion. And certainly these savage Ages of the World would not have spared the rest of the *Deer Kind*, *Stags* and *Hinds*, *Eucks* and *Dees*, which we still have, but that these, being of a much smaller Size, could shelter and conceal themselves easier under the Covert of Woods and Mountains, so as to escape utter Destruction.

And here I cannot but observe, that the *Red Deer*, in these our Days, is much more rare with us in *Ireland*, than it has been formerly, even in the Memory of Man: And tho' I take it to be a Creature, naturally more peculiar to this Country than to *England*, yet unless there be some Care taken to preserve it, I believe in Process of Time, this Kind may be lost also, like the other Sort we are now speaking of.

It remains that we enquire what *Species of Animals* it was, to which these stately *Horns* formerly belonged. I know it is an Opinion generally receiv'd, that they belonged to the *Alche*, *Elche*, or *Elende*, and therefore are vulgarly called *Elche's Horns*: But I have seen a Pair of genuine *Elche's Horns* brought out of *Swedeland*, and they differed extremely both in *Figure* and *Size*, from these we have now described. They were abundantly smaller, and quite of another *Shape* and *Make*, not *palmed*, or broad at the End farthest from the *Head*, as ours; but on the contrary, broader towards the *Head*, and growing still narrower towards the *Tips End*, the smaller *Branches* not issuing forth from both *Edges* of the *Horns* as in ours, but growing along the upper Edge only, whilst the other *Verge* of the *Horn* was wholly plain without any *Branches* at all. The faithful *Gesner* speaking of the *Size* of them, says, *Cornua singula Libras circiter duodecim appendunt, Longitudine fere duorum Pedum*: Whereas the *Horns* we find here in *Ireland* are near thrice that Length, and above double that Weight, tho' dried, and much lighter from their being so long kept. Moreover the *Elche*, as described by *Apollonius Menabenus*, who had seen many of them, is no larger than a middling Horse. And Mr. *Duncombe* told me, when he was Envoy in *Sweden*, he had seen there above 100 *Elches* together in a Herd, and none of them above five Feet high. And if so, we cannot imagine a Creature of that small Size could possibly support so large and heavy a Head, with so wide and spreading a Pair of *Horns* as these we are speaking of; considering that exact *Symmetry*, and due Proportion of Parts, Nature observes in the Formation of all the larger and perfecter Sort of Animals.

De Quadrup.
c. 1.

But the Description of that lofty horned Beast in the *West-Indies*, called a *Moose*, much better agrees with our *Irish* Animal than that of the *Elche* does. This Animal I find described by Mr. *John Josselyn*, among his *New-England* Rarities, in these Words: *The Moose-Deer, common in these Parts, is a very goodly Creature, some of them twelve Feet high, (in Height, says another Author more particularly, from the Toe of the Fore-Foot to the Pitch of the Shoulders 12 Feet; in its full Growth much bigger than an Ox) with exceeding fair Horns with broad Palms, some of them two Fathoms or twelve Feet from the Tip of one Horn to that of the other. This is 14 Inches wider than ours was. Another thus describes the manner of the Indians Hunting this Creature: They commonly hunt the Moose, which is a kind of Deer, in the Winter, and run him down sometimes in half, otherwhile a whole Day, when the Ground is covered with Snow, which usually lies here four Feet deep; the Beast, very heavy, sinks every Step as he runs, breaking down Trees as big as a Man's Thigh with his Horns; at length they get up with it, and darting their Lances, wound it so, that the Creature walks heavily on, till tired and spent with Loss of Blood, it sinks and falls like a ruined Building, making the Earth shake under it. So that we have not the least Reason to question but these vastly large Irish Deer and the American Moose, were certainly one and the same Sort of Animal, being all of the Deer Kind, carrying the same Sort of palmed Horns, which are of the same Size and Largeness as well as Figure; and the Bulk of their Bodies corresponding exactly in proportion to the wide spreading of their Horns. So that we may securely assert, that Mooses formerly were as frequent in this Country, as they have them still in the Northern Parts of the *West-Indies*, *New-England*, *Virginia*, *Maryland*, and *Canada*, or *New France*.*

And lest we may think this Animal peculiar to the *Continent*, and not to be found in *Islands*, a remarkable Passage in *John de Laet's* Description of the *West-Indies* clearly shews the contrary: *There are found, says he, great Numbers of these Animals in an Island near the Continent, called by the English, Mount Mansell. This may give us reasonable Grounds to believe, that as this Island of Mount Mansell must of necessity have had some Communication with the Main-Land of America, to have been thus plentifully stock'd with this Sort of Beasts; so Ireland, for the same Reason, must in the many past Ages, long before the late Discovery of that New World, have had some Sort of Intercourse with it likewise, (though 'tis not easy, I acknowledge, for us at present, to explain how) for otherwise I do not see how we can conceive this Country should be supplied with this Creature, that, for ought I can yet hear, is not to be found in all our Neighbourhood round about us; nay, perhaps in any other Part of Europe, Asia, or Africa: And then 'tis certain, as Ireland is the last or most Western Part of the Old World, so 'tis nearest of any Country to the most Eastern Parts of the New; Canada, New-England, Virginia, &c. the great Tract of Land, and the only one I yet know, remarkable for Plenty of the Moose Deer.*

XXXVII. *Tonna*, a considerable District of *Thuringen*, near to *Ersurt*, was formerly subject to the Family of *Glichen*, which becoming extinct, it had afterwards

An Elephant
found under
Ground near
Erfurt in
Germany:
By Will.
Ern. Tent-
zelius. n.
254. p. 757.

afterwards several Masters, and at last was annexed to the Dukedom of *Saxe-Gottha*, being claimed, in the Year 1677, by Prince *Frederick*, Father of the present Prince of that Name, as his hereditary Right. It has two small Towns or Villages of the same Name, one of which is called *Burg-Tonna*, or *Castle Tonna*; and the other *Grafen Tonna*, or *Earl's Tonna*. Which of the two is most ancient I cannot take upon me to determine; but it appears from the Annals of the Country that there was an ancient Town, called *Donnaba*, in the Charter of *Otton* the Great, which was given in the Year of *Christ* 973, and in my Opinion the Town there meant was *Burg-Tonna*. Very near this Town there is a sandy Mountain or Hill, at the Bottom of which there is Plenty of a very pure white Sand, which they used to carry to great Distances for the Use of various Artificers. As they were digging here in *December*, in the Year 1695, they found some prodigious large Bones, which seemed to belong to the hind Feet of some Quadruped, one of them weighing nineteen Pounds. Then they found a round Head of a Bone, larger than a Man's Skull, fixed in a Socket, weighing nine Pounds; and then a larger Bone, like that of the Thigh, weighing thirty-two Pounds. Searching farther in the cold Weather, which is common in the Beginning of the Year, they hit upon the back Bone, with the Ribs adhering to it, and digging still deeper they found two more round Bones larger than the former one, together with the Bones next to them, *viz.* those of the fore Feet; then the Shoulder Blade, four Feet long, and two Spans and a half broad. Soon after they came to the *Vertebrae* of the Neck, together with the *Dentata*; and last of all appeared the Head of a monstrous Size, with four of the Grinders, each of which weighed twelve Pounds, and the two largest Teeth or Horns, two Spans and a half thick, and eight Feet long, standing out from the Head. In order that the Head might be better seen, a Hole was dug in the Hill of twelve Cubits, or four and twenty Feet deep; which being done, his Serene Highness came himself, and I had the Honour to be one of those who attended him by his Order, where there was a great Concourse of Spectators, and every Body admired the prodigious Size of the Head and Teeth; but we were very sorry to find that the Head and all the other Bones and the Teeth, except those of the Jaws, which were almost entire, were become so brittle, carious, and so thin with lying, that we could not find one of them that was quite sound, but they were all broke to Pieces.

When the Report of these Bones was first spread abroad, the common Opinion was, that they were the Bones of a Giant, which both I and other considerate Persons laughed at, and as soon as the Head appeared that Opinion vanished. But afterwards there were two other Opinions started, one of which was, that these Bones must be the Skeleton of an Elephant, very much decayed or corrupted with Time; and the other, that it was rather a Fossil Unicorn, as they call it, or a Mineral mimicking an animal Production. I imagine the former to be the most probable of the two. For by comparing this Skeleton with that of the Elephant given to the University of *Dublin* in *Ireland*, in the Year 1681, by *A. Moulins*, it appears that these two agree in every Circumstance. This, especially, is to be remarked, that, as *Moulins* says,

says, in the Cranium of the Elephant there are a great Number of Cells, for the most part triangular, lined with Membranes in which there is a curious Disposition of the Blood Vessels, which are very numerous; and that these Cells are composed of thin bony Plates. Now not only the Persons, who digged up this Cranium at *Tonna*, say, that they found it not only concave and perforated like an Ant's Hillock, but the same thing appears very plain from the Fragments of it, where those Cells made of bony Plates, and the greatest Part of them triangular, are very conspicuous, going sometimes obliquely, and sometimes directly cross the Skull. The Membranes, together with their dried Blood Vessels, we found glewed very firmly to the Cells tinged with a yellow reddish Colour, and happening to try them with a Knife, they fell off in Pieces, taking away with them that Colour, and thereby exposing the white Bones to view. Besides that Foramen, which *Moulins* observed in the Cranium for the Passage of the Medulla Oblongata, that singular Cavity for lodging the Brain appears likewise in ours; and the Length of the Cranium, which he measured from one Extremity to the other, to be twenty Inches and a Quarter, in ours is said to have been three Feet and a half, which being forty-two Inches, makes us conjecture, that this Elephant must at least have been twice as large as the one in *Ireland*, which will appear still more plain from what follows. Concerning the external Shape of the Skull of the Elephant, another *Englishman*, viz. *John Ray*, in his Synopsis of Quadrupeds, observes, that its posterior Part is divided into two very large Sinusses or Lobes, so as to resemble a Man's Hips; nor is there any Cavity to be observed jetting out for receiving the Cerebellum, as in many other Quadrupeds, but it rather resembles the Figure of the human Skull. And I call all those to witness, who saw the Head lying in the Sand, whether this Description of it is not exact. The longest Teeth or Horns, besides their Thickness and Length above-mentioned, at the same time discovered that natural Smoothness, yellowish Colour intermixed here and there with blackish Spots, Crookedness, and Striæ, which are common to the Teeth and Horns of no other Animals. Nay, what is extremely remarkable, there remains still the Print of the right Tooth, which appears evidently to have been filed, according as *Pliny* remarks, "that Elephants sharpen, and file their Horns upon Lib. 18.
" a Tree". Neither must I forget to mention, amongst others, who came in Shoals from all Quarters to view this Sight, a certain Merchant, who had lived many Years in *India*, and according to the Rules of the *Indians*, which he said he knew very well, he judged from the Teeth or Horns of this Elephant, that it must have lived upwards of two hundred Years. Upon this Subject *Aldrovandus* brings in the Testimony of *Aloysius Cedamastus*, who says he once saw an Elephant killed of a very moderate Size, the Length of whose Teeth exceeded three Palms or Spans; they stood up two Spans above the Gum, and the third sunk into the Gum, so as to be hid by it, like the Roots of other Teeth; and since the Age of these Animals is known by their Teeth, this must have been very young in Comparison of others, whose Teeth are so large as to supply the Place of Posts and Pales for Hedges, as *Pliny* says; and as the *Blacks* relate, in some Elephants, they grow to such a Length as to exceed

exceed twelve Spans. This last makes very much to our Purpose; for *Cadamustus* means the greater Palm, which we otherwise call a Span; twelve Palms then make eight Feet, which is the Length of the Teeth at *Tonna*. That which *Harduin*, the last Commentator on *Pliny*, mentions he saw at *Dieppe*, comes pretty nigh to this, being seven Feet long, and weighing upwards of a hundred Weight. Besides *Gellius* asserts, that they frequently grow to the Length of ten Feet. Nor is there any thing surprizing in the Weight of the Teeth at *Tonna* being upwards of a hundred Pounds, seeing there are found some that weigh a hundred and forty Pounds, such as a Friend of mine told me he saw in *Holland*; or one hundred and fifty, or two hundred Roman Weight of twelve Ounces, as *Erasmus* relates of *Franciscus*; or a hundred and sixty, such as *Terzagus* describes in the *Septalian Museum*. *Vertomannus* likewise saw two in *Sumatra*, which together weighed three hundred and thirty six Pounds. It is sufficient for me to mention the undoubted Testimony of a certain Ducal Minister, who lived some Years in *Sumatra*, and other Parts of *India*, and affirms, that he has seen Teeth six or eight Feet long, two Spans and a half broad, and weighing a hundred and twenty-five Pounds. I do not intend to meddle with that ancient Dispute, viz. whether they ought properly to be called Horns or Teeth; nor at the same time will I deny, that I like the Opinion of *Aldrovandus* and *Bochart* of their partaking of the Nature of both, as their Origin confirms, which was long ago observed by *Pausanias*, who says, that they descend from the Temples, and so make their Way downwards and outwards, as he remarked in the Skull of an Elephant in *Campania*. The Teeth at *Tonna* had the same Situation, and the Observation of *Moulins* and *Ray* is no Objection to this, they deriving these Teeth from the upper Jaw, and describing their internal Structure in this manner, viz. "That they are hollow within, and filled with a Kind of compact medullary Substance, with some Mixture of Glands". *Ray* too adds, from an Observation of *Lieurwenboeck*, "That they are composed of very slender Tubes joined to one another, which take their Origin at the inner Part or Cavity of the Tooth, and terminate in the Circumference". Besides we evidently observed these Tubes in every Part of the Teeth at *Tonna*, together with different Layers of a Cortex, as it were going round them, by which we saw the different Years of the Elephant, or perhaps greater Periods of Life, marked upon the Teeth. But, to tell the Truth, neither of them had a larger Cavity, than just to serve for their Insertion into the Head or Temple, or more properly the upper Jaw, nor does *Cardanus* nor *Aldrovandus* mention a larger in any of them. And although it is described, as being larger both in *Moulins* and *Ray*, yet they could only produce the Teeth of younger Elephants; for I imagine, that all those of the older Kind have the same Structure as the Teeth at *Tonna*, and the Cause of the Difference is this, viz. in the older Teeth the Tubes and Layers of the Cortex are not only increased outwardly, but more and more compressed and compacted inwardly, and at the same time the medullary glandular Part is gradually contracted, and at last obliterated.

I proceed next to the Grinders, of which there were four of a prodigious Size and Weight in the Head at *Tonna*, agreeing exactly with *Ray's* Description in the following Words: "The Mouth of the Elephant is provided with four Masses of Grinders in each Jaw; for there are several Teeth so firmly fixed into a solid hard Bone, as with it and with one another to make one continued bony Substance. These Teeth make eight or nine parallel Lines waved on the Surface of the Mass, and whiter than the rest of the Bone. Each Mass of Teeth is inserted by Gomphosis into the Jaw: But the foremost Tooth in the upper Jaw is fixed into the Jaw Bone with the Extremity of the other, and being produced forwards parallel with the Palate of the Mouth, it ends at last in a sharp Point, which is received into a Sinus made on Purpose for it in the Extremity of the Jaw".

"The Incisors are altogether wanting". And indeed they are wanting too in the Elephant at *Tonna*; but each of the Masses of Grinders is composed of a hard Bone shining like Glass, and a Nucleus, and on their Surface they have twelve parallel Lines disposed in a wavy Manner, whiter than the rest. On each Side there are sixteen of these Lines, and they are inserted into the Jaws by Gomphosis by the same Number of Cavities. Upon perforating these Teeth, we found them full of a hard reddish Substance, very like Medulla, with Vessels and Nerves petrified. Besides, in that Part which is prominent above the Jaw, there plainly appears a Smoothness for almost two Inches, such as *Moulin's* observed in the Teeth at *Dublin*. Nor needs the Number of eight Teeth in each Jaw in that in *Ireland* give us any Uneasiness, although *Gassendus* speaks of the same Number in another Elephant at *Peirescium*, which he felt by thrusting his Arm into its Mouth; for they are reckoned to be but four, not only by the Antients, as *Aristotle* and *Pliny*, but by the Moderns, as *Walter Schultze*, who lived a long Time in *India*, and in *Ray* too, who otherwise would not have said that there are four Teeth in each Jaw, but in the Jaw on each Side. The Cause of this Difference may be owing either to the Variety of Nature; for as she does not produce always the same Number of Teeth in other Animals, and even in Man himself, so likewise in Elephants; or in the Difference of the Age, so that the foremost Teeth having cut the Gum, while the Animal was young, and being plentifully supplied with Nourishment, they filled up the Place where the others ought to sprout out. It is certain, that the four Teeth at *Tonna* in the back Part have their Extremities and Processes manifestly crooked, from which it is plain, that they were placed at the Extremity of the Jaw. Their anterior Part too shews the same Thing, and those that were inserted into the upper Jaw are not only longer than those of the lower, according to *Moulin's* Observation, but they end in a sharp Point, as *Ray* has observed. Nay, they fill up almost the whole Space that *Moulin's* eight did; for he measured the Length of the foremost Tooth of the lower Jaw to be six Inches and a half, and that of the backmost to be three; but the Length of that whole Jaw was only one and twenty Inches and a Quarter, as that of the upper was only eighteen. The Diggers at *Tonna*, not observing this Difference in the Length of the Jaws sufficiently, called them both alike long, viz. three Feet, or six

and thirty Inches. They found the Jaw Teeth standing close by one another, and the Length of each of them they called a Span and a half; but upon inquiring more narrowly I found it to be different; for the upper Teeth, upon Account of their sharp Point, were almost fifteen Inches, and the lower ones only fourteen. The Length of the Jaws, which the same Workmen gave in, was three Feet and a half, or forty-two Inches, which being compared with the twenty-one Inches, which *Moulins* allows between the two *Ossa Jugalia*, we will find, that the Elephant at *Tonna* must have been twice as large as the one in *Ireland*. And this is confirmed by the Length of the Cranium from the one Extremity to the other, that in *Ireland* being only twenty Inches and a half, whereas that at *Tonna* was three Feet and a half.

There were likewise found the Vertebrae of the Neck, which (according to the Dimensions taken by the Diggers) were four Spans in Circumference, and two in Height. There are three of them still remaining, which correspond with one another, and the uppermost of them is pointed at Top. There was found too the Shoulder-bone, with the Acetabulum, and two large Heads or Globes, which are still remaining, together with the Bones of the Fore-feet, the Ulna, Radius, Carpus, and Metatarsus, some of which have such a large Cavity as you may thrust your whole Hand into it. They are all filled not with Sand, but with very small Particles of petrified Medulla, which, being put into the Mouth, do not occasion a Noise between the Teeth like Sand, but melt upon the Tongue, and discover their being changed by the earthy Taste which they leave in the Mouth. The Vertebrae of the Back were found too, with the Ribs standing out from them, but there was none of them left entire. I only saw two small Fragments of Ribs, one of which was eleven Inches thick, and the other more than seven. There was likewise found the Os Coxendicis of two Feet and a half in Length, together with the Acetabulum, and the Head of the Thigh-bone fixed into it. *Moulins* does not mention the Length of this Bone, but the Os Innominatum, he says, was twenty-five Inches; but the Os Coxendicis is only a third Part of the Os Innominatum, and the other two, viz. the Ilium and Pubis, the Diggers neglected to measure. There were found also the Thigh-bones, with those of the hind Legs, the Tibia, Fibula, Tarsus, and Metatarsus; and there is still remaining a Part of the Tibia, wanting the two Extremities, in its upper Part however two and twenty Inches thick, and above you may easily see that it must have increased to six more. In the lower Part of the Tibia it is seventeen Inches thick. Whence it appears, that the Circumference of this Bone, where it is largest, measures twice the Length of the one in *Ireland*, which *Moulins* says was nineteen Inches long; at its thickest Part more than fourteen Inches thick, and where it was smallest, seven Inches and a half. I must here observe, that the fore Legs of the Elephant are thicker and stronger than the hind ones, and this is explained by *Albertus* and *Aldrovandus*. Neither is the Tibia so capacious as to allow the Hand to be thrust into it, which you might do into some of the Bones, and the Ulna, without Doubt, as both the Diggers and others relate. Last of all, there still remain two Bones of the Tarsus contiguous to one another, lest any Body should question these Bones being there.

All these Bones are porous and full of Chinks, as they are in other Animals, and quite of a different Form from the Teeth, both the Grinders and the Tusks.

It may likewise be worth while to mention the Position of the whole Skeleton, as it was found under Ground. The Horns, or great Teeth, pointed towards the North-East; the left fore Foot lay extended by the Side of the Head, and the right one was inclined downwards under the Body; the left hind Leg was bended at the Acetabulum, and the right, which was first found, was distorted several Ways. All which plainly shew, that the Position was by no Means natural or common, but unusual and violent. In short the Diggers tell us, that the Bones lay all in their natural Order, but at the Articulations, some of them were a Hand-breadth, and others of them half a Hand-breadth (by a Hand-breadth here, I mean four Inches) distant from one another. Which must have been owing to the Fat, Ligaments, and Cartilages, &c. wasting away, and the Space, which they took up, being afterwards possessed by Sand, which by its Weight had separated the Joints more and more from one another.

I come now to examine another Hypothesis, viz. whether these belonged to a Fossil or Mineral Unicorn bred under Ground, or were rather the Bones of a putrified Animal? No Body, who knows any Thing of natural Philosophy, will deny, that there are Fossil or Mineral Substances found, resembling very large Skulls, Teeth, and Bones; and how Nature produces such large Skulls, and other Parts resembling those of the human (and I may add of the animal) Body, as the Thigh-bones, the Tibiæ, Ribs and Teeth, Kircher, I think, has explained most clearly and rationally of any. He says, "*That* Mund. subter. lib. 8. c. 4.
 " *in the Bowels of the Earth within the Chaps of rocky Mountains, there is a*
 " *Kind of slimy Earth, which with Agricola I have before called Marl, mixed*
 " *with a Sort of Parget, which Earth, meeting with a nitrous Solution in the*
 " *Chinks of the Mountains, is covered over as it were with a Shell of Parget,*
 " *which as it petrifies with Time, so likewise by the Lustre of the Nitre it resem-*
 " *bles very much a Bone in Whiteness, being both white, porous, and brittle. If*
 " *then it meets with a round Cavity in the Earth, it produces a round Ball,*
 " *which, being broke very much, resembles a Skull, or if the Mould, in which it*
 " *is cast, has the Form of a human Thigh-bone (or that of another Animal) or*
 " *of a Rib, or any other Bone, the Marl, that is contained in it, having the*
 " *nitrous Liquor added to it, will resemble the human Os Femoris, &c. which*
 " *will be lesser, larger, very great, and almost gigantic, according to the Size of*
 " *the Mould it happens to be cast in. And these are the Bones which Nature pro-*
 " *duces, and which are sometimes called the Bones of Giants by the Vulgar; but*
 " *if you break them, there is no medullary Substance to be found in them, which*
 " *ought to be the Case, were they the Bones either of Men or other Animals.*"

These Observations Kircher confirms from his own certain Experience, having seen in the Sides of the Cave at Palermo Teeth of all Sizes, small, middling, great, nay, monstrous large, having the same Appearance with those of Animals, and in such great Abundance, that he believes you might easily load a hundred Carts from thence. In other Parts there stuck out Vertebrae, Knee-pans, Parts of Tibiæ and Skulls, but in no Kind of Order; nor a-

6 Agro So-
lonio.

mongst them all could he find any organized like the Head, Hands, or Feet; whence he plainly confesses, that he first was informed of the wonderful Contrivance of Nature in forming of Bones, or stony Substances very much resembling Bones, from the Marquess *Ventimiglia*, who accompanied him in that Search, and informed him of two Circumstances which are very much to our Purpose; one was that in * *Solon's Field* near the Sea, between *Trapani* and *Palermo*, there are still dug up by the Peasants the real Bones of Elephants, which in past Ages were brought from *Africk* to *Sicily* in the Wars between those two Countries, and being killed there, were buried, and the Bones being afterwards discovered, are bragg'd of sometimes by ignorant People, as those of Giants. The other is, the Difference between the true Bones, and those Mineral Substances, which resemble them, *viz.* that the first retain always the Cavities of the *Tibiæ*, and the other Bones wherein the Marrow was contained; whilst the others are all solid, without any such Cavities. But the Bones at *Tonna* are so far from wanting the Cavities for the Marrow, or from lying without any Order, or having nothing of organized Bones in their Structure, that all these Marks of *Kircher* are evidently plain in them, and obvious to the Eyes of every Body that sees them.

For whatever Bones are hollow and filled with Marrow in the Elephant, they are the same in our Skeleton. Neither ought we to trouble ourselves about the Solidity of the Tusks, as far as to that Part where they are inserted into the Jaw, seeing that is the Case in the largest Elephants. Besides, they were all found lying in a natural Order, even though the Posture of the Animal must have been violent, and not common. In short, the Bones which *Kircher* calls organized, and which he sought for in vain amongst the Mineral Bones in the Cave at *Palermo*, appeared evidently in our Skeleton, even to the very least of them.

The Skull was curiously marked with Holes for transmitting the Nerves and Blood-vessels, nor was the Cavity for the Brain wanting, and the *Medulla Oblongata* as it goes out of the Skull. The Tusks still retain their natural Colour, Smoothness, *Striæ*, Tubes, and Interstices or cortical Layers, nay, the right one appears filed by the Animal while alive. And the Grinders agreeing exactly with *Kircher's* Description, are inserted by *Gomphosis* into Cavities or Sinuses of the Jaw, which are still full of a reddish, petrified *Medulla*. The *Vertebræ* of the Neck, which are pointed above, and the Bones of the *Tarsus*, agree exactly with one another. The large Heads of the Thigh-bones were joined with the *Acetabula*, and the Ribs with the Back-bones. But I shall not repeat any more of what I have said before, seeing any Body, who considers these Things, will easily be persuaded, that Nature in a Frolick, and left to herself, could never form an intire organic Body, whose Parts should all correspond to that of a compleat Animal. But if any will be obstinate, and assert, that there are some Fossil Unicorns, as they are commonly called, and Mineral Bodies having Cavities like Bones, I will answer him from *Kircher's* Principle, which is founded upon Experience, that these Fossils of his are not of the Mineral, but of the Animal Kind, leaving it to him to prove the contrary. For it is an unanswerable Argument, which *Conringius* proposes in his
Conjectures

Conjectures concerning the antient State of *Helmstat*, p. 13. "But that Nature is able of herself, without any Assistance, to make Bones quite perfect, such as are formed in the Fœtus, and afterwards compleated by long Nutrition in the Adult, is absolutely impossible. Neither can you attribute the making of so many Bones fit for a living Animal, and every Way perfect, only to a wanton Frolick of Nature, without the greatest Absurdity."

There is still another Argument of no less Weight, which *Kircher* furnishes with in the same Place, where he says, that according to the Difference of the Cavity, or the Disposition of the Matrix in the Bowels of the Earth, the Marl produces different Resemblances of Bones. Allowing then in the Sands at *Tonna* a Marl and a Fluid, or a petrifying Water, which *Kircher* calls a nitrous Solvent *, to meet with one another; yet can any Body ever imagine, that the Cavity or Matrix there was formerly so disposed, as to represent the Skeleton of an Elephant in the extraordinary Posture above described, which was filled afterwards accidentally with the melted Marl, and in Process of Time increased to such a Bulk? To be sure the Nature is the same, the Matter the same; the Heat, the Humour, and the Nourishment from the Earth must all be the same; and the Manner of generating the whole is the same, and yet the Bones produced are very different from one another, according to the Difference of the real Bones of the Elephant. For Example, the Bones of the Head have a great many Cells; the Grinders are hard as Glass, and shining with a great many wavy Striæ; the Horns or Tusks are smooth, yellow, filed at the Point, and marked with Layers of Tubes and cortical Substances, and the rest of the Bones are porous, and evidently formed according to the Rules and Manner of an organic Body. Now who, I pray, after considering all those Circumstances can ever allow himself to think, that these are Mineral Productions? Is not the Opinion of *Anselmus Boetius de Boodt*, chief Physician to the Emperor *Rudolphus* the Second, more probable, Lib. 2. Cap. 242. ? who, after he had said, "That the Marl, moistened or dissolved by a subterraneous petrifying Water, flows like Milk through the Cavities of the Earth, and the thinner Parts being drained off, the thicker Part filling up the Cavities stops there, and all the Water being carried off, it concretes into the Form of Stones and Horns, which is the common Opinion both of *Kircher* and others: He adds, "but if this milky Liquor does not fall into a Cavity, but lights upon Wood dried with Age, and penetrates its light porous Substance, and the finer Parts of it exhaling the grosser are left behind, at last, being con- creted, it will change the Wood, and assimilate it to its own Nature, but in such a Manner, however, as, that you can still distinguish its Species, and sometimes even the Smell of the Wood remains. What happens in this Manner to Wood, may likewise happen to Harts Horns, Elephants Teeth, and other Parts of Quadrupeds, if they fall into such Places. Hence it is, that these Fossil Horns differ much from one another, and few of them have the same Appearance, some resembling Teeth, others the Shank Bones, and others Jaw Bones, or other Parts of the Body." *Olaus Wormius* in his *Museum*, Page 54, thinks, that this Opinion approaches very near to Truth. What should hinder us then from acquiescing in the Determination of those learned Physi- cians,

* Fluor ni- trofus.

cians, and expressing in their Words the Manner in which the Bones at *Tonna* were petrified, especially as they evidently own, that not only the Teeth of Elephants, but likewise other Parts of Quadrupeds (and why not of the greatest of them) may be changed in this Manner.

Grant then that any how, and at any Time (which we shall explain afterwards) there was an Elephant left upon the Sand Hill at *Tonna*, whose Bones, dried by Length of Time, a subterraneous Fire had calcined, and being then smooth and porous, that milky Liquor of *Marl* had entered them, and the Water being exhaled, the thicker Portion of it remained (the Particles of which in porous Bones may very easily be discerned from the bony Substance, upon Account of its Whiteness) and at last coagulated, to have changed the whole Skeleton of the Elephant into a stony Nature, but in such a Manner as both the external and internal Figure of the Bones, and perhaps even the Smell of them should still remain. I have spoken doubtfully of the Smell, because I have not yet examined that. But if *Boetius* means that Smell, which Wood and petrified Bones send forth when burnt, this I can assert from the latest Examination I have made upon these Bones, that upon holding them near the Nose, they have the very same Flavour, which Bones and Horns that are burnt usually have. *Bartholine* gives some Examples of Ivory, or the Fossil Elephant's Teeth, in his last Chapter upon the Unicorn, but he leaves it undetermined, whether they were Teeth hardened into Stone by lying long under Ground, or whether they were originally Stones formed by Nature accidentally in the Shape of Teeth. He owns, however, that each of them has its Foundation, if you will not grant either of them; adding, that the Examples and Causes of Petrification are not to be despised. He expresses himself in the same doubtful Manner about the Grinder of an Elephant, and a Tooth of the Rosemary-Tree turned into Stone or Flint. However, Dr. *Arngrimus* of *Iceland*, is entirely of our Opinion, which he illustrates with another Tooth of the Rosemary-Tree. *Antonius de Pazzis*, chief Physician to the Emperor, favours the same Opinion still more avowedly in his Epistle to *Lambecius*, which this Author has added to the sixth Volume of the Commentaries upon the Emperor's Library, p. 315, 316, together with a Figure of the Grinder of an Elephant. For he has not only that Tooth, but the Bones of the Thigh and Leg found at *Baden*, for the true Bones of an Elephant petrified; accounting for it in this Manner, that if they put on a stony Nature, this happens from the Earth in which they were buried, which insensibly, by its concentrating Principle, extracts and hardens the Seeds of Petrification. I find there are more petrified Elephants of the same Kind in the *Roman* Collections from an Observation of the famous *Ciampini*, which I met with in the *Ephemerides Naturæ Curiosorum*, for the Year 1668. p. 446.

He mentions Bones that were dug up of a surprizing Bigness, viz. the Thigh-bone, Scapula, and five of the Vertebrae, amongst which was that of the Neck, which together weighed more than one hundred and eighty *Roman* Pounds, by most People taken for the Bones of Giants, and compared with others of the same Kind in the Town Repositories, especially at *Chisiano*, they were the largest of all. But a Doubt having been started, whe-

Ac. Med.
Hafn. Tom.
I. p. 38, 84.
Tom. IV.
p. 182.

ther they were really the Bones of a Giant, or rather those of an Elephant, there were Letters sent to a learned Friend at *Florence*, desiring him to send a Specimen of the Skeleton of the Elephant in the famous *Museum* of the Physicians there; which accordingly was done, and being compared with these Bones, it was unanimously agreed, that those which were lately found, as well as those which were preserved in the Repositories, were the Bones of an Elephant, and we found likewise, that those mentioned by *Pliny* most certainly belonged to an Elephant. *Cianpinus* adds, that there were collected besides various other petrified Bones and Fossil Teeth.

I will not deny, my good Friend *Megliabeek*, that upon recalling these Things to my Mind, when I was thinking upon the Bones at *Tonna*, I first took a Resolution of explaining the whole Affair to you, being in good Hopes, that, the aforementioned Dispute being happily decided by Means of the Skeleton at *Florence*, ours might be so too. But you may be very sure, that the Elephant's Skeleton at *Tonna* has lost the greatest Part of its former bony Nature by the subterranean Calcination, analogous to the Chymical one, and is therefore brittle like other calcined Bones, and of a very astringent Quality. And indeed, if there is an astringent Quality in native Ivory, which however is not observable to the Taste, as *Aldrovandus* has remarked, why will not that rather discover itself, and adhere to the Tongue in Ivory, that by lying so many Years under Ground is calcined, and in a great Measure petrified. Neither are the Bones of Animals converted so much into Stone, as that there remain no intrinsic Marks of Bone about them, which may be extorted by the Help of Fire in a Chymical Examination. These Things, being doubted, put us upon examining the Bones in that Way; and we found not only the Pieces of Bones, which were thrown into an earthen Retort, remaining of the Colour and Figure of *Spodium*, and having evidently the Smell of a burnt Bone or Horn, but Phlegm too in the Glass Receiver, which discovered Sal Volatile by the Taste, and an Oil by the Fat swimming at Top. Afterwards being calcined in a Potter's Furnace, and becoming very white, they evidently shewed the small Tubes and Striæ of the Elephant's Teeth. Then being decanted and inspissated, to use the Words of the Chemists, the Sediment or Lixive contained a chrystalline Salt, and the Phlegm was a great deal sharper to the Tongue, the saline Speculæ swimming in it very beautiful to the Sight. All which are daily extracted from the Bones and Horns of Animals, but none of them from *Stones*, *Marl*, or *Osteocolla*, because you cannot calcine Mund. sub Lib. X. cap. *Stones*, but they degenerate into *Lime*, the Cause of which *Kircher* attributes to the small Quantity of Moisture in them, whereby the spirituous Parts of the *Stones*, from the Oiliness of the Sulphur, resolve the fixed Parts into a *Calx*. Who then will scruple any longer to assent to my Opinion, and to own, that the Bones at *Tonna* are the real Bones of an Elephant, but calcined by subterraneous Heat, and in a great Measure petrified, which the Smell of earthy Sulphur, both in the Phlegm and Residuum, sufficiently evinces? And this is the Reason, why neither a volatile Salt nor Oil could be expected in such a Quantity as from recent Bones; and the more so, as even in these, according to the Observations of that *English* Physician, *Clapton Havers*, in his *Osteology* lately published, the volatile Salt scarce makes up a thirtieth Part,

and the Oil little more than a twenty-fourth Part of the Bones. But who will deny, that such a small Quantity as that must be almost entirely absorpt in the petrified Bones, so as scarce to leave the least Portion behind ?

But there is another Doubt started by some, which I have still to remove, *viz.* whether ever there was an Elephant in Nature, whose Bones answered to the Bigness of these. These Gentlemen I would advise by all Means to be quiet, and only read the Journals of *India* or *Afric*, where they will meet with Elephants, not only as large, but a great deal larger than ours. Indeed the one in *Ireland*, which ours has been frequently measured by, was scarce larger than that at *Antwerp*, which *Goropius Becanus* measured very accurately in Presence of *Aldrovandus*, and found its Height to be eight Feet. But in the Skeleton in *Ireland* the Length of the Os Innominatum is twenty-five Inches, of the Thigh-Bone twenty-eight, and of the Tibia nineteen, which all together make seventy-two Inches, or six Feet. To these I add two Feet to fill up that Space, which the Feet themselves, the Curvature of the Back, the Cartilages, Flesh and Skin require; and thence I discover, as I said before, the Height of the Elephant in *Ireland* to be eight Feet. But as we find, that the Bones at *Tonna*, by comparing them as above, are, at least, twice as large as the others; hence we find, that this Elephant must have been about sixteen Feet high. And this is so far from being an uncommon Height in these Creatures, that *Scaliger* in his *Exercitatio*, p. 204, has expressly mentioned the same Measure, relating from the Writers of Voyages to the *Indies*, that there are Elephants there above sixteen Feet high. But there are Elephants still larger. *Johannes Jacobus Saar* mentions in his Journal a certain Kind of Measure, called *Gobdel*, equal to three Quarters of an Ell (that of *Norimberg* I imagine, the Author being of that Country) and in the Island of *Ceylon*, those Elephants which are seven, eight, nine, ten, or eleven *Gobdels* high, are valued at three or four hundred imperial Crowns, but larger than these he never saw. But the *Norimberg* Ell is about four Inches longer than two of those Feet which I have hitherto measured by; whence it follows, that the Measure *Gobdel* is about one and twenty Inches, and therefore the largest Elephant seen by *Saar* was more than nineteen Feet high. *Philippus Pigafetto*, in his Description of the Kingdom of *Congo* in *Africa*, affirms, that the Prints of the Feet of the largest Elephants there are four Spans in Diameter, that is, upwards of two Feet eight Inches. In the Elephant at *Antwerp*, the Diameter of the Soal of the Feet was one Foot and two Inches, or thereabouts. And comparing these Diameters of the Feet with the Height of the Body, we shall find, that the largest Elephants in *Afric* are upwards of eighteen Feet. From what has been said it likewise appears, that the Elephants in *India* are larger than those in *Africa*, which *Aldrovandus* and *Bochart* prove from ancient Writers. Nor do I doubt, but that Elephant's Rib was brought from *India*, which is shewn in the Anatomical Theatre of the University of *Leyden*, and according to its outer Curvature measures eight Feet, and where it is thickest towards its Conjunction with the Sternum, its Diameter is a Foot and about three Inches, as described by *Theodore Rickius* in his Oration *de Gigantibus*; whereas the longest Rib of that in *Ireland* was scarce thirty-two
Inches

Inches long. And as eight Feet contain ninety-six Inches, it follows, that that Elephant, whose Rib is preserved at *Leyden*, must have been twenty-four Feet high; and the Elephants of *Cosrois*, King of *Persia*, mentioned by an anonymous *Arabian* in *Bochart*, were at least of that Height. Some of them, says he, were twelve Cubits high, which is very rare, for the most Part of them do not exceed seven. If the Cubit here is taken in the common Sense, it is scarce equal to two Feet, or twenty-four Inches, and by this Means those Elephants were of the same Height with that at *Leyden*. But I imagine, that *Cosrois* measured his Elephants by the old *Persian* Cubit, explained by *Goltius* in his Notes upon *Alferganus*, p. 74, 75. from an * *Arabian* Writer of *Geda*,
* Arabi
Geodatic.
 each of which contained seven and twenty Inches. But, according to this Computation, each of those Elephants must have been seven and twenty Feet high. O stupendous Height, and worthy of the Stable of a King! Which, whoever considers, will not wonder so much at the Size of the one at *Touna*, which is more than one half less than those of *Cosrois*.

But from whence could this Elephant, larger at least than usual, come into this Country, and to this Sand-Hill? This Question of the learned *Magiacbeck* has occasioned a great many Conjectures amongst the Curious, some of whom have alledged, that it was brought into this Country, and there buried by the *Roman* Merchants; others by *Atila*, others by *Charles the Great*, others by the *Counts of Glichen*, and others will have it, that it was brought there only the last Century. But, besides that each of these Opinions labours under Difficulties which I now forbear mentioning, they may all be confuted together by various Arguments. Such as, that the Use of Ivory, which is very ancient, will not allow us to believe, that upon burying the Elephant there they should neglect to take away the Teeth, which were very large and fine; nor could an Animal of that Size be easily transported from *India*, or *Africa*, in former Times, or even in latter Days; and it has been observed by others, that not the old ones, but the young ones are brought over into *Europe*; far less would any Body be at the Pains to dig a Pit of twenty-four Feet deep to bury a dead Elephant in. But the strongest Objection of all is the Construction of the Sand-Hill, which, being carefully examined, evidently discovers, that it had never been digged into, and afterwards filled up again. The first Layer of Earth is a black Mould four Feet deep; and this is succeeded by a sandy Gravel of two Feet and a half, the Middle of which is filled up by a Kind of Chalk-Stones, and † a binding Earth. Next fol-
 low six Feet of a sandy, white Clay, with two Inches of binding Earth again, and below that it is a Foot deep. After this comes a Layer of Gravel about six Feet thick, and last of all, a pure, white Sand, the Thickness of which is not yet discovered, because in it the Skeleton of the Elephant appeared, before they had dug quite three Feet into it. Now had this Hill been dug into, and filled up again after the Elephant was thrown into it, these different Layers of Earth, Clay, Gravel, &c. would not have been found in such a regular Order, but they would have found them all mixed with a black Earth, as we see every Day in digging of Graves. Far less could the Chalk-Stones grow to such a Hardness, or the binding Earth spread its Roots
 † *Osteocolla*

and Veins through the whole Hill, even to the very Surface, or grow in such a Quantity, as to extend two Feet in the Middle of the first Gravel, which lay immediately below the black Earth, and under that again half a Foot, and then getting lower into the sandy, white Clay, take up two Inches there, and below that again the Space of a Foot. There only remains then for us to judge, that this Elephant, at the universal Deluge, in which it perished with other Animals, both of its own and of different Species, being tossed here and there in the vast Abyss of Waters, at last, when they began to decrease, fell to the Bottom, and the Waters laid over these different Strata of Sand upon it, and these, being dried at Top, were, at last, covered with a black Earth. For as the different *Strata* of Sand prove, that the Hill at *Tonna* derived its Origin from the Flood, so the Depth of the black Earth confirms it; both which I shall explain in a few Words.

The first I shall do from some Observations of *Nicolaus Steno*, a celebrated Physician with you, in a Dissertation upon the Dissection of the Head of a Dog-Shark, added to his Specimen of Myology, all which, however, I cannot run through in an Epistle. He talks indeed chiefly of the Parts of those Animals that live in Water, such as Oyster-Shells, and the like, dug out of the Earth. But the same Thing may be said of the Parts of Land Animals dug up in the same Manner. For what *Steno* says of the Earth, out of which these Things are dug, may evidently be applied to the Hill at *Tonna*, seeing it is harder in some Places containing Chalk, and a cementing Earth, and softer in others, filled with Gravel and Sand, laid over one another in *Strata* running obliquely with Regard to the Horizon. But *Steno* argues very well upon this Subject: “ *That, says he, regards the softening Quality of the Earth,*
“ *as these Bodies are the softer (here I understand the Bones of our Elephant) and*
“ *less able to bear the Touch, the deeper they are buried; and hence the Earth is*
“ *so far from producing them, that it must rather destroy them. Nor let any one*
“ *believe, that they are soft upon Account of their not being yet perfect; for those*
“ *Bodies, which are soft while they are first generated, have their Parts united*
“ *together with a certain Glue, as it were (as you may see in the recent Barks of*
“ *Pines and Almonds) but these Bodies, being robbed of that Glue or Cement, fall*
“ *down into a Powder, and therefore that Softness is an Argument of their*
“ *being destroyed, not of their being produced*”. What follows in *Steno* about that Earth not being compact, when these Bodies were produced, and that it was not only covered with Water, but even intimately mixed with it; nay, that it ought to be reckoned a Sediment of the Water heaped up gradually, can by no Means be applied to the Hill at *Tonna*. I shall only take the Liberty of quoting some Things from Pages 211, 212, viz. “ *That white Clay*
“ *and Sand may be mixed with Water violently agitated, Torrents tumbling down*
“ *upon Earth of that Kind, and the Agitation of Waters from the Winds, make*
“ *it so evident, that it would be quite needless to insist longer upon it. Nor is*
“ *it a hard Matter to prove, that in stagnating Waters, even the clearest of them*
“ *all, there are Sand, Clay, and Chalk-Stones, nay all Kinds of solid Bodies fre-*
“ *quently found concealed*”. Who then will longer doubt, that the Sand-Hill at *Tonna* was produced from a Sediment of the Flood? *Jacobus Grandius*, a *Venetian*

netian Physician, produces more Arguments for this Hypothesis from the Bowels of the Earth, in his Epistle concerning the Truth of the universal Deluge, and the Generation of Shells found far from the Sea, of which I shall only pick out the three first. “ I. In many of the highest Mountains, not only “ of Europe and Asia, but likewise of Africa and America, there remain still “ certain Marks of the Sea, which depositing Sediments there has produced Strata “ uniform, and parallel to the Horizon, which no Reason can persuade us could “ have happened, except at the Time of the universal Deluge. II. The same “ Opinion is proved by very long Tracts of Land covered with various Sand- “ Hills, produced from the Sediment of the turbid Element that watered them at “ that Time, and having a great Resemblance with the Bottom of the Sea. “ III. The great Gaps of Mountains, made by the Corrosion of Rivers and Tor- “ rents, shew different solid Bodies produced from the surrounding Waters, con- “ taining and petrifying variously various Bodies; as also various Sediments placed “ hard by one another, abounding with true Shells and other Productions of “ the Sea”.

But concerning that black Mould, which grew over the Earth after the Flood, *Rudbeckius*, a Swedish Physician, has observed a great many Things peculiar, in the first Volume of the *Atlantica*, Chap. VI. which, being approved likewise by other learned Men, need not here be transcribed. But if they were to be applied to our Sand-Hill, you must know first, that in those Mountains in the Forest of *Duringen*, which contain Metals, and are composed of the hardest Rock, I found that black Mould about two Feet thick, much thinner, however, as you descended. But in other Places it was equal to four Feet or more, viz. in the Vallies which first received it, washed down by the Rains from the Mountains. Which, as it answers *Rudbeck's* Desire, who wanted to know the Depth of the black Mould in the warmer Parts of *Sweden*, that are plentifully supplied with Rains, so it likewise shews that Mould to have been derived to the Hill at *Tonna* to the Depth of four Feet after the Flood, and thereby proves, that the Elephant could not have been buried there since. But what should hinder us from joining to these foreign Physicians *Herman Conringius*, a German, who, in his Conjectures concerning the ancient State of *Helmstat*, and the Country adjoining, wanting to prove, that this Country was likewise overflowed by the Flood, insists chiefly upon three Arguments, which are founded upon the *Sea-Shells*, the *Bones of Beasts*, and *Trees*, or *Parts of Trees*, which are found both upon the Tops of the highest Mountains, and in the deepest Caverns of the Earth. Amongst the rest he mentions Stakes for Hedges found ready prepared, and the Horns of *Buffaloes* found in the deepest Caves amongst the Rocks of *Thuringen*, of which that of *Salze*, which is scarce a German Mile distant from *Tonna*, in the Mountain *Seebergen*, near to *Saxe-Gotha* (where the most beautiful Shell-Fish are likewise dug up) *Albinus* mentions to have been still remaining, in his Chronicle of the Mountains of *Meissen*, Tit. 22. n. 7. to which may be added, perhaps not undeservedly, the Leaves of Trees, Bundles of Wood, and Ears of Corn hanging to the Stalk, all which are found petrified in the Stone Quarry at *Tonna*, not far from the Hill where the Elephant was found.

There is a very singular Observation of *Conringius* expressed in these Words pag. 37. “ *Besides, these Trees are almost all situated alike, viz. with their* “ *Roots inclining North-West, and their Tops South-East, the Cause of which* “ *you cannot, with any Probability, attribute to a Frolick of Nature. But it is* “ *most likely, that these Trees were blown down by the North-West Wind, and* “ *covered over with a marshy Earth from the Northern Ocean: Especially as from* “ *that Quarter, and by that Wind, when it blows high, the whole Sea-Coast of* “ *Germany, even at this Day, is frequently threatened with Inundation*”. And here arises a new Argument to support my Opinion, since the Horns of this Elephant were pointed towards the North-East, and though this Position seems a little different from that mentioned by *Conringius*, yet it is to be considered that a Beast taken up by the Sea may move itself variously, whereas Trees remain in the same Position in which they were first left. And it is no Wonder that the Elephant, being tossed by the huge Billows should at last acquire an extraordinary and violent Position, and that the Bones after the Flesh was decayed should lie at a Distance from one another. And perhaps the Teeth or Horns were found to be bended inwards from this very Cause, although the Position of them is almost the same in the Head of the Elephant in *Ireland* as delineated by *Mowlins*, which doubtless would have been more accurately expressed if the greatest Part of them had not been consumed, so that that was more owing to the Putrefaction or Decay of the Parts than to the fatal Waves.

*Mineral
Maps, by Dr.
M. Lister.
p. 164. p. 739.*

XXXVIII. We shall then be better able to judge of the Make of the Earth, and of many *Phænomena* belonging thereto, when we have well and duly examined it, as far as human Art can possibly reach, beginning from the Outside downwards. For this Purpose it was adviseable, that a Soil or Mineral Map, as I may call it, were devised. It might be distinguished into Countries, with the Rivers and some of the noted Towns put in. The Soil might either be coloured, or otherwise distinguished by Variety of Lines or Etchings; but the great Care must be, very exactly to note upon the Map where such and such Soils are bounded. As for Example, in *Yorkshire*, 1. The *Woods*; *Chalk*, *Flint* and *Pyrites*, &c. 2. *Blackmoor*, *Moors*, *Sand-Stone*, &c. 3. *Holderness*; *Boggy*, *Turf*, *Clay*, *Sand*, &c. 4. *Western Mountains*; *Moors*, *Sand-Stone*, *Coal*, *Iron-Stone*, *Lead-Ore*, *Sand*, *Clay*, &c. *Nottinghamshire*; mostly *Gravel*, *Pebbles*, *Clay*, *Sand-Stone*, *Hall-Plaster*, or *Gypsum*, &c. Now if it were noted how far this extended, and the Limits of each Soil appeared upon a Map, something more might be comprehended from the Whole, and from every Part, than I can possibly foresee; which would make such a Labour very well worth the Pains. For I am of the Opinion, such upper Soils, if natural, infallibly produce such under Minerals, and for the most Part in such Order.

*Schemes of
Sands, &c.
Clays; By
Dr. Lister,
p. 164. p. 740.*

XXXIX. I have some Reason to think that Sand was once the most exterior and general Cover of the Surface of the whole Earth; because all our *Northern Mountains* are more or less covered with it at this Day, and the higher

higher the Mountains, still the more, and the coarser the Sand: because the Rivers arising in the Mountains do yet daily bring it down in great Quantities. And that it has been so in all Probability, in all Ages, since the first Rains fell upon the Face of the Earth, seems to me to be Truth-like, in that the Sea-Shores, or Mouths of Rivers, are usually barred with it; besides the Sandy Sea-Grounds in most Places of the Sea, and which seems a clear Evidence for the Length of Time (for that the low Ground near these Rivers, which have been in all Ages upon Record, *Mosses*) if you pierce so deep into them, as to discover their Bottom, you meet with this Mountain Sand in great Quantities, and in some Places a Moss under that, and the same Sand-Bed under that. Now if we consider how long these Mosses or Turf is in growing, it being mostly the Leaves and Roots of Plants, we must allow very many Ages for this Purpose. And altho' *Herodotus*, one of the most ancient Historians that are, boldly conjectures that the Nile in *Ægypt*, long before our Times, would be dammed up and useless by the great Plenty of Mud yearly brought down that vast River; yet it does not appear, that the Country is much different from what it was in his Time: so that the Sand and Mud is still carried to Sea.

Another Argument of the Sand's being the universal Cover of the Face of the Earth, is, from the great Hardness, and consequently the Durableness and unalterable Quality of this Mineral, above any other in Nature. For tho' many Things are called Sand, from the Smallness and little Cohesion, or Dryness of the Grains, yet this Kind of Mountain-Sand, above all others, keeps its natural and original Magnitude; and is not made (as most Sand is) by the Attrition or Wearing of one Particle of Stone against another, but is of a constant and durable Figure: and therefore, I say, it seems to me, for this Reason, to be the most fit for an Outside or Cover to the Globe of the Earth.

It may be objected, that the uppermost Beds of Stone, on the *high Wools* all over *England*, are soft *Chalk*, and on the smooth Surface no Appearance of Sand. This indeed is in Part granted: but that there is no where any Sand upon the *Chalk Mountains*, is not true; for to instance in those inland *Sand-Hills*, above *Bulloigne* in *Picardy*, which Sand is the very same with that on the Sea-shore at *Calais*, and although this is not in *England*, yet the Sea hath but accidentally divided us. For from *Dunstable* in *England*, even as far as the Walls of *Paris* by *Calais*, is, as it were, a continued *Woold* of *Chalk* and *Flint*. What Difference there is betwixt the *Woold's Mountain-Sand*, and that of the *Northern Mountains*, will best appear in the Table. Now the Nakedness of the *Woods* is from the Smallness of its Sand, which readily yielded not only to the Rain that fell, but to the Wind also. Which is evident from that vast Tract of *Sandy Hills*, which bound the Coast of *France*, *Flanders* and *Holland*, and which have made their Coast so shallow in Respect of ours, as being in great Part blown off the *Yorkshire*, *Lincolnshire*, *Suffolk*, or *Essex* and *Kentish Woods*, and wrapt up upon their Coasts: and the Reason of this is partly from the more constant *Westerly Winds* blowing over from
our

our Coasts; and also from the Meeting of the two Tides, viz. That of the *Channel*, and that other of *North Flood* upon their Coasts.

I am very well aware, that the finding of *Cockle* or *Shells*, as most Writers are pleased to call them, upon Mountains, and Sand also there, is by the same *Herodotus* used as an Argument of a great *Deluge*, or *Inundation* of Waters; but, as I have elsewhere, I think, demonstrated, that the *Rock Cochlites* are no Shells, so neither can I grant that the *Sand* was adventitious to the Mountains, but naturally originated there: for that it is there plainly to be found, some loose, and the rest in Beds, yet unloosened, as I could name very many Places; for Instance, on *Silden* and *Thorp Fells* in *Craven*, this Mountain-Sand is a white and transparent Pebble, and as some of it is small, and easily swept and blown away, so is there much of it upon the high Mountains mixt with white Pebbles of greater Size.

'Tis the Character of this Sand not to yield to Fire, as *Flint* will do; and tho' it agree with that and some other Metals to strike Fire from *Steel*, yet it does not calcine, as *Flint* will be brought to do. And therefore this Sand is the true *Tarso* of the *Italian* Mountains, of which the fine *Venetian Glass* is made; and for this Reason the *Flint Glasses* were here in *England* ill compounded, the Foreigners mistaking the Materials, which yet our Country affords in Plenty all over the Northern, and (I doubt not) the Western Mountains too: I have seen from the *Scots* Mountains very excellent and large.

A T A B L E

TABLE of Sand (drawn up about the Year 1673.) Such chiefly as I have found in the Northern Parts of England.

{ Sharp, or Rag Sand, composed of small transparent Pebbles, naturally found upon the Mountains, not calcinable.

Sand	Fine	White	Stitneham-Moor in the Road washed up very White Pebble. Flamborough-Head, of which the Light-House there is cemented. Calais Sand burns reddish, but falls not in Water.
		Grey	Seaton Banks near Hartlepool, on the Tee's Mouth. Escrick in the Gravel-Pit there; a Vein of exceeding fine Sand.
			Reddish
	Coarse	Brown	In a Spring at Hestington. The Sand at the Bath in Somersetshire.
		Griestly	Acome near York, drifted Sand. Hutton Moor Washt. Thorp Fells. Ooze at York. Nid at Mountain. Dug up at Rawcliff near Snath. Wharfe at Ickly and Denton. Air at Carleton in Craven. Eure at Craven. Gauton. Santon in Lincolnshire. Bromeby Common. Skipwith Common.

Soft, or Smooth with flat Particles {
 { At — in Yorkshire.
 { A Vein at Oswell-
 { From Lime- (Bacon in Lincolnshire,
 { stone with Mica of Glittering Par-
 { ticles.

Of Westmorland. { Silver-like { Sea Sand about the Scilly Islands.
 { Gold-like { In Cleveland, and about Scarborough.
 { { Ouze Dust or Sediment at Rawcliff.
 { { A Vein of Mica in Heslington Gravel-Pit.
 { { Mica Argentea in Red-Sand Rock, near Rippon,
 { { plentifully.
 { { Mica Aurea of Cleveland.

Clay seems to be another Coat of the Terrestrial Globe in the more depressed and hollow Parts thereof. The Mixture of Sand and Clay is not unusually called Earth: Yet, this Term being too large, it will be convenient, as I think, to limit it to such a Mixture as we usually find upon the Surface of the Ground; which hath ever in it, besides such Sands and Clays, as either the Soil naturally produces, or have by Floods and Winds, or other Accidents, been brought thither, a great Part of the rotten Parts of Plants and Animals: and in this Sense, Turf is Earth, which is mostly where the *Erica* or *Heath* grows, because 'tis made up of the deciduous Leaves of that Plant, which, being by the Current of Showers brought together, make up the Moors, Mosses and Fens, and in the Mountains, in hollow Basons or Depressures without Vent, Mosses of incredible Depth; one or two Fathoms ordinarily in the same Kind of black Earth, called *Peat* or *Turf*.

A Table of Clays.

Clay { Pure, that is, such as is soft like Butter to the Teeth, and has little or no Grittiness in it.
 { Greasy, to be reckoned amongst the Medicinal Earth, or *Terra sigillata*.
 { 1. Fuller's Earth.
 { Yellowish. { At Brickbill in Northamptonshire.
 { { At . . . under the Yorkshire Woods.
 { Brown, about Hallifax.
 { White, in Derbyshire Lead-Mines.
 { 2. Boli { In Cleveland.
 { { At Linton upon Wharfe.
 { 3. Pale Yellow, in the Marle-Pit at Ripley.
 { 4. Cow-shot Clay, or the Soap-Scale lying in Coal-Mines.
 { 5. A dark blue Clay, or Marle, at Toltbrop.

- Clay { Harsh and Dusty when Dry.
- 6. *Creta* properly so called, or the Milk White Clay of the Isle of *Wight*.
 - 7. The Potter's pale yellow Clay of *Wakefield Moor*.
 - 8. The blue Clay of *Bullingbrook Pottery* in *Lincolnshire*.
 - 9. A blue Clay of *Bugthorp Beck*, in which the *Astroites* are found.
 - 10. Yellow Clay in the Seams of the red Sand Rock at *Bilbro*.
 - 11. Fine red Clay in the red Sand Rock at *Bilbro* and *Rippon*.
 - 12. A soft chalky blue Clay } at *Buttercrain*.
 - 13. A soft chalky red Clay }
- Stony when dry.

- Mixt {
- 14. A red Stone Clay { In the Banks of *Whitear-Beck*, near *Leppington*, and
 - 15. A blue Stone Clay { at *Housam* in the *Milscar*.
 - 16. *Clunch*, a white Stone Clay in *Cambridgeshire*.
- With round Sand, or Pebble.
- 17. The yellow Loame of *Skipwith Moor* in *Yorkshire*.
 - 18. A red Sandy Clay in the right-hand Bank of the Road beyond *Collingham* near the *Lime-Kilns* going to ———
 - 19. A red Sandy Clay in the red Sand Rock near *Rippon*.
- With flat or thin Sand, glittering with Mica.

- 20. *Crouch* white Clay in *Darbyshire*, of which the *Glass Pots* are made at *Nottingham*.
- 21. Grey or blueish *Tobacco-Pipe Clay* at *Hallifax*.
- 22. A *Red Clay* in the red Sand Rock at *Rotherham*.

XI. These wonderful Sands have not yet exceeded one Century, since they first broke Prison. Their Original is in a Warren in *Laken Heath* (a Town belonging to the *Dean and Chapter of Ely*, distant not above five Miles, and lying South West and by West of this Place;) where some great Sand Hills, (whereof there is still a Remainder) having the Superficies, or Swerd of the Ground, as we call it, broken by the impetuous South West Winds, blew upon some of the adjacent Grounds; which being much of the same Nature, and having nothing but a thin Crust of Barren Earth to secure its good Behaviour, was soon rotted and dissolved by the other Sand, and thereby easily fitted to increase the Mass, and to bear it Company in this strange Progress.

A Sand-heap at Downham in Suffolk; By Mr. Tho. Wright, n. 37, p. 722.

At the first Eruption, I suppose the whole Magazine of Sand could not cover above 8 or 10 Acres of Ground, which increased into 1000 Acres, before the Sand had travelled four Miles from its Abode. All the Opposition it met:

met with in its Journey hither, was from one Farm-House, which stood within a Mile and a half from its first *Source*. This the Owner at first endeavoured to have secured by Force, and building of Bulwarks against the Assaults thereof; but this wing'd Enemy was not to be so opposed: Which, after some Dispute, the Owner perceiving, did not only slight the former Works, but all his Fences, and what else might obstruct the Passage of this unwelcome Guest, and in four Years affected that by a Compliance and Submission, which could never have been done upon other Terms; in which he was so successful, as that there is scarce any Foot-Steps left of this mischievous Enemy.

'Tis between 30 and 40 Years, since it first reached the Bounds of this Town; where it continued for 10 or 12 Years in the Gut-skirts, without doing any considerable Mischief to the same. The Reason of which I guess to be, that its Current was then down Hill, which sheltered it from those Winds that gave it Motion; but that Valley being once past, it went above a Mile up-hill in two Months time, and over-ran 200 Acres of very good Corn that same Year. 'Tis now got into the Body of this little Town, where it hath buried and destroyed divers Tenements and other Houses, and has enforced us to preserve the Remainder at a greater Charge than they are worth. Which doubtless had also perished, had not my Affection to this poor Dwelling obliged me to preserve it at a greater Expence than it was built. I have at last given it some Check: for by stopping of it four or five Years (what I could) with *Furze* Hedges set upon one another, as fast as the Sands levelled them (by which I have raised Sand-Banks near 20 Yards high) I brought it into the Circuit of about eight or 10 Acres, and then in one Year, by laying some hundred Loads of Muck and good Earth upon it, I have again reduced it to *Terra Firma*: I have cleared all my Walls, and by the Assistance and Kindness of my Neighbours (who helped me away with above 1500 Loads in one Month) cut a Passage to my House through the main Body thereof.

At the other End of the Town divers Dwellings are buried or overthrown, and our *Pastures* and *Meadows* (which were very considerable to so small a Town, both for Quantity and Quality) over-run and destroyed: and the Branch of the River *Ouse* upon which we border, (being better known by the Name of *Thetsford* or *Brandon* River, between which two Towns we lie) for three Miles together is so filled with Sand, that now a Vessel with two Load Weight passeth with as much Difficulty as before with ten. But had not the Stream interposed, to stop its Passage into *Norfolk*, doubtless a good Part of that Country had e'er now been left a desolate Trophy of this conquering Enemy. For according to the Proportion of its Increase in these five Miles, which was from 10 Acres to 1500, or 2000; in 10 Miles more of the same Soil, it would have been swelled to a great Vastness.

It is observable, that the Situation of the Country in which this troublesome Guest first took its *Rise*, lies *E. N. E.* of a Part of the great Level of the *Fens*, and is thereby fully exposed to the Rage of those impetuous Blasts

we yearly receive out of the opposite Quarter: Which I suppose acquire more than an ordinary Vigour by the *Winds* passing through so long a Tract, without any Check. Another thing which contributes to it, is, the extreme *Sandiness* of the Soil, the Levity of which, I believe gave occasion to that Land story of the Actions that use to be brought in *Norfolk* for Ground blown out of the Owners possession.

XLI. Besides the *Bolus Armenus*, and the *Terra Silesiaca*, there is an Earth found in *Hungary* about the River *Tockay*, thence called *Bolus Tockaviensis*, having as good Effects in Physick as either of the former.

*An Hunga-
rian Bolus,
By . . .
n. 1. p. 11.*

XLII. *Soap Earth* is found only in two Places near *Duraclea*, a large open Village about 6 Leagues to the Eastward of *Smyrna*; and in a very flat Plain, about a League Westward of the River *Hermus*, and several Leagues from the Sea. 'Tis a fine *Soap*, and at the first gathering whitish Earth, which boileth or shoots up out of the Earth. 'Tis gathered always before Sun rise, and in Mornings when there falls no Dew, so that a Stock must be laid up for the whole Year in the Summer Months. It comes up in some Places an Inch or two above the Surface of the Ground. But the Sun rising upon it, makes it to fall down again. Every Morning there is a new Crop, tho' all be taken away which the preceding Day afforded. The Earth producing it lies low in both Places, and is in the Winter washy; 'tis cover'd, tho' but thinly, with Grass.

*The Soap
Earth from
Smyrna; By
Dr. Esw.
Smith. n.
220. p. 228.*

Three hundred Drams of this Earth put into a *Retort in Balneo Arenæ* for 12 Hours *cum Igne Violento*, gave between 5 and 6 Ounces of an *insipid Phlegma*, the Smell only such as proceeds in such Operations from the Fire.

Finding therefore no *Volatile Salt*, as what must have come over by the foregoing Experiment; 200 Drams calcined at a *Bagnio Fire*, in a *German Crucible*, were dissolved in Water. The Composition of Earth and Water, boil'd into a *Lixivium*, made 500 Drams.

It was boiled for three Hours, still scumming off the Froth, then *Filtrated*, after *Evaporated* over a gentle Fire; it was kept to *Chrystalize*, and appeared of a fix'd Salt.

At the *Soap Houses* they mix $\frac{3}{4}$ of Earth with $\frac{1}{4}$ of Lime, and dissolve the Composition in boiling Water; where stirring it often with a Stick, there floats a-top a thick brownish Substance, which *Scumming* off they preserve in Basons apart, and this *Scum* is much richer than the Liquor underneath; yet both are used in making the Soap. Into a large Copper Caldron they put 50 Kintals of Oil, applying a very hot Fire, which burns continually until the Soap is made. When the Oil has boiled, they begin to throw in of the Scum, and sometimes of the Liquor from which the Scum was taken. They often repeat this throwing in of the Scum and Liquor for 13 or 14 Days, in which time the Soap is usually perfected. The brownish Scum, and what is useful of the Liquor, incorporating with the Oil, what is useless sinks to the Bottom of the Caldron, where it is let out to make room

for throwing in more. The Water thus let out, is again thrown upon a new Composition of Earth and Lime; but when the Liquor becomes wholly insipid, 'tis then judged to be exhausted. After 13 or 14 Days, when the Soap is finished, 'tis laded out of the Boiler, and laid upon a Lime Floor to dry.

They proportion two Load of Earth of five Kintals each, to 50 Kintals of Oil; the Produce is between 70 and 80 Kintals of Soap.

The Earth is bought at a Dollar a Load, and the Soap, when this Account was made, at $6\frac{1}{4}$ a Kintal. There is employed in making Soap yearly at *Smyrna* 1000 Kintals of Oil.

Bringing Soap-Earth employs a 1000, or 1500 Camels daily, for eight Months; the four Summer Months being too hot for Camels to travel.

An ordinary Soap-House produces 1000 Dollars a Year clear Profit, *communibus Annis*.

*The Use of
Turkish Ruf-
ma; By Mr.
Smith. n.
243. p. 295.*

XLIII. This black Earth, which is call'd *Rufma*, and seems as if it were burnt, must be beaten in an Iron or Marble Mortar to a fine Powder, and sifted diligently; when you use it, take one part of the said Powder, and two parts of unslacked Lime; put these mix'd together into a Linen Rag, which infuse in warm Water the space of a *quarter* of an *Hour*, or till it becomes of a black Colour, then apply it to the Place from whence you would take the Hair; as soon as the Hair begins to be loose, the Part must be washed with warm Water and Soap.

*Coal Mines
in Somerset-
shire; By
Mr. J. Beau-
mont. Pb.
Col. n. 1. p. 6.*

XLIV. Within 5 Miles Northward of *Stony-Easton*, there are 6 distinct Coal-Works. The chiefest Observables I met within them, are,

1. The branched Clift, which usually lies over the Coal, and is all wrought with the Representations of sundry sorts of Herbs.

2. A Clift all interwoven with *Arborescent Marchasites*, which commonly lies over the former, and is call'd by our Colliers the Thorny Clift.

3. We here observe, that some Coal Veins are much more tinged with *Sulphur* than others; a Vein being wrought in one of these Works some Years since, which received such a Resplendency from its Sulphury Tincture, that in all its Joints it seemed as though it was covered with leaf Gold, and hence by the Colliers it was called the *Peacock Vein*.

4. I may heretake notice, that about four Years since, on one of these Works was found about 2 or 300 Weight of very good *Lead Ore* growing to a Vein of Coal, the *Ore* being tinged somewhat yellow by the Sulphur: We look upon this as a Rarity with us, none ever having been found in a Coal-Pit before; the sulphurous Spirit being there generally too strong for the Generation of that Metal.

*A Subterra-
neous Fun-
gus; By Mr.
Jeslop. n.
100. p. 6179.*

XLV. 1. The *Fungus Subterraneus* I sent you a large Quantity of, was gotten in rocky Lime-stone Ground, on a Common about two Miles distant from *Castleton*, in the *Peak of Darbyshire*, 15 or 16 Yards deep, in the *Old-Man* (as they call a Mine formerly wrought and stopt up) cover'd with

with Earth, and that had either fallen or was thrown in. There is no Coal-Bed, that is known of, within 5 or 6 Miles of the Place.

2. The Pieces of this *Fungus* which I received, are much like *Peats*, or *Turff*, cut up in the high Moors, both in the sooty Colour and inward Substance; this only is more clammy and tough, and dries not. And some of this *Fungus* Substance is very soft and like Gelly. In and about the more solid Pieces, (of which I have some half a Foot square) are many big Lumps of a *Bituminous* Substance. This *Bitumen* is very inflammable like Rosin; it is very light, it breaks firm, and shines like good *Aloes*; and for Colour it is not much unlike it, save that it is more dark-coloured and purplish; yet there is much of it of a dark-green Colour. We distilled a Parcel of it, which yielded us an *Acidulous Limpid Water*; then a white Liquor, which was, I guess, from some of the oily Parts precipitate; and in the last Place, a copious yellow Oil, not unlike that of *Succinum*, or Pitch. In the Neck of the *Retort* we could discern no volatile Salt, as in the like Process upon *Amber*. I have not read of any such *Fungus* Earth, in which *Bitumen* naturally grows and adheres: And the finding of it in an *Old Mine*, doth much favour an Opinion of its being a vegetable Substance, either the very Substance of the Props of Wood they make use of in lining and supporting the *Grooves*, thus altered, or certain *Fungus's* growing out of them. That Birch, of which there is great Plenty, and hath been vast Woods, all these mountainous Parts of *England* over, will yield a *Bitumen*, as *limpid* as the Sap is which runs from it by tapping, if we now had the Skill to extract it. *Pliny* is very express, l. 16. c. 18. *Bitumen ex Betula Galli excoquant.* And moreover it is certain, that much of that Wood, if not all, which is dug up in the high Moors of *Craven*, and which the People there call and use for *Candle Wood*, is no other than Birch, as it appears from the Grain and Bark; and yet this Wood kindleth, flames, and exudates a *Rosin*, which makes many pronounce it very Fir-Wood. Whatever this *Bitumen* is, which this *Fungus Subterraneus* yields, it much differs from the *Asphaltum* of the Shops.

By Dr. Lister. ib. p. 6180.

XLVI. Mr. *Jessop* sends me word, that Capt. *Wain* has given him a white Liquor resembling Cream both in Colour and Consistence, which he found in great Quantities in the bottom of a Coal-Pit 49 Yards deep. And Mr. *Geo. Planton* writes from *Sheriff-Hales* in *Shropshire*, that in the Iron Mines, especially that which the Country People there call the *White-Mine*, which yields the best Iron-stone, the Miners do commonly, upon the breaking of a Stone, meet with a great Quantity of whitish Milky Liquor, inclosed in the Center of it; they sometimes find a Hogshhead contained in one Cavity. 'Tis in Taste sweetish; only it hath a vitriolick and iron-like Twang with it.

A Mineral Juice; By Dr. Lister. ib. p. 6181.

XLVII. In *Brosely*, *Bently*, *Pitchford*, and other Places adjacent in *Shropshire*, there lies over most of the Coal-Pits or Mines a *Stratum* or Layer of a blackish

A Blackish Stone in Shropshire, yielding Pitch, Tar, and Oil; By Mr. Marten Ele. n. 28. p. 5442.

Blackish Rock, or Stone, of some Thickness, which is porous, and contains in it great Quantities of *Bituminous* Matter.

This Stone being brought to the Work-House, is ground small by Horse-Mills, such as are used for grinding Flints to make Glass of; the Powder is thrown into great Coppers of Water, where, by boiling, the *Bituminous* Matter is separated from the Stony or Gritty, this last sinking to the bottom, the other swimming at the top of the Water.

This *Bituminous* Substance being gathered together and evaporated, comes to the Consistence of Pitch, and with the Help of an Oil distilled from the same Stone, and mixed with the Pitch, comes to be thinner, or like *Tar*; the Uses of both which Materials, either for Shipping or otherwise, these Substances are said to supply, nay even go beyond. And this has been tried on several Boats this 3 or 4 Years past, and does not crack as the ordinary Pitch or Tar, but always keeps black and soft, and therefore is proposed to hinder the Worm from getting into the Ships pitched with it.

There is likewise distilled from this Stone, an Oil which may be used for Oil of Petre, or Turpentine, and has been tried by divers Persons in Aches or Pains.

*A Mineral
Balsam in
Alsatia; By
•••••
n. 8. p. 135.*

XLVIII. In the Valley called *Libertal*, near *Geesbach*, (an ancient Mine-Work in *Alsatia*) there runs out of a Cavern a foul, flattish, oily Liquor, which affords an excellent *Balsam*, by taking a Quantity of it, and putting it in an earthen Pot well luted, that no Steam may exhale; and then with a gentle Fire at first, but a stronger afterwards, boiling it for 3 Hours together, in which Space it will boil in a 4th Part, and an earthen Matter, like Pitch, will settle itself at the Bottom; but on the Top thereof, when cold, there will swim a fatty Substance, like Line Oil, limpid and somewhat yellowish, which is to be decanted from the thick Sediment, and then gently distilled in an *Alembick* in *Arena*; by which means there will come over two differing Liquors, one *Pblegmatick*, the other Oily, which latter swimming on the *Pblegm*, is to be severed from it. The *Pblegm* is used as an excellent Resister and Curer of all the Putrefactions of the Lungs and Liver, and it heals all foul Wounds and Ulcers. The Oily Part, being diluted with double its Quantity of distilled Vinegar, and brought three times over the Helm, yields a rare Balsam against all inward and outward Corruptions, stinking Ulcers, hereditary Scurfs and Scabs. 'Tis also much used against Apoplexies, Palsies, Consumptions, Giddinesses, and Head-aches. Inwardly they take it [with *Succory Water* against all Corruptions of the Lungs. It is a kind of *Petroleum*, and contains no other Mineral Juice but that of Sulphur, which seems to be thus distilled by Nature under Ground; the Distillation of an Oil out of Sulphur by Art, not being so easy to perform.

*A Mineral
Balsam in
Italy; By S.
M. Antonio
Castagna. n.
79. p. 3059.*

XLIX. In the Territory of *Bergamo* Sig. *M. Ant. Castagna*, upon the Confines of his *Jurisdiction*, lighted accidentally upon a not ordinary sweet balsamick Scent, which directed him to a *Rocky Hill*, where he found the Stones harboured that

that Fragrancy, which was so strong, and by Trials found so friendly to the *Uterus*, that being applied, they did in a very short time cure it of any Evil 'tis subject to. Encouraged hereby, he made his Workmen dig into the very Bowels of the Hill, where he discovered Holes in some Stones, as if excavated by Art, of a greenish Colour, in which he found, as distilled by Nature, and kept in Vessels, that *Liquor* and *Balsam*, which proved the Source of that *Scent*, which was limpid, and of a white Colour, like the White of an Egg, but somewhat *Oleaginous*, floating upon all sorts of *Liquors* like *Oil*. Besides, he met in the same Cavities some small Grains concreted of the same *Liquor*, resembling that which they call *White Amber*, which being chymically distill'd, had the same Odour with the *Balsam*.

L. I find that *Osteocolla* grows in a sandy, yet not gravelly Soil, and not at all (that I know) in any rich or clayey Ground. It shoots down two Mens depth under Ground; the Branches most commonly growing strait up, yet sometimes also they spread sideways. The Branches are some of them thicker, some slenderer, and the further they are distant from the common Stem, the thinner they are; the Stalk being thickest of all, usually equalling the Thickness of an ordinary Arm or Leg, and the Branches the Thickness of one's little Finger.

Osteocolla
about Frank-
fort on the
Oder. by J.
Christopher
Beckman.
n. 39. p. 771.

Upon the Sand, which is here every where yellowish, there appears a whitish fatty Sand, which if it be dug into, hath under it a dark, fatty, and (how hot and dry soever the other Sand be) a somewhat moist and putrid Matter, like rotten Wood; which Matter spreads it self here and there in the Earth, just as the *Osteocolla* itself doth, and is called by those whom I have employed to look for it, the Flower of this Substance. The *Osteocolla* being thus found, is altogether soft, yet rather friable than ductile: Wherefore if one hath the Curiosity of getting out of the Ground a whole Piece of it with its Branches, he must very carefully remove the Sand every way from it, and then let it lie so a while; its Quality being, that remaining exposed to the Sun for half an Hour, or somewhat longer, it grows to that hardness as 'tis found in the Shops.

It seems to be a kind of *Marle*, or to have great Affinity with it, of which we here have also great Store, yet not near those Places where I have found *Osteocolla*. It requirerh also time to come to Maturity, which appears from hence, that in the very same Place where I digg'd some of it last Year, I this Year found other, yet with this Difference, that those grew hard, after the manner before described, but these remain still soft and friable, tho' now in the 5th Month.

The Cause of its being divided into so many Branches, I conjecture to be from the Roots, which spread themselves here and there in the Earth, so that the Matter gathers and settles itself about them, and afterwards according to the Division of the Roots, acquires a plantal Form and Appearance. Whence it seems also to proceed, that thro' the midst of the *Osteocolla* there always passeth a dark Line, which is thought to be a Piece of the *Root*. And it often happens, that the Stroke loseth itself by little and little, and
the

the *Osteocolla* in the middle grows clear; which comes to pass when the Root by the Corruption begun in the *Osteocolla* is reduced to Powder. Yet have I found a Place hereabout, where the *Osteocolla* was not hollow at all; but there I observed, that instead of settling about a big Root, it had gathered it self about many small Fibres; whence also this sort had acquired Pores through its whole length, but no Cavity like the other.

Black Lead,
by Dr. Plot,
n. 240. p. 183.

LI. The Mineral Substance call'd *Black Lead*, found only at *Keswycb* in *Cumberland*, and there call'd *Wadt* or *Kellow*; by Dr. Merret, *Nigrica Fabrilis*, from its use in scoring, as the *Rubrica Fabrilis*, or the *Red Ochre* is; is certainly so far from having any thing of Metal in it, that it has nothing of Fusion, much less Ductility; nor can it be reckoned among the Stones, for want of hardness; it remains therefore that it must have place amongst the Earths, tho' it dissolve not in Water, as most Earths will, except stiff *Clays* and *Ochres*; among the latter whereof I guess it may be reckoned, it seeming to be a sort of close Earth, of very fine and loose parts, so burnt that it is become black and shining, discolouring the hands, as all the *Ochres* do: whence the most proper Name that can be given it, perhaps, may be *Ochrea Nigra*, or *Black Ochre*, being a stony sort, as there are stony sorts of the *Red* and *Yellow Ochres*, as well as Clay.

Irish Slate,
by * * * * *
n. 243. p. 271.

LII. It having been discovered to the *Philosophical Society* at *Oxford*, by Mr. *Henwick* Physician at *Worcester*, that the *Irish Slate* pulveriz'd, and infused in Water for a Night or less, would impart its *Vitriolick Quality* so far forth to it, that it would strike of a faint reddish Colour with Powder of *Galls* (as the *vitriolick Waters* of *Tunbridge*, *Astrop*, and divers others do) it led me to believe that these Waters, some of them, might as well issue from *Slate* as an *Iron Ore*, unless it should appear, that this sort of *Slate* were an *Iron Ore* too, which put me upon calcining it for 3 or 4 Hours, after the Manner of Dr. *Lister*, to experiment whether it would then (like other *Iron Ore*) apply to the *Magnet*; wherein altho' I was altogether unsuccessful, the *Magnet* not taking the least Notice of it, yet it afforded me another Discovery altogether as satisfactory, viz. that upon Torrefaction, it was all become a *Yellow Ochre*, and would score like it; which further persuades me, that the *Yellow*, or rather *Orange-colour'd-Sediment* we find at the Bottom of these *Fountains*, comes rather from this sort of *Slate*, than an *Iron Ore*: For I much question, whether some of the *Yellow Ochres* (tho' it's plain the red ones do) come from, or are *Iron Ores*, because the *Shotover Yellow Ochre* will not own the *Magnet* after 36 Hours Calcination, or better.

Chalk, and
some other
Bodies not
properly
Stones, tho'
commonly
reputed so;
By Dr. Fr.
Slate. n.
182. p. 114.

LIII. In a small Treatise of the *Calculus Humanus*, I found reason to complain of the Imposition of our Senses upon our Conceptions, in calling that a *Stone* by its external Appearance, when it has no real Properties of a *Stone*. I have also, in this, Reason to except against *Chalk*, commonly taken for a *Stone*, for being brought to the *Hydrostatical Examen*, (if that may be allowed as a Standard) it wants much of the true Consistence of a *Stone*; for it

wants

wants much of that weight, which real Stones are proved to have in *Water*, and it may perhaps be better reckoned amongst *Boles* than *Stones*. I found this true not only in Chalk, but various other Bodies taken for granted to be *Stones* at large: Some of which are nearer *Earths* than *Stones*, others have nothing but *Earth*, *Sulphur*, and *Metal*, and yet must be called *Stones*, as all *Marchasites* are; of these the former, (namely the *Boles*) many of them fall short of our Standard of *Stone*, others are more ponderous, and so exceed our Standard: Whereas true *Stones*, tho' differing much in hardness, whether *Pebbles*, *Flints*, *petrefy'd Waters*, &c. do answer the same Standard of *specific Gravity* that a *Diamond* does; which is, as about $2\frac{1}{2}$ to 1.

LIV. Upon the River *Done* near *Aberdeen*, a little below the Bridge, near the River's Mouth, there is a Bank, the Face of which is broken down, and it is full of *Stones*, which one would think were *in fieri*; they are all either round or oval, of different Sizes; the Faces of most of them are broken off, they are soft, and will easily rub down with your Hand, they are of different Grits and Colours, and are made up of different Sands and Clays mingled together: The Clay is soft both to Hand and Taste, in some of them white, in others gray, tho' in some Places the Clay and Sand are harden'd to the Consistence and Colour of such oval *Stones* as we usually see in the Fields; but where they are at the softest, the Bed that each Stone lies in, is always hard, and of another Grit and Colour.

Imperfect Stone in Scotland, by Dr. Geo. Gordon. n. 175. p. 1157.

LV. There is an excellent *Quarry* within Cannon-shot of *Maestricht*, lying in a Hill, where there are about 25 Fathom of Rock and Earth over-head; it hath one Entry towards the River *Maese*, where Carts can pass with great ease, and unload the *Stones* upon the brink of the River; the *Quarry* within being parallel to the Horizon, and elevated but very little above the River. It affords one of the most surprizing Prospects, when well lighted with many Torches, that one can imagine. For there are thousands of square Pillars in large level Walks, and those almost every where above 20, and in some places many more Foot high; and all wrought with much Neatness and Regularity.

A Stone-Quarry near Maestricht. By . . . n. 67. p. 2051.

This *Quarry* serveth the People that live thereabout, for a kind of impregnable Retreat, when Armies march that way. For being acquainted with all the Ways in it, they carry into it whatsoever they would have safe, as well their Horses and Cattle, as their moveable Furniture, till the Danger be over; there being so vast a deal of Room, that 40000 People may shelter themselves in it.

In this vast *Grotto* 'tis remarkable, that there is but little Rubbish, which shews both the Goodness of the Stone, and the Carefulness of the *Workmen*. And in divers places there are little *Pools* of *Water*, perhaps made on purpose for Beasts to drink, and to serve for other uses in time of need: For in no place almost are there any Droppings to be seen; nor are the Walks at all wet under foot: only it seems, that Rain gets in by the Air-Shafts, which for saving of Labour, and perhaps too, to make these *Pools*, are let down from

from such Places commonly, as are the *Pools* thereabout; and so the Rain, that falls on the higher Grounds does easily find the way thither.

*Quarries
and Rocks in
Austria and
Hungaria,
&c. by Dr.
Ed. Brown.
n. 59. p. 1050.*

LVI. Upon the North-side of Mount *Calenberg*, two German Miles from *Vienna*, are Stones mark'd with Trees and Leaves. In the *Hermitage* of the *Camaldulenses*, seated upon a Peak of this Hill, I saw fair ones, with which they paved the Walks in their Gardens.

Not far from *Manners Dorf*, is the Emperour's Quarry of Stone, out of which are made the best Buildings in *Vienna*: In which, wheresoever there is a Cleft or Separation of one Stone from another, the Water falling betwixt them, leaves a Petrefication; thereby, as 'twere, healing the Wound, by making a stony *Callus*, not exactly like the Parts which it joins together.

An English Mile from *Freistat* in Hungary, Northward, is a Quarry of Stone, out of which many great Stones are digged, transparent and resembling *Sugarcandy*.

At *Banca*, two Hungarian Miles from *Freistat*, Northward, is a Quarry of *White Stone*, nigh the *Hot Baths* of that Place, over which is a Lay of *Chalk*, of about a Yard thick, very beautiful to the Eye, as being of all Colours except Green, so finely mixt, streaked and shaded, that it surpasseth *Marble Paper*; and the Water dropping upon it, doth, as 'twere, varnish it.

At *Schemnitz* in Hungary, famous for *Silver-Mines*, is an high Perpendicular Rock, part of which, from the Top to the Bottom, is naturally tinctured with a shining fair blue and green: And I have heard from a *Spaniard*, who lived long in the *West-Indies*, that there is also a Rock like this nigh to the *Silver-Mines* in *Peru*.

The Mountain of *Cliffura*, being a part of Mount *Hemus*, as also Mount *Pyrlipe*, do shine like Silver, and Day and Night, either by the Light of the Sun or Moon, afford a glittering pleasant Shew, caused by the great Quantity of *Muscovy Glass*, wherewith these Hills abound. There are also *Talcum Rocks* nigh *Spital* in upper *Carinthia*: And a Hill nigh *Sarvizza*, which consists of an Earth of a fine red Colour, out of which the red earthen Vessels of that Country are made.

White Marble in Ireland, by Dr. Ash, Bishop of Cloyne. n. 243. p. 294.

LVII. A Quarry of *White Marble*, is lately discovered in the County of *Antrim*, and 'tis of an extremely fine Grain, soft at first, but grows very hard afterwards, like *Portland-Stone*.

Stones growing at the end of a Rush, by Sir R. Redding. n. 198. p. 663.

LVIII. I send you herewith some Stones of an *Amber Colour*, taken out of a Spring, called *Cranbourn Spring* near *Lough Neab*, which the Country People tell us, grow at the end of a little Rush, and drop off, and are to be found only on a *Mayday-Eve*, and good for God knows what: They look like the Germinations of some of your Salts, but in the Fire shew no signs thereof by crackling: They are Electrical and Angular, and being pounded, the Powder is white.

LIX. 1. The highest *Icy Mountains* of *Helvetia*, about *Valesia* and *Augusta*, in the Canton of *Bern*, about *Taminium* and *Tavetsch*, of the *Rhetians*, are always seen covered with Snow. The Snow melted by the Heat of the Summer, other Snow being fallen within a little while after, is hardened into Ice, which by little and little, in a long Tract of Time depurating itself, turns into a Stone, not yielding in Hardness and Clearness to Chrystal. Such Stones closely joined and compacted together, compose a whole Mountain, and that a very firm one; tho' in Summer-time the Country People have observed it to burst asunder with great Cracking, Thunder-like. Such Cracks and Openings being by the Wind covered with *Snow*, are the Death of those that pass over them.

The Icy Mountain Gletscher,
by M. Murat.
tus. n. 49.
p. 982.
By---to Mr. Justel.
n. 100. p. 982.

At the foot of these Mountains, are with great Labour digged out Chrystals, which are found among other Fossils, of two Sorts and Colours; some of them are darkish and troubled, which by some are called the *Chrystal Ore*, to be plenteously found in the Ascent of Mount *Gottbard*; others transparent, very pure, and as clear as *Venice Glass*, sexangular both great and small; as in the Mountains about *Valesia*, and the Town call'd *Urselen*, at the foot of the Hill *St Helenin*, they are digged out, and sold at a good Rate; one particularly sold for 80 *l. Sterl.*

2. This *Icy Mountain* called the *Gletscher*, is very high, and extends itself every Year more and more over the neighbouring Meadows, by Increments that make a great Noise and Cracking. There are great Holes and Caverns which are made when the *Ice* bursts; which happens at all Times, but especially in the *Dog-days*. Very little of the Surface melts in the Summer, and all freezeth again in the Night. When the Sun shineth, there is seen such a variety of Colours, as in a Prism.

At the foot of the Mountain, a Rivulet issues forth from under the *Ice*, which is pretty deep and extremely cold.

There is such another Mountain near *Geneva*, and upon the *Alps*. A certain *Capuchin* told me, he had been upon the highest of these Mountains, with a Trader in Chrystal, who having driven his Hammer into one of these Rocks, and found it hollow and resonant, made a Hole in it, and thence drew forth a Substance like Talk; which to him was a sign there was Chrystal. After which he made a great Hole with Gunpowder, and found Rock Chrystal in it.

LX. Being in the *Val Sabbia*, at a Place called *Le Mezzane*, where I knew that Chrystals are generated, I observ'd in a spacious Round of a *Meadow* seated on a Hillock, some narrow Places bare of all Herbs, in which alone, and no where else thereabout, Chrystals are produced, being all sexangular, both Points of them terminating in a Pyramidal Figure, sexangular, likewise.

The Formation of Chrystals,
By P. Francisco Lana,
n. 83. p. 4068.

I was told, that they were produced from the *Dews*, because (forsooth) being gathered over Night, the next Morning there would be found others at such a time only, when it was a serene and dewy Sky. But when I had examin'd that in the Neighbourhood of that Hill, there was no Mark at all of any Mines, I did conclude that it might be a plenty of Nitrous Streams, which

might withal hinder Vegetation in those Places, and coagulate the Dew falling thereon; for *Nitre* is not only the natural Coagulum of Water, as is manifest in artificial *Glaciations*, but also it ever retains the abovesaid *sexangular* Figure, altogether like that of these Chrystals. Which may also be the very Cause of the *sexangular* Figure in Snow; this being nothing else but Water concreted by its natural *Coagulum*, which is a nitrous Exhalation. And to make it yet more manifest, that these are indeed Expirations of *Nitre*, I digg'd up some of the Earth, and drew a Salt from it, which had both the Taste and Figure of *Nitre*; tho' some Grains of it were of a square, others of a pyramidal Figure. And since these Chrystals are only found in those narrow Places, we may very probably infer, that from thence are raised the Exhalations, which do concrete the Dew; after such a manner as the Vapour or Exhalation of *Lead* coagulates *Quicksilver*.

An odd Figured Iris; by Dr. Lister. n. 110. p. 222.

LXI. I have not observed any Rock, or sort of Stone, whether metalline or more vulgar, which has not its different sort of Sparr both for Colour and Figure, which is very common in our blue Lime-stone Rocks in *Yorkshire*, out of which plenty of Lead-Ore is got. They are mostly of a black Water, like the black Flint in *Chalk-Hills*, but there are of them, which have a purplish or *Ametbystine* Colour, and some there are as clear as Chrystal. They adhere to the Seams of the Rock, be it betwixt Bed and Bed, or wherever there are cross and oblique Veins thro' the very Substance of the Bed. The smaller the Veins, the less the *Iris*. You will find of them as small as Wheat Corns, and others an hundred times bigger. They shoot from both sides the Steam, and mutually receive one the other.

They are figured thus, *viz.* a Column of 6 Plains, very unequal as to the Breadth: the end adhering to the Rock is always rugged, as a thing broken off, the other end of the Column consists of three quinquangular Plains, very little raised in the middle: These Plains too are very unequal. Let them hug one another, and be any ways streightned and compressed in their shooting; yet the Number of Plains mentioned, both of the Column and Top, is most certain. The Places where infinite of them may be had, are *Rainsborough Scar* upon the *Ribble*, also in a Stone Quarry, near *Eshton Tarn* in *Craven*.

Transparent Pebbles; by Dr. Lister. n. 201. p. 278.

LXII. These *transparent Stones* are of a constant Shape, and in some ancient Leases of Royal Mines, they are called *rough* or *mineral Pearl*, being resplendent and bright, and figured like a Drop of Water. Some of them are exactly spherical, others like a half Globe, others like a half Oval, with an Edge raised on the top. It was not without reason that they were esteem'd by the Ancients: For their *natural Polish* is not to be counterfeited, but very easy to be distinguish'd with a Microscope, from the *artificial Polish* of *Glass* and *Chrystals*. Now *Gold*, *Silver*, *Diamonds*, *Pearl*, are for no other reason estimable, but because they have certain indelible Characters, which all the Subtilty and Wit of Man hath not yet been able to counterfeit, notwithstanding many Pretences thereunto: As *Gold*, for example, that it will endure the drown-

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