THE

Religious Philoſopher:

Or, the Right USE of

Contemplating the WORKS of the

CREATOR:

I. In the wonderful Structure of Animal Bodies, and in particular, MAN.

II. In the no leſs wonderful and wiſe Formation of the ELEMENTS, and their various Effects upon Animal and Vegetable Bodies. And,

III. In the moſt amazing Structure of the HEAVENS, with all its Furniture;

DESIGNED

For the Conviction of ATHEISTS *and* INFIDELS.

VOL. II.

Throughout which, all the late DISCOVERIES in *Anatomy*, *Philoſophy* and *Aſtronomy*, together with the various Experiments made uſe of to illuſtrate the ſame, are moſt copiouſly handled by that Learned *Mathematician*, Dr. *NIEUWENTYT*.

Tranſlated from the Original,

By JOHN CHAMBERLAYNE, *Eſq*; *F.R.S.*

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THE

THE *Religious Philosopher:*

Or, the Right Use of the Contemplation of the Works of the CREATOR, *&c.*

VOLUME II.

CONTEMPLATION XVII.

Of the Air.

SECT. I. *Transition to the Contemplation of the World.*

WE have hitherto been employ'd in Contemplating what we our selves are, and with how much Wisdom and Power; and (what lays us under higher Obligations) with how much Goodness our most gracious Creator has thus wonderfully formed us, and daily and hourly preserv'd us. If now we proceed, and observe all that is round

about us, we ſhall again diſcover a whole World full of innumerable Bodies, innumerable Motions, innumerable Phænomena or Appearances, innumerable Operations and Effects of an inexpreſſible Number of Things; ſo that the moſt laborious and diligent Enquirers, after their indefatigable Diligence, have made ſo little Progreſs, as to be forced to acknowledge, that all that they know of the Univerſe, even at this time, is but a ſmall part of what is ſtill to be known. However, as little as this may ſeem to be, it is yet ſo conſiderable, that it muſt cauſe every Man that is not vainly puffed up with the Conceit of his own Wiſdom, to ſink down into the deepeſt Humility and Submiſſion, when forced to confeſs a Glorious Creator, from the Contemplation of the moſt amazing Greatneſs of his Works; ſo that it is not poſſible (unleſs the Vengeance of a God unjuſtly blaſphem'd reſts upon him) that there ſhould be one ſingle Soul ſo miſerably blind and unhappy, as to think it credible, after a regular Inquiry, that ſo many and ſo wonderful things, that for ſo many Ages together could continue without change and confuſion in their firſt appointed Order and State, can be the effect of mere Chance and ignorant Cauſes. Beſides that, as unconceivably great and terrible as they may appear with reſpect to Men, they are nevertheleſs compell'd by an inviſible Power and Direction, not only to concur in preſerving us alive, but alſo to contribute after ſuch different ways to our Convenience, Refreſhment and Pleaſure.

And that we may not be ſuppos'd to advance this, from an Admiration merely groundleſs, (for Admiration may be owing to Ignorance, as well as Knowledge) of the many Properties of Things, whoſe particular Diſcuſſion would not only exceed the Deſign of this Book, but even

our

our Strength and Understanding, let us take a few into Consideration, in which the Great Creator and Ruler of the World has vouchsafed to reveal his Ways in some measure to Mankind: And further, seriously reflect with our selves, whether they may not chearfully and undeniably serve to convince a Mind desirous to know its Maker, that we have much more reason to acknowledge, in the Structure of the Universe, a Wise, Powerful, and Gracious Being, than the Skill of an Artificer from the most curious Machine that ever was produced by the Ingenuity and Workmanship of any Man whatever.

Sect. II. *First of the Air.*

To avoid Confusion, and observe some Order in the Contemplation of so many things, we shall begin with those that are absolutely useful and necessary to the Preservation and Well-being of Man; therefore we shall treat of Air, which is the principal of them all; and first, of some Properties thereof, and then of what Advantage and Service it is to Men, Beasts, Plants, and other Things; all which we shall briefly shew in some few Cases.

Sect. III. *The Gravity and Elasticity of the Air.*

The Diligence, or rather the good Fortune, of the Philosophers of the last Age, has brought to light two remarkable Discoveries, and which were entirely a Secret to all the Ancients, touching the Constitution of the Air; namely its *Gravity* or Weight, and its *Spring*, called in Latin by the Modern Naturalists, *Vis Elastica*.

Sect. IV. *An Experiment concerning the Gravity of the Air.*

For some thousand Years the Air was esteem'd to be a Body so light, that it would never descend like other Bodies, till the Invention of *Barometers* gave the first hint to Mankind, that the Air might likewise be a heavy Body.

And how greatly the Experiment of these Weather-Glasses has contributed to the chief Proofs of the Gravity of the Air, may be seen by the Suspension of the Quicksilver in those Tubes in many Cases, which is to be ascrib'd, first to its Elastic Faculty, and afterwards to its Gravity, which causes the said Faculty to exert itself; as will appear by what follows.

Wherefore, in order to prove directly the Gravity and Weight of the Air, this Method seems to afford the strongest Proof, or at least the clearest and simplest: Take a Glass full of Air, and weigh it in a nice and exact Pair of Scales; then drawing out the Air as far as possible with an Air-Pump, and weigh it again, you will find that it was sensibly heavier before the Air was exhausted than it is afterwards. The hollow Glass Balls which are commonly sold with the great kind of Air-Pumps, are very proper for such an Experiment, and bigger Glasses are yet more so.

I find in my Notes, that such a Ball or Bubble had lost with its Air, sixty two Grains of its Weight, which is more than sufficient to convince us of the Gravity of the Air. According as we make use of bigger or smaller Bubbles, this Difference will appear greater or less.

Sect. V. and VI. *The Air's Elastick Faculty, proved Experimentally.*

The Second Property, for the Knowledge of which we are beholden to the Discoveries of later Years, is the *Elastick* Power or *Springiness* of the Air; whereby its Parts, like Steel Springs that are bent with Force, do continually endeavour to expand themselves; and so by their Separation from each other, to take up a larger Space, driving away and pressing on every Side, all that makes any Resistance to them.

To prove this, many Experiments have been made by the Famous *Boyle* and others. The common Method of shewing it is by a little Bladder E (*Tab.* XIII. *Fig.* 1.) which is about as big as a large Goose Egg, when full blown. Squeeze the Bladder so as to leave but a very small quantity of Air in it: Then having tied the Neck close, hang it up by its String to the little Hook D, of the Glass Receiver A B C, which being laid on the Plate of the Air-Pump B A, if you exhaust the Air from the Receiver at F, which pass'd on the outside of the Bladder, the Spring of the Air in the Bladder will exert it self so, that the Bladder will swell as if it was strongly blown up with a Pipe.

And for a further Proof of this Elastick Power of the Air, several other Experiments, hereafter quoted in the proper Places, may be serviceable.

Sect. VII. *The Pressure of the Air.*

Now that Operation or Effect which the Air has upon other Bodies, by this its Weight joined to the Expanding or Elastick Force of its Parts, is what the Moderns call the Pressure of the Air: The

The surprising Strength of which is incredible to many, and the Properties in its Uses no other than wonderful.

Sect. VIII. *The Mistakes of some Atheists.*

Now before we proceed any farther, let us answer these Men, who to defend their unhappy Notions, *viz. That there is not much Wisdom requisite in the Direction of many Things about them*, alledge, That most of those Things are either entirely at rest, or at least mov'd but very slowly, and think this a strong Argument for their Assertions, because when things are suppos'd to be without Motion, there does not seem much Wisdom not Power necessary to continue them in the State in which they are; because a slow and languid Motion is known not to want so much Force and Direction to prevent its doing Mischief, as that Motion which has more Velocity and Strength in it: And if this last be allow'd, the first carries a great deal of Probability with it, at least in the Minds of ignorant Persons: For several People sitting in a Chamber, for instance, are not sensible of any Force upon them from Powers operating externally; the Glass of the Windows, that is known to be so brittle, remains in the same Condition; the Tapistry or Hangings of the Room immoveable; not a Hair of their Head stirs; in short, every thing seems to them plainly enough to be in perfect Rest. Let 'em go abroad, and unless the Air be put into Motion by Winds or Storms, they meet with no violent Opposition, but every thing seems still and calm to them, excepting perhaps some uncommon Revolution or Changes, which, because they cannot easily trace the Causes, seem to be merely fortuitous; from whence they conclude, that at such

such times they are Safe and Secure enough, and stand in need of no greater Power than they themselves are able to furnish for their own Defence.

This Mistake does oftentimes render the unhappy Atheists very easie for a while, and makes them flatter themselves, that there is nothing about them which they need to fear. But in order to excite different Thoughts in them, and to make them apprehend Matters as they really are; let them go on and Contemplate with us those great and terrible Powers, which, even at the very time that they think themselves to be in the surest Calm and Stillness, move continually round about them, and they continually live in the midst of 'em; which Powers, if they were not most wonderfully restrained by an *Equilibrium* or Balance, (and so hinder'd from hurting us, and thereby only render'd insensible) would be able, as soon as ever that *Equilibrium* ceased to operate, in an instant of Time to crush us into Atoms.

Sect. IX. *A Description of the Barometers; and an Experiment of the Pressure, and of the Weight of the Air thereby.*

Now to the end that this may not appear to any one more marvellous than true; take a Glass Tube A O (*Tab.* XIII. *Fig.* 2.) of about three Foot in length, and of the bigness of a Goose or Swan's Quill, closed at A and open at O; let it be filled with Quicksilver; then stopping the Orifice O with your Finger, turn it down into another Vessel of Quicksilver, as described here in the Glass B O D; then drawing your Finger away, the Quicksilver that is in the Tube will have an opportunity of sinking down, some of it running to the other that is in the Glass. But it

is well known to all that have taken any Pains to enquire into the Modern Philosophy, that the said Quicksilver that is in the Tube will stop about F, at the height F I of 28, 29, 30, or 31 Inches above the uppermost Superficies B D of the Quicksilver that is in the Glass Vessel. Now that this happens because the Air does press upon that Part of the Superficies B D, that is out of the Tube, as much as the Quicksilver within does upon the Part C I, which is directly under the Tube, will appear from the following Reasons.

I. Because when the Pressure of the Air upon the Quicksilver B D out of the Tube is greater or less, that within the Tube does either rise or fall, as is obvious in all the *Barometers* or Weather-Glasses which are only made after this manner.

II. This may be likewise deduced from thence, that in case we pour Water, Lye, or any other heavy Liquor to the Height W K, upon the Quicksilver B D, and so augment the Pressure with that additional Weight, the Quicksilver at F will be proportionably higher; and again lower, if we draw the Water off by a Pipe or Crane, and thereby lessen the Pressure upon B D.

III. The same is very plain, if we cover the whole with a long Glass Receiver, H G L, on the Air-Pump, and by exhausting the Air in P, or in the said Receiver, from thence into the empty Pump remove the Pressure which this Air made upon the Quicksilver B D; for then we shall see that the other in the Tube between I and F, will descend to C I, or about as low as that which is in the Glass out of the Tube, and rise again to the same Height F, when we let in the Air again to the Receiver, whereby the Pressure upon the Superficies B D may be increased.

Hence

Hence then it is plain, that while the Quicksilver stands thus still in the *Barometer*, and in the Glass Vessel in the open Air, every similar part of the Horizontal Superficies of the Quicksilver Y X (which may be supposed to pass through the Mercury under the Orifice of the Tube O M) suffers a like Pressure; because otherwise the Quicksilver would not remain at rest, but the Parts of it that were more strongly pressed, would recede downwards; and the Parts that were least pressed, would be compelled to ascend; which is sufficiently known from the Principles of *Hydrostaticks*: for which reason then, if one supposes the Part N Q to be equal to O M, both of 'em will undergo an equal Pressure; for the Parts of the Quicksilver R N Q S, and C O M I, being of an equal Height, are likewise of equal Weight; and since they are at rest, they must have the same perpendicular Pressure; the Part R S, which is in the open Air, will be as much pressed by the perpendicular Column of Air T R S V, as the Part C I, which is in the Tube, by the incumbent Column of Quicksilver Z F C I. And to conclude; each part of every thing that has Air impending over it, suffers as great a Pressure as if there were a Column of Quicksilver of 28, 29, 30, or 31 Inches upon it, according to the Heighth in which it is found at that time in the Barometer.

Now, according to our Experiments, as well as those of others, Quicksilver is about fourteen times as heavy as the like quantity of Water; and so the Air presses as strongly upon every thing over which it is impending, as if there were fourteen times twenty eight Inches, or reducing the same to Feet, as if there were 32 $\frac{1}{2}$ Feet of Water (taking it at the very lowest) lying upon it.

Sect. X. *A Barometer of Water and Lye, and some Experiments.*

Now that we may not be here mistaken in the Deduction of Consequences, which often happens in Physical Enquiries (forasmuch as when we think to have deduced by good Arguments a second Phænomenon from a once made Experiment, we do not always find the matter of Fact to agree with our Thoughts; since in the second Trial, other Causes may likewise intervene and co-operate, which we did not think of in the Deduction, as it happens to those that exercise themselves in such Enquiries more frequently than they could wish;) I therefore took a Tin Tube of 36 Foot in Length, but found, tho' it had been made with great Exactness, that it was not compleatly Wind-tight; wherefore there was another Tube of Glass of about the same length prepared, in order to make it a Barometer of Water: This was fasten'd to a piece of Wood, and then tied to the Sail of a Wind-mill, and so let down perpendicularly, its lower end being first stopp'd with a Cork and Bladder; after which, it was filled full of Water from above, stopping at every turn till the Air got above the Water: being full, it was after the same manner carefully stopp'd with a Cork and Bladder; then the lower Orifice of the Tube that stood in the Water being open'd, the Water in the Tube immediately descended, but stood still at the Height of about 33 Feet, as the Quick-silver does in a Barometer, till the upper Orifice being likewise unstopt, and the Pressure of the external Air thereby admitted, the whole Mass of Water that was in the Tube suddenly subsided into the Cistern. Thus this Experiment shews the Agreement between the Matter of Fact,

Fact, and the Consequences that we have before deduced touching the proportionable Gravity of Water and Quicksilver; namely, that Air presses upon all Bodies with the same Force as Water would, if it were incumbent on them about 33 Foot.

If any one should have a Mind to try the same Experiment, but had not the opportunity of procuring from proper Glass-Blowers such a Tube of 36 Foot in Length, he may, as we do, make use of the broken Necks of Bolt Heads or little Chymical Phiols, which being thrust into one another, may be joined with the *Emplastrum de Minio*, or Red Lead, mix'd with Oil of Olives, and boil'd up to the Consistency of a Salve; and putting a wet Bladder over it, bind it about with a small Packthread: This will make a Tube as perfectly Wind-tight for a while, and as good for the Purpose, as if it had been one whole piece.

Another thing which must not be here past by, is, that the subsiding of the Water with an infinite Number of little Bladders, appeared ascending thro' the Water; which did not proceed from the external Air, but from that which was in the Water; the Cause of which was, that by the subsiding of the Water there was an empty space left above in the Tube, and consequently the Pressure upon the Water was remov'd; whereupon the Air that was in the Water, expanding it self, ascended just after the same manner as we see it happen in Water, under the Bell of the Air-Pump, when the Air that pressed upon it at first is exhausted.

They that desire to be entirely satisfied of what we here mention, may fill the Tube of the Barometer (*Tab.* XIII. *Fig.* 2.) A O M, with Water instead of Quicksilver, and place it in the Glass Vessel that is likewise filled with Water up to B D; then

then pumping the Air out of the Receiver H G L, they will see the Water subside from A to F, and lower; but in the mean while, numberless little Bubbles ascending in the Water for the Reasons before-mention'd; and that those Bubbles are really Air, and not Water it self, may appear, *First*, By letting the Air into the Bell again, because that the said Air remaining above at A F, will hinder the Water from being pressed by the Air P, and rising higher in the Tube than F. *Secondly*, Because if you exhaust the Air that is in the Receiver at P any farther, the Air at A F expanding it self, will press the Water a great way beneath C I, or B D, where descending only by its own Weight, it would have stopp'd by it self. *Thirdly*, For a farther Proof of the aforesaid Proposition, you may see by taking away the Receiver H G L, and holding a Coal of Fire near the Air at A F, that the Water being rarified by the heat of the Coal, will be pressed down to Z F; which assoon as the Air at A F becomes cold, will ascend again.

I find these Particulars among my Notes upon this Experiment, to prove that it is not possible to make a lasting Barometer of Water, which would otherwise have a great many Advantages over those of Quicksilver. If instead of Water one should take Lye (which tho' it had stood six Years in the open Air, had never admitted any Air into it, at least as far as could be discover'd by the help of an Air-Pump) it might perhaps furnish us a useful Barometer, and in my Opinion, even better than one of Water, out of which the Air has been driven by Boiling, because after a while the Air mingles it self again with the Water.

I hope this Account will not be uncacceptable to such as do not understand the true Properties of the Barometer, tho' it be now very common; the rather, because what we have said above (namely,

(namely, that the Force with which the Air presses upon all things is equal to that of a Column of Water of about 33 Foot in Height) is shewn in all its Circumstances; and so every one that represents the thing to himself, may consider the terrible Powers which, tho' he feels nothing of 'em, are continually exerting themselves upon, and round about him.

Sect. XI. *The dreadful Pressure of the Air upon a Man.*

Now to shew the incredible Greatness of that Force which the Air exercises upon our Bodies, let us for once suppose (it being too laborious and unnecessary also to describe the same with the utmost Exactness) that a Man of six Foot in Height, is one Foot in Breadth from Top to Bottom, the broader and narrower Parts being reckon'd together; so that the Superficies of his Body, both before and behind, may comprise 6 Foot each, the roundness of the Sides being counted in, if this Computation should seem too large.

Now according to what has been said, every Foot in Breadth sustains as much Weight as if there were a Column of Water of 30 Foot at least upon it; we put 30 instead of 33 Feet here, because the Air has a different Weight at different Times, and the very smallest of it will be a sufficient Proof of our Hypothesis.

And every Cubical Foot of Water weighs about 63 Pounds, as we have found it upon Trial, tho' others make it a little heavier, which may proceed from several Causes, such as the difference of Waters and Seasons, and of the mixture of more or less Air therein; but this is not material, for the smallest Weight is here the strongest Proof.

This

This then being ſuppos'd, altho' this Preſſure upon our Body is moſtly ſidewiſe, and (excepting that upon the Head) is rather a lateral than perpendicular Preſſure; yet it is well known to thoſe who underſtand *Hydroſtaticks*, that by reaſon of the height of the Air, and the ſmallneſs of a Foot with reſpect thereto, there is little difference between the lateral and perpendicular Preſſure; and he that is no Mathematician may likewiſe experience the ſame; becauſe, whether he ſtands upright, or whether he lies all along upon the Ground (at which time the Air will preſs perpendicularly upon every part of his Body) he does not perceive the leaſt Difference. From whence it then follows, that upon every Superficies of one Foot of our Body, there always lies a Weight of 30 times 63, that is, 1890 Pounds; and accordingly, upon 6 Foot, which we have ſuppoſed to be the Breadth of the Body, 6 times 1890, that is, 11340 Pounds, with which Weight our Body is preſſed only before, or behind; ſo that if you take the whole Force of the Preſſure, which is equally ſuſtain'd on both ſides of the Body, the whole Weight will amount to 22680 Pounds. Now to avoid any miſtake, we will ſuppoſe it in round Numbers to be no more than 20,000 Pounds, which is certainly not too much.

Sect. XII. *Convictions from the foregoing Obſervations.*

Now could any Body have imagined, if this irrefragable Truth had not been demonſtrated by the plaineſt Experiments, that when he thought he was free and felt nothing, he ſhould be loaded upon every part of his Body before and behind with no leſs a Weight than that of 20,000 Pounds; and that nothing could have ſaved him from being

cruſhed

crushed to pieces by so terrible a Force, than that exact Balance of another Force against it; whereby the one operates just as much in favour of us, as the other would do to our Prejudice.

Now that this most astonishing Force would be more than sufficient to crush our Body to pieces, can be doubted by no Body; forasmuch as if the Pressure of 10,000 Pound Weight upon one side should cease to resist or balance the like Weight on the other, our Body would feel the same, just as if a Weight of 10,000 Pound did press upon the forepart of it, not only slowly and gradually, which yet would be enough to deprive us of Life, but as much as if the like Weight of so many Thousand Pounds were suddenly cast against our Body: For the Elastick Power of the Air, if the Balance thereof be taken away, exerts its Pressure with a more terrible Velocity than can be imagined. Now since every one of us is bound to acknowledge herein a Power preserving him every Minute from utter Destruction, and that the same Power operates according to the Rules of a wonderful Wisdom; can we do otherwise than ascribe all this to an infinitely Wise Director? And if it cannot be deduced from ignorant Causes, let the Atheist consider with himself what he has to expect for such blasphemous Negations of so wise and mighty a Being.

Sect. XIII. and XIV. *Experiments shewing the Pressure of the Air.*

Now as strange as all this may appear to any Body, yet all they who are used to Pumps, know that it is true: For if on the Top of a round Brass Vessel (*Tab.* XIII. *Fig.* 3.) which is open at C D, you fix a flat Glass A B, which is adapted to the upper Orifice thereof; and (to prevent the

the entrance of the least External Air N, and mixture with that of K in the little Vessel) thro' the Passage which is between the Glass A B and the Circumference of the Vessel, it being stopt with a mixture of Sheeps Suit and Wax, and so set down together upon the Brass Plate H I, of the Air-Pump and its Leather; then the Glass A B (like all others that are in the Air) will remain wholly unmoved between the equal Pressure of the opposite Air at N and K, as is sufficiently known.

Now that this only happens on account of the exact Balance of both those Columns of Air, by means of which the Air at K presses the Glass upwards with just as much Force as the same is prest downwards by that at N, may appear from hence; forasmuch as when the Force of the Air at K is never so little diminished by pumping out some of it, one shall see that the Column E A B F, of the external Air N, pressing upon the other side of the Glass, will not only burst it, but will break it all to pieces, with a Noise like the Discharge of a Gun; which to perform in the like manner, would require a very great Strength and Swiftness in the blow of a Hammer.

The said Force of the Air appears likewise by exhausting as far as one can the Air out of a Globe of Glass A B (*Tab.* XIII. *Fig.* 4.) and afterwards having turned the Cock E, by taking the same off and placing it in a Vessel of Water L F G M, with its Orifice D downwards. Then turning the Cock E back again, whilst it is under Water, so that the said Water may enter into the Globe by the part D B; whereupon immediately as soon as the Cock E is open'd, the Air at H and K, gravitating or pressing upon the Water L M, which is on the outside of the Tube D B, exerts its Force, causing the Water to spring thro' the Tube into the empty Globe with as much Vio-

lence and Swiftness as a Fountain, so that it will very much surprise those that have never seen the like.

Now the Cause thereof is, that by exhausting the Air out of the Globe A B, the Opposition or Resistance is likewise taken away; which otherwise, when the Globe is full of Air, does with equal Force withstand the Water to be driven up thro' the Tube D B, by the Pressure of the external Air at H and K, is plain from hence; because we know that upon admitting the Air again into the Globe, and putting every thing in *Statu quo*, there will not be the least Motion discover'd in the Water; which being pressed upwards and downwards with equal Force in the Tube B D, between the two Powers of the Air within and without the Globe, reciprocally acting upon each other, does consequently remain quiet, and, as far as it appears, without any sensible Disturbance.

Sect. XV. *Convictions from the foregoing Observations.*

Now I submit it to any Body, who from what we have here said has attained to a true Idea and Conception of these dreadful Powers of the Air, whether instead of believing that all things in which he can discover no Motion round about him, do remain at Rest; whether, I say, he is not now convinced that he is every moment of his Life encompass'd with such a Force as acts upon him and every thing besides; and of which, if the Wisdom of the great Director did not hinder it by an *Equilibrium*, from exerting all its Strength upon him, the half only would suffice to crush him and every thing else breathing, to pieces; and consequently, whether he can imagine, that it is by mere Chance only, and without any Wisdom, that

while he walks in the midſt of it, he is preſerv'd from the fatal Effects thereof; the rather, if he does at all reflect upon the following wonderful manner of ſuch Preſervation. As *firſt*, that a very ſmall Quantity of the Air, and which is hardly worth naming, ſhould be capable of making a Reſiſtance, and of balancing an unſpeakable greater Quantity thereof, and hinder it from cruſhing moſt of the things that are under it. *Secondly*, that beſides ſuch a Reſiſtance, the aforeſaid ſmall Quantity of the Air does equally operate and gravitate with all the reſt of the Air extended even to the Clouds and higher. Now as the firſt hinders every thing from being deſtroy'd, the ſecond is no leſs uſeful to Men, tho' they are capable of uſing but a very little thereof.

Sect. XVI. *A little Air reſiſts a greater quantity.*

One may ſee an Inſtance of the firſt in *Tab.* XIII. *Fig.* 3. where a Glaſs A B, impervious to the Air, is placed upon a little Veſſel A B C D; which ſtanding upon the Braſs Plate and its moiſten'd Leather H I, is thereby cloſed at Bottom, as it may be after another manner, if People will, ſo that the little Air at K, remaining incloſed therein, makes ſo equal and ſo compleat a Reſiſtance againſt the Air E A B F (which otherwiſe, as we have ſhewn above, breaks the Glaſs, and being extended from the Top of the Clouds down to the Earth, does a thouſand times ſurpaſs the Air at K, both in Quantity and Gravity) that the Glaſs A B, tho' never ſo thin and brittle, is not in the leaſt hurt thereby.

Sect.

Sect. XVII. *A little Air gravitates as strongly as a great deal.*

The *Second*, by which we see that a small quantity of Air (besides the Resistance abovementioned) does likewise gravitate and press equally with the whole external Air, may be first proved by *Tab.* XIII. *Fig.* 2. where the Quicksilver in the Barometer A I, with its little Glass B X, standing in the open Air, is thereby raised and suspended to the Heighth F I. Now if you cover the whole with the Glass Receiver H G L, so that no Air besides that which is in the Receiver can act upon the Quicksilver at B D; yet you will see that that which is in the Tube will preserve the said Height of F I. So that it is here proved unanswerably, that the Air in the Receiver, how little soever it be, gravitates as strongly, yea even more upon the Quicksilver B D, than the whole external Air had done before.

But in *Tab.* XIII. *Fig.* 5. you may have an ocular Demonstration of it, if you place a long Tube F O (like that of a Barometer, but open at both ends) in a little Glass Vessel G K P Q, thrusting it thro' the Covering of the said Glass Vessel G K at I, and closing it round about; into this Vessel you must pour thro' the little Hole at N, (which was stopp'd before with a Screw) some Quicksilver, till it rise up to B D, a good deal higher than the End of the Tube O, whilst the rest of the Vessel B D G K, has nothing but Air in it. Then stopping again the little Hole at N with the Screw, set the whole Apparatus under the Receiver H S L, and exhausting the Air V V, you will see that the little included Air at G B D K, will lose its Resistance, and pressing upon B D, by its rarifying and expansive Faculty, will force the Quick-

ſilver in the Tube to aſcend to the Heighth of F; which was about the ſame with that at which the Quickſilver remained ſtanding in a Barometer, when ſuſpended by the Preſſure of the whole Air.

Sect. XVIII. *The Difference between the Gravity and Elaſticity of the Air.*

Now the firſt (that is to ſay, the Reſiſtance which a ſmall Quantity of the Air makes againſt a greater) is common to all other Liquids, according to the wonderful Laws of *Hydroſtaticks*, to which the weight of all Fluid Matters ſubmits itſelf in its Operations. Accordingly, we ſee that all Liquors preſs'd upon, do either preſs reciprocally, if they be elaſtical, or otherwiſe reſiſt like ſolid Bodies; as may be experienced in a cloſed Syringe or Air-Pump, in which there is either Water or Air; this laſt Effect however, ought to be rather aſcribed, as we think, to the Air's Elaſtick Faculty, than the Weight thereof, which appears from hence, that the weight of the included Air G B D K, does hardly bear any Proportion to that of the Quickſilver in the Tube F I; and again, becauſe if we ſhould fill the ſpace G B D K, where the Air is, with a heavier Matter, or with Quickſilver itſelf, the Quickſilver in the Tube (tho' the Air were exhauſted out of the Bell) would not riſe higher than I.

Sect. XIX. *How the Elaſtick Power of the Air works by the Gravity thereof.*

Now in order to underſtand in ſome manner, how the Weight of the Air and the Spring thereof, do produce theſe their Operations with one another, we muſt repreſent to ourſelves, that in *Tab.* XIII. *Fig.* 6. there is a Column of Air, A,H, conſiſting

consisting from Top to Bottom of a great number of Air Particles, such as A, B, C, D, E, F, G, P, *&c.* each of which have a certain Weight, whereby they gravitate upon those that are under them.

We must likewise suppose, that in each of them (of what Figure soever they be) there is an inherent Elastical Power, by which, like the Steel Springs of Watches, *&c.* being bent together, they endeavour to expand themselves again with the same force wherewith they were bent.

From hence it follows, that the lowermost Parts of the Air, G and P, *&c.* bearing the Weight of all those that are above 'em, must be more bent than those that are higher and bear a lesser Burden, as A B C; for which reason the undermost, P G, endeavouring more forcibly to restore themselves, will press the Body I K, that supports them, with more violence, as those that stand above the Body N O, do the same.

And so far the Point H bears no more than the Weight of all the Air-Particles A,B,C,D,E,F,G,P, *&c.* which stand upon one another, without any remarkable Alteration of the Elastick Power.

But if we proceed further, and place another solid Body between these Air Particles, thereby cutting off those that are at P and G from the aforesaid Column, and likewise encompass the place L I K M by solid Bodies, in such manner, that the Air Particles, P and G, are entirely separated from the others. If now (as in Water which has little or no Elasticity) the Parts P and G did press by their Weight only upon the Body I K at H, the said Body I K, would be so much less pressed than before, that the Body L M was placed above G; forasmuch as I K does now only bear the Weight of P and G; whereas it had born before, the weight of all the Parts of the Air of which the whole Column A P consisted.

But ſuppoſing on the contrary, that the Parts A, B, C, D, E, F, G, P, had all, like the Air, an Elaſtick Faculty, and ſhould again endeavour to expand themſelves in Proportion to the Preſſure of thoſe above them, the Body I K; will then be preſſed as much by theſe two Parts P and G, as it was before by the whole Column of Air from A to P; for ſince the Parts P and G, that were cut off, are continued in the ſame Inflection, by the Reſiſtance of the ſolid Body L M, which they had acquired by the weight of the incumbent Parts A, B, C, D, E, F; their Expanſive Faculty, and conſequently the Gravitation or Preſſure which they make upon the Body I K at H, will remain equally great.

And thus we ſee, that the weight of the Air Particles, bearing upon one another from A to P, do preſs the lowermoſt P G; and bending the ſame, do encreaſe their Elaſtick Force; ſo that how little ſoever they might have been, whilſt by the Reſiſtance of a ſolid Body I L M K, they were hinder'd from expanding themſelves farther, theſe few Parts P G, that are cut off and excluded from the reſt, do preſs the Body I K, upon which they act, as much as if the whole Column of Air A P remained over them.

Now, that this laſt obtains in the ſeparated Parts of the Air, has been lately ſhewn in §. xvii. from the Effects of the included Air in the Place G B D K.

Sect. XX. *The Air that bears moſt Weight is moſt compreſſed.*

What we have juſt now ſaid, namely, that the undermoſt Parts of the Air, P and G, being preſſed by a greater weight of thoſe that are above them, will be more compreſſed than thoſe of D and E, which have the ſhorter Column of Air

Place this fronting Page 388

TAB. XIII

NB. Thro' a miſtake of the Engraver the Tables following this, are falſe Numbered, that marked XIII. ſhould be XIV. and ſo of the reſt.

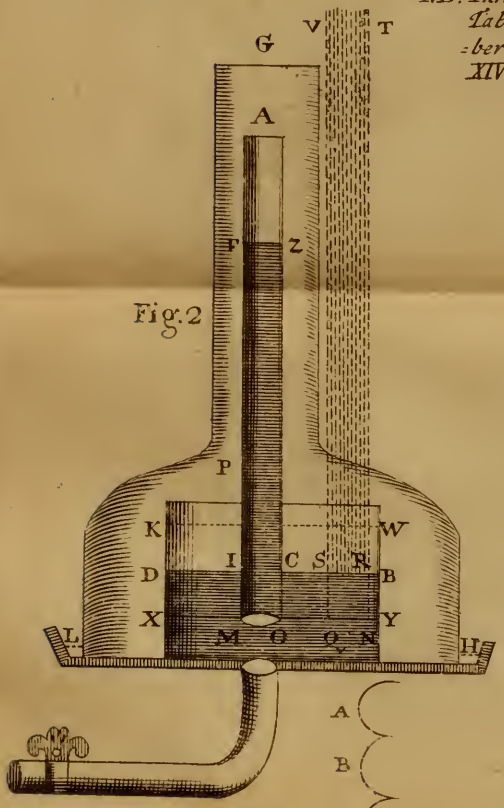

Fig. 2

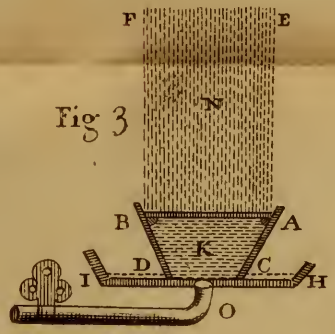

Fig 3

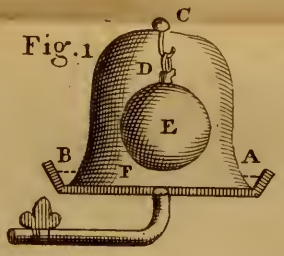

Fig. 1

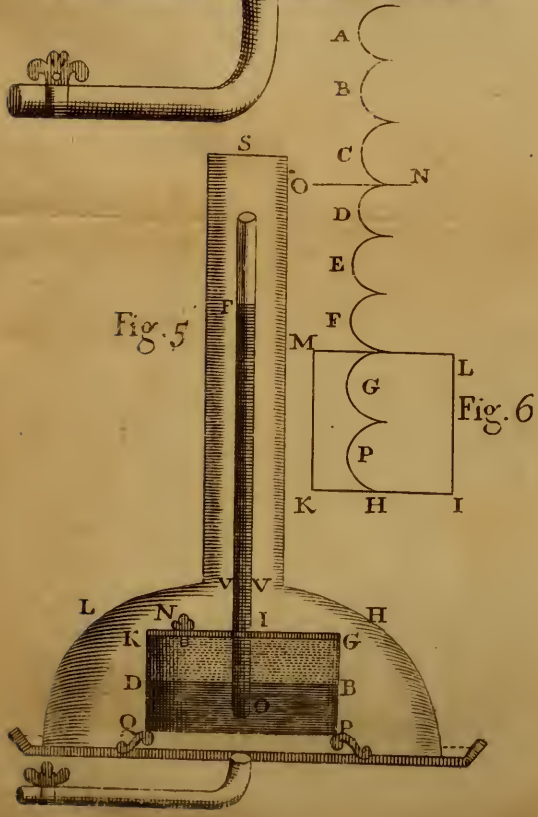

Fig. 5

Fig. 6

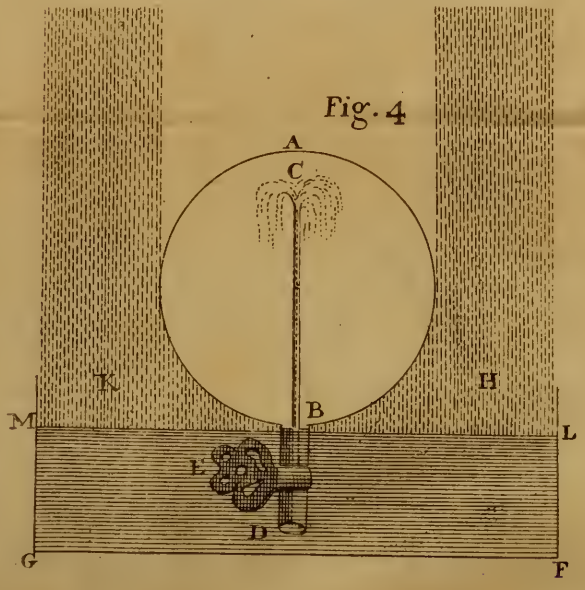

Fig. 4

Air, A C, over them, and conſequently a leſſer Weight, may be proved by the following eaſie Experiment among others: Take the Tube of a Barometer (*Tab.* XIV. *Fig.* 1.) let it be open at I, and ſhut at F; fill it with Quickſilver ſo far as to leave a little Air at the Top of it; then ſtop the Orifice I with the Finger H, and turn it ſuddenly upſide down, ſo that the Finger which was before at the Top, may now be at the Bottom. This being done, you will ſee that the Air that remained in the Tube, and which, by the inverting thereof, does now bear the Preſſure of the whole Column of Quickſilver, will be immediately contracted into a much narrower ſpace than it was at I; and that as it aſcends thro' the Quickſilver from I to F, it will continually poſſeſs larger Spaces, becauſe the incumbent Quickſilver does continually loſe of its Heighth above it; and therefore the higher theſe Air-Bubbles come, the leſs Weight they feel; and this is the reaſon why they appear to us larger at A than at I, at B than at A, at C than at B, and ſo on, till they have got up as high as F, where being no longer preſſed, they are expanded to the utmoſt Bigneſs.

We may likewiſe ſee the ſame Appearances, but with leſs difference of Size, if we fill the Tube with Water inſtead of Quickſilver: From whence it may be then concluded, that the Air which bears the greateſt Weight, is alſo the moſt compreſſed.

Sect. XXI. *Air that is moſt Compreſſed, is moſt Elaſtical.*

Now that the Air that is moſt compreſſed, does make the ſtrongeſt Efforts to dilate or expand itſelf again, and accordingly preſſes more powerfully upon all the Bodies about it (beſides, that the

same appears from the Wind-Guns, and the little Fountains of *Hero Alexandrinus*) may be prov'd by a very easie Experiment, (*Tab.* XIV. *Fig.* 2.)

Take a Syringe S D (those that are used in Anatomical Operations are, by reason of the Narrowness of the injecting Tubes, very fit for this purpose) and drawing out the Piston S C half way as far as C, so that the Part A B remains full of Air; put the End or Nose of it D, in Water, which will enter into it, by drawing back the Piston to F G; then screwing upon it a little Tube D E, which has a small Orifice at E, if you lay the Syringe horizontally, so that the Water A may cover the Hole D, and the Air B remain over it, you will not be able to discover the least Motion therein; but if you suddenly, and at once, protrude the Piston from F G, to C, so as to make the Water spout out at E, and the Air at B is the more compressed thereby; tho' you should immediately stop the Piston again, you will yet find, that the Air at B being more compressed, does likewise expand itself with greater Force, and presses upon the Water A; so that the Stream of Water E K, does thereby continue for a long time to run out at E, even tho' the Piston do lie still at C, and presses no farther; from whence what has been said above is proved.

Sect. XXII. *Convictions from the foregoing Observations.*

Now, if any would contemplate the aforemention'd Laws, and how the formidable Power of the Air is so wonderfully balanced by so small a part of the same; Can he still imagine, that all this is owing to Chance, without any Design or Wisdom of the Maker?

Without such a Law, and in case that the little Air which is in a Chamber could not sufficiently balance

balance the vast Ocean of the external Air, how could it otherwise be, but that all our Glass Windows, like the Glass Vessel mention'd in §. xiii. should be immediately broken into small Pieces? Forasmuch, as according to the preceding Calculation §. xi. upon every square Foot thereof there is a continual Pressure of above 1800 Pounds Weight. Without this Law, how could an Army Tent, a Peasant's House, or a Shepherd's Cottage, yea even the most stately Edifices, remain standing? Since, if they be taken in their Largeness and Circumference, as an Apartment, which being but ten Foot in Length, and of the same Breadth and Heighth like a Dye, the four standing Sides, and the Ceiling, being each 100 Foot broad, and each pressed upon with 189,000 Pounds Weight, and consequently the whole Apartment would be pressed with five times as much Weight upon all its Sides, on which the Air is incumbent, that is to say, with a Weight of 945,000 Pounds. Whereas in the space of 1000 Foot, which the whole Compass thereof contains, the whole Body of Air that resists such an External Pressure, would not gravitate more than 63 Pounds; supposing, with many Enquirers, that a Cubic Foot of Water weighs 63 Pounds, and is a thousand times heavier than a like Foot of Air. Without this Law, how is it conceivable that we, who are continually pressed with a weight of above 20000 Pounds round about us, should not have been long since crushed to Pieces, since the third Part thereof is able to do it? And in case our Breast, by the Roundness of its Ribs and Cartilages, might make some Resistance, how comes it, that our Belly and Loyns are not pressed flat and close together by such a Force, were it not that they did contain some little Quantity of elastick Air, which, tho' so very small, is yet able to balance so terrible a

Pressure

Pressure? 'Tis by such included Air, that we see those Creatures that are put into a Glass Vessel, from which the Air is exhausted by the Pump, swell and grow bigger as soon as the said Air within them expands it self, for want of an external Resistance and Balance. This Experiment I find in my Notes to have been made upon a *Mouse*, a *Kitten*, and other such little Creatures.

Now can any one imagine, that forasmuch as without this wonderful Balance (by which a small parcel of Air is able to make head against a mighty Column extended from the Surface of the Earth up to the Clouds and higher) no House would be habitable, no Creature could remain alive, but every thing in the World would be broken and crushed to Pieces) I say, can any one imagine, that it is by Chance, and without any Design of the Creator, that there is such an amazing Balance provided against these great Powers, and that the Air and other Fluids are bound by certain Laws of Gravitation, which are observed to be so different from those in solid Bodies? And whereas the last do only gravitate in proportion to their Weight, that in the Air, and other Fluid Bodies, as has been shewn before, a little Portion of 63 Pound in Weight, can hinder a perpendicular Pressure of 180,000 Pounds, and a lateral Pressure of about 900,000 Pounds from exerting its Force.

Miserable Philosophers! who finding themselves every Minute of their Lives preserved after so wonderful a Manner against such dreadful Powers, from sudden Death and other frightful Effects; yet that they may not be forced to acknowledge with Gratitude, the Wisdom, Power and Goodness of their glorious Creator, will rather ascribe all to mere Chance, operating without Laws or Reason, or else to Causes wholly ignorant of what they themselves are doing! In Case there were a Room

of

f ten Foot in Length, and as much in Breadth, ıe Ceiling of which were made of Lead or heavy tones, weighing 180,000 Pounds, which being ›oſe on all ſides, was only ſupported by a ſimple alance, and thereby hinder'd from falling down pon the Floor, and cruſhing every thing to pieces nat ſtood in its way; and in caſe one ſhould then ut into the Hands of one of theſe Philoſophers, . Weight of 63 Pounds, and with that only, and vithout any Mechanical Inſtruments (at leaſt any hat were made of a ſolid Matter) bid him Ba- ınce that mighty Weight; could he expect any hing elſe upon entring into a Chamber in ſuch . Poſition, but the miſerable Death of being ruſhed to pieces? And then if another Perſon, ›y inventing ſuch a Method, could prevent the all of this threatening and dreadful Weight with ı Counterpoiſe of 63 Pounds only, without any Mathematical Inſtruments; would he not, if he ıad the leaſt ſpark of Generoſity in him, own the Wiſdom of the Inventer, (tho' he could not diſ- :over the Manner how) and extol it far above his ›wn? And if he did not know the Manner, but vas at the ſame time ſenſible that his own Power vas much too weak to preſerve himſelf by putting he ſame in Execution, would he not think himſelf ›ound to confeſs with Gratitude, the Power and Goodneſs of this his Preſerver? And can he then live :aſie in theſe Circumſtances, and without making ıny Reflections upon them? Can he, knowing the errible Greatneſs of theſe Powers (with which he s ſurrounded, and which if the Balance ſhould ceaſe o perform its due Functions, would threaten him vith the ſame Dangers, and even with as unavoid- .bleDeſtruction, as if he were to have expected the all of ſuch a heavy Ceiling) ſtill proceed, after be- ng ſo wonderfully ſaved, blaſphemouſly to diſown

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the Preſervation? And the more, ſince if he underſtands the uſe of the Barometer, the ſame would teach him, that theſe Gravitating Powers, as well as their Balances, are daily encreaſed and diminiſhed by Cauſes, which if he does know, yet neither he, nor any Man living can prevent; ſo that it is impoſſible for him here to ſcreen himſelf behind Laws of Nature fixed and immutable, and always obſerving the ſame Courſe.

And to ſay no more, when he muſt confeſs, if he reflects upon what follows, that this Gravity and Elaſticity of the Air, is ſo entirely neceſſary to the Support and Convenience of Men, of Beaſts, of Fiſhes, of Plants, that without the ſame, whatever lives upon this Globe would immediately periſh: And this Preſſure of the Air, among all thoſe Advantages which it imparts to all things, does likewiſe carry along with it this great Diſadvantage, that it is capable of bringing the whole Earth, and every thing upon it, to the extreameſt Confuſion, by cruſhing to Pieces and, as it were, annihilating all that it ſurrounds, with its reſiſtleſs Power. Can he think that it is by Accident, and without Wiſdom, that there is a Means found out, by which every one is permitted to enjoy the Benefits of the Air, and yet is ſo well ſecured againſt the pernicious Effects thereof, that this great Preſſure, and this terrible Weight, is in a manner inſenſible and unobſervable even to the moſt tender Perſons?

Once again, if all theſe Experiments about the Gravity and Elaſticity of the Air, about its dreadful Force and wonderful Balance, by which the ſaid Force is hinder'd from deſtroying every thing be not ſufficient to convince an unhappy Sceptick that there is a GOD, who in his Wiſdom has brought all this to paſs; let him go a little farther with us, and anſwer ſincerely, whether ſeriouſly reflecting upon all theſe things, he ſpeaks with

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Conviction of Conscience, when he asserts, that it seems to him to have come to pass by Chance, and without any wise Direction, that such a great Sea of Air has fixed itself round about the whole Globe of the Earth; which, if one may judge according to the most probable Opinions, is extended to some Miles in Heighth; and without which, every thing that breaths, would give up the Ghost. And who is there that cannot say experimentally, how much all humane and other Creatures are depending upon it? Which, tho' they are able to want both Sleep and Food for some Days, yet if they be depriv'd of this Air but some Minutes, they will infallibly perish. And how necessary the Air is to them, will appear particularly from hence: That during the whole space of their Lives, they are continually employed in breathing it In and Out; so that both these Functions even at the time of Sleep (which does otherwise free them from all their Labours) must be incessantly discharged, and without any Rest at all, if they desire to live.

Can even the boldest *Epicurean* imagine that so necessary a Substance has by mere Chance surrounded this Globe of the Earth, upon which all Men and Beasts are placed by God, who would have bestow'd all his Art, Wisdom, Power and Goodness in vain, nor would those noble Creatures have been able to have liv'd one Hour after their first Production without it. Nay, tho' they had sprung up out of the Earth like Mushrooms, according to the undemonstrable, or rather ridiculous notion of *Epicurus* himself, yet he, and all his Followers must agree, that without Air they would have return'd to it again, and the World would have been without any one Man that could have lived or breathed but one Day.

Has there not then the Hand of a wise Creator been visibly employ'd herein, who has made this Air

for

for the Preservation of Men and Beasts? To what purpose is their Body provided with such Instruments, which serve alone to this, and to no other end, than to enable them to enjoy the use of Air? And, not to repeat all that has been said before concerning Respiration, why have they *Lungs*, unless it be for the Reception of Air? Why do they lye in that place, and in such a Disposition, that the whole Mass of Blood may pass so often thro' them, but that it might partake of the Operation of the Air? Why are the *Diaphragm*, *Ribs* and *Cartilages* of the Breast so framed, that their principal, if not only Function consists therein, to draw in and drive out this Air from the Lungs? To what End, that we may say no more, is this most ingenious Structure, which that it may not be easily hinder'd in so necessary a Work, does employ about a hundred Muscles in that whole affair of Respiration? Why are most of the Instruments which are useful herein, formed already in a Child before it is Born, and at a time when there is not the least occasion for them, were it not that at the very instant when the little Creature comes into the Air, it should be able to use them for the support of its Life? And if these Philosophers can with a safe Conscience maintain that *Air*, and the Instruments of our Respiration have each of them acquired their Existence without any Design or Wisdom, why don't they say the same when they see a curious Strong Box open'd and shut with a fine Key adapted to it? Certainly if they would be counted wise Men, they would not dare to affirm it before any rational Creature.

SECT. XXIII. and XXIV. *The Elastick Power of the Air is the Cause of Suction; confirmed by an Analogous Experiment.*

IF the Air be produc'd by Chance; if it be by Chance also, that it is endowed with an Expansive and Elastick Power; it is then by the same Chance that any Child could ever suck a drop of Milk out of its Mother's Breast: For in case the Air, by the aforesaid Power, did not press upon all the Parts of the Breast, and cause the Milk to spring out of it at the time when the Child does, as it were with a natural Air-Pump, make a Vacuum in its Mouth before the Orifice of the Nipple, the least drop of Milk would not come out of it; by which means Young Children, and all other Sucking Creatures, would be bereaved of their best and most agreeable Sustenance. Now, can any one imagine, that in the Structure of the Breasts of Females, and that of the Tongue, Lips and Cheeks of Children, there should be found such an Aptitude and Faculty of making use of the Elastick Power of the Air, in a Business of such vast Importance as is the Sucking of New Born Children, whilst there is no other so apposite and so convenient a Method for that purpose; and that this Power of the Air, and the adapting thereof to those Instruments employed by Children in Sucking, should be only Accidental, and produced by an Ignorant Cause, without any respect to such a Design?

If a Man should look back to *Tab.* XIII. *Fig.* 4. and peruse again what we have said in §. xiv. when he sees the Water B C, spouting up into the Globe A B, exhausted of Air by the Pressure of the external Air H K, upon the Water L M, he may observe an Operation analogous and uniform to that of a Child's Sucking; especially if he will suppose

ſuppoſe the Part A B to be the Child's Mouth, and the Vacuity form'd therein, and the Superficies of the Water L M, to be the Breaſt of the Mother. And that he may be yet more fully convinced of the exact Agreement between that and Sucking, let him ſtop the Orifice D of the exhauſted Globe with his Thumb, and he will feel ſomething, which if he did not know how it happen'd, he would not ſcruple to call Suction.

Sect. XXV. *Convictions from the foregoing Obſervations.*

To ſhew then, before we quit this Subject, the unreaſonableneſs of the Atheiſt from the Preſſure which the Air alone produces in Childrens Sucking; if he dares not maintain, that both the Pumps in a Fire-quenching-Engine do, by preſſing the Water, raiſe a mighty Stream thro' the long Leather Pipe thereof, without being adapted to ſuch a Purpoſe by the Contrivance of the Artificer; Can he with any more ſpecious pretence affirm, that the Air, which by preſſing upon the Breaſt, forces the Milk to flow out of it, has acquired ſuch a Property by mere Chance, to be applied to ſo much greater Uſes, as the adminiſtring Food to a new born Child; and that not once (which perhaps one might affirm to be accidental) but in all the Parts of the whole Earth, where Children, and ſo many thouſand other Creatures are brought forth? Can he not here diſcover a wiſe Deſign of the great Director of all things? Why then does he not as boldly and peremptorily deny the Skill and Ingenuity of the Artificer in the Formation of an Engine or Fountain to raiſe Water, in the Preſſure whereof there is neither ſo much Wiſdom nor Uſefulneſs to be diſcover'd, as is ſhown by the Air in the Circumſtances abovemention'd.

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Once again, if this Elasticity and Pressure of the Air is to be ascribed to Chance only, they that maintain such an Hypothesis for Truth, ought to live in a continual Fear, that the same Chance may likewise alter the Air and deprive it of these Powers, whereby they themselves, and every living Creature besides, will be suddenly suffocated for want of Breath: For if all this comes to pass by Chance, and by the same Chance only is so continued to this very Hour, there is no reason to think but that it may be immediately alter'd by a like Chance; since it is of the very Essence of Chance to have nothing of Certain in it.

Sect. XXVI. *Experiments to shew that Living Creatures will Perish in a Place from which the Air is exhausted.*

Now that such an Apprehension would be very reasonable, appears; *First*, because we are taught by the Barometers, that (as has been shewn once before) this Elastick Force, whether it be from it self, or whether it proceed from a Change in the Weight of the Air, may be often visibly diminished, and upon that account the Quicksilver will subside. And *Secondly*, because a great Diminution of this Elastick Power of the Air is in a manner fatal to all Creatures; certainly to most of those upon which it has hitherto been tryed: For Dogs and Cats, Rats and Mice, being placed under the Receiver of an Air-Pump, become immediately sick and out of order, as soon as the Elastick Power of the Air round about them is never so little diminished; and as it is taken away more and more, they dye in a small space of Time. But if you take them out before they expire, and place them in another Air, the Elasticity of which is greater, they will sometimes recover, especially if the Force of the

Air be not too much diminished before. Birds are usually not able to withstand this Alteration in the Air so long; but generally fall into Convulsions, which are presently attended with Death: Flyes and Spiders (according to my Observations) after three or four Strokes of the Pump, seem to be wholly deprived of Motion, but when brought into the external and more gravitating Air, they begin to shew some tokens of Life again.

From these Appearances, and many more that you will meet with among the Modern Naturalists, it undeniably follows, that unless the Air were, thro' the Goodness of our Creator, preserved in its present State and Condition, whereby every thing breathing is saved from immediate Death; and in case that it were nothing but mere Chance, by which the Air, without being subjected to any higher Laws, is render'd one while Stronger, and another while Weaker in its Expansive and Elastick Powers, every Body would be in a continual Dread, that he himself, and all living Creatures round about him, would inevitably and immediately Perish; the rather, because several things, such as Steel and others, in which there is an Elastick Force discoverable, are often found to be entirely divested of it, by remaining bent a long while; and so it would happen to the Air too, which, after such an Expansion, will not be able to restore itself to its former Elasticity and Spring.

Sect. XXVII. *Atheists deny their own Principles.*

This being proved by so many Experiments and yet we being unable to discover such a just Dread among the Atheists, it must undeniably follow, either, that thro' their Blindness they are hinder'd from observing the Consequences of their own Opinions, and therefore do treat this great Affair

Affair, which is of the utmost Importance to them, with so little Judgment and Understanding: Or, how boldly soever some of these miserable Philosophers may assert the contrary in Words, yet that they are convinced in their own Consciences of the Falseness of their Sentiments, and consequently are perswaded that it is by another Power, and not by ignorant Causes, they are preserved, even without and against their own Will; and thus they deny their own Principles.

Sect. XXVIII. *To Die in an Unelastical Air, is no necessary Consequence of Nature.*

That it is no fixed Law of Nature, that every thing that lives in an Expansive and Elastical Air must immediately die when the Spring thereof is either weaken'd or totally destroyed, and therefore that these miserable Cavillers do torment themselves in vain, to deduce this Appearance from the unknown Laws of *Matter* and *Motion*, or from a Necessity determining every thing, may appear from hence; that the contrary is true in the case of a *Frog*, as many other have observed, of which I find among my Notes the following Experiment; That a *Frog* being put under a little Receiver of an Air-Pump, and the Air being exhausted from thence, not only the Belly thereof, in which one might expect there was Air, but likewise all the other Parts, as, Head, Legs, Muscles, *&c.* were swelled to a great Thickness; which, upon the admission of the external Air, did all subside again, and the Creature return'd to its first Size: But that which is most for our purpose is, that the *Frog* remained a quarter of an Hour in the Receiver entirely exhausted of Air, without appearing to be the least affected with it, and when it was let out, immediately sprung away, as if nothing had ailed it.

SECT. XXIX. *To Die therefore in an Air divested of its Elasticity, is the Result only of the Will of GOD.*

CAN it therefore be denyed, that since all Creatures are not equally affected with the Elasticity and Gravity of the Air, what had been said before must not be admitted to be a general Law of Nature, which taking place between the Air and all Creatures, produces such Effects without Understanding? And must not that Man be allowed to argue much more rationally, that does acknowledge herein the Hand and Work of a wise Artificer, who, that we may not ascribe that which happens to most of the living Creatures with respect to the Air, to necessary and unavoidable Consequences of ignorant Corporeal Motions, has been pleased by such an Exception as this, and perhaps by many others, to shew that all must be resolved into his good Liking and Wisdom; and that he has thought fit that the Air amongst its other Properties, should always preserve a certain degree of Force in its Expansion; without which the whole Globe of the Earth would be in a manner deprived of all Living Creatures? And likewise, that when he thought fit to order it otherwise, he could preserve some of 'em alive without Air.

SECT. XXX. *The Elastick Faculty of the Air is not alone sufficient for the Preservation of Life.*

FOR the proof of this last Proposition, it may likewise be particularly serviceable to shew, that this Elastick Faculty of the Air is indeed necessary to Life, but that it is not sufficient alone. Thus we find in times of Pestilence, that the Air is sufficiently Elastick, but nevertheless Contagious and

Fatal

Fatal. And the great Naturalist, *de Stair*, relates, that not only many other Creatures, but likewise a *Frog* that can live in Air, in Water, and without Air, yet died in a little space of time with an Air or Steam that proceeded from Dough. And Experience does abundantly teach us, that a Living Creature shut up in the same Air, without any Circulation or Change therein, cannot long subsist so, altho' the Elasticity or Spring of the Air were not so much weaken'd, as that we should ascribe the Cause thereto; forasmcuh as it appears, by the Barometers, that the Air by which we are surrounded, can undergo great Alterations in its Elastick Faculty, without any Prejudice to breathing Creatures. But of this Property of the Air, which, besides its Gravity and Elasticity, is necessary for the support of Creatures, we have already said something in our Discourse upon Respiration.

SECT. XXXI. *The Elastick Power of the Air does likewise cause Fish to live and subsist under Water.*

BUT before we take our Leave of Living Creatures, can any one observe without Astonishment, that even the Fish in the Water do receive their Life and Well-being from the Pressure and Elasticity of the Air? which being removed or taken away, scarce any of 'em can contain themselves under the Water, but in spight of all the Resistance, must emerge and rise up to the top of it.

They that would see the Experiment of it, may put some Water and a Gudgeon, or any other little Fish, into the Recipient of the Air-Pump; and removing the Pressure of the Air, will find that a Fish immediately rises up to the Top, but upon letting in the Air, it will sink down again. The Reason thereof, and how the Bladders within their Body being dilated by the diminution of the Air's Pres-

ſure, and becoming larger, do render the Fiſh ſo much lighter than Water, as to make them aſcend, ſhall be more fully treated of hereafter, when we come to conſider the Nature of Beaſts, *&c.*

Now ſince moſt Fiſhes are of ſo wonderful a Structure, that they can and muſt make uſe of the Preſſure of the Air, in order to remain under the Water, and in ſuch Places as are moſt convenient for them, without being forced to Aſcend or Deſcend againſt their Wills; and that all of 'em, without ſuch a Preſſure of the Air, being forced to the Top of the Water, would ſoon be deſtroyed; let us draw this Concluſion only here, That he muſt be a very ſtrange Perſon that ſhall maintain, that the Air and its Preſſure, ſo very neceſſary in this caſe, is produced upon the Earth by meer Accident, and without any view towards ſo uſeful an Operation; and that the Fiſhes are likewiſe formed caſually, juſt after ſuch a manner, as to be provided with Inſtruments by which they can encreaſe or leſſen the quantity of Air, for the aforemention'd Purpoſes.

Sect. XXXII. *Plants do alſo live by Air.*

The Air is not only of ſuch great Uſe to Men, Beaſts and Fiſhes, but even to Plants themſelves, which vegetate thereby in ſuch a manner, that a great Part of the Sap with which they are nouriſh'd, is compoſed of it. Wherefore, in caſe Men could have lived even without Air, yet they could not have enjoyed ſufficient Food from the Earth without it, becauſe it contributes ſo much to the Fertility thereof, which is well known to the Husbandmen, who for that reaſon Break up and Plough their Lands ſo frequently, in order to expoſe them to the influence of the Air.

However, if what we have here ſaid, be not clear nor intelligible enough to any one, namely, that

that Air insinuates itself into Plants, and that they cannot grow without it, they may consult those accurate Enquirers into the Nature of Plants, *Malpighi* and *Grew*, concerning the Air-Vessels which they have discover'd therein by the help of Microscopes; and *Boyle* and *de Stair*, concerning their Observations with the Air-Pump: these Gentlemen having shewn, that Air can be drawn out of Plants placed *in Vacuo*. But he that would have ocular Demonstration thereof, let him take a little piece of a Twig from a growing Tree, or Green Leaves cut asunder, and other Parts of Plants, and tie them to a Nail, or any other heavy Matter, and put them into a Glass in which there is *Lye*, made of *Salt* of *Tartar*, or *Pot-ashes*, in order to make them sink down into it; then putting them all together under the Receiver of an Air-Pump, and exhausting the Air out of the Receiver, he will presently see the Air coming out of the Ends that were cut off from the Plants, in numberless Bubbles, and rising up to the top of the *Lye*; at least it happen'd so in all the Experiments which I have had occasion to make in this Matter; and from some of them particularly, as from the Twig of an Elm-tree, I observ'd a much greater Stream of Air than can easily be believed by those that had never seen the same.

The reason why we rather prescribe the use of Lye than of Water in these Experiments, is, because no Air will mix itself with the former, tho' it be never so long exposed in an open Vessel. You may use Water also, after you have boiled it so long, till all the Air be evaporated, and let it stand till it be cold again.

Can any one fancy that this is likewise accidental, and without design, or believe that he owes no Thanks for this noble benefit of the Air,

to the bountiful Giver of it? Who has been graciously pleased to provide thereby not only for the Life of Man, but also for his Sustenance and Food, which springs out of the Earth.

Sect. XXXIII. *Fire is maintained by Air.*

Add to what has been said, that Air has this Property likewise besides all the rest, that Fire (which, without all Contradiction, is one of the most useful things that is known to Man) cannot burn without Air; at least, that kind of Fire that we commonly make use of: So that for want of Air, almost all Fire will be extinguished *in Vacuo*, or in any Vessels into which one puts live Coals and closes them therein. Now how many Inconveniences would befall the whole World, if we had not the use of this glorious Creature, but should be bereaved of its Warmth in Cold Weather, of its Light in Darkness, and of many other Advantages it brings along with it! But we shall say no more of it here, because we design to treat of it more expresly in our Discourse upon that Element.

Sect. XXXIV. *Air causes Smoak, and the Particles thereof to ascend.*

This is certainly true, that if the Pressure of the Air did not cause the Smoak of all things that are burnt with Fire, of all putrified and rotten Matters, and other disagreeable Vapours perspiring from solid or fluid Bodies, to mount up like Oyl in Water, the same would render the surrounding Air foul and unhealthy to us: And how would Mankind be refreshed with that vast number of sweet-scented Flowers and Plants with lovely Perfumes and Spices, if the Creator had not endowed

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the Air with a Property of conveying to the Instruments of Smelling, all those Exhalations which we endeavour to discover and enjoy by the help of that Sense?

Sect. XXXV. *Air is the Cause of Sounds.*

But that which shews in the plainest manner the Obligations of the Thankfulness we lye under to the Great Creator, is that those wonderful Instruments of Hearing, notwithstanding the most wise and artful Contrivance thereof, would have been implanted in Mankind and all other Living Creatures in vain, and without any manner of Advantage, unless the Air by its Motion had been endowed with a Power of producing Sounds: For how miserable all Men would have been without Sounds, and consequently without Hearing, has been already proved in our Contemplation upon the *Senses*.

Sect. XXXVI, and XXXVII. *Several Experiments to prove the Production of Sounds by the Air.*

It is not now our purpose to enquire here what kind of Motion, or what Parts of the Air produce Sound: This seems to be certain, that it is a Motion of the Air's Elastick Particles; for upon exhausting these Elastick Parts of Air suddenly from the Glass Globe A (*Tab.* XIII. *Fig.* 4.) and upon their protruding one another towards the space of the empty Pump, we could observe a Sound or Noise, which, when the Receiver was full of Air, and the Spring of the Air more strongly dilated, that is to say, at the beginning of it, is loudest, but upon evacuating the Receiver, and consequently upon weakening the said Spring, or perhaps also,

upon

upon leſſening the number of the mov'd Parts, the Sound is gradually diminiſhed.

Thus we find by hanging a little Bell within the Receiver, and pumping the Air out, the Sound of the Bell becomes much weaker. A Striking-Watch ſhut up in the Receiver of an Air-Pump, and faſten'd to a String, is not heard ſo plain as when it is out of the Bell; but upon exhauſting the Air, the Sound was ſo much and ſo ſenſibly diminiſhed, that it could ſcarce be heard at all. But as far as I could ever yet learn, no body has been able to exhauſt the Air ſo far, as that the Sound of a Clock or Bell ſhould not be heard at all; unleſs it were only Mr. *Huygens*, who in his *Traitté de la Lumiere*, *p.* 10. informs us, that he placed a Clock upon Feathers or Cotton, to the end that its tremulous Motion might not be communicated to the Glaſs in which it ſtood.

And it is likewiſe obſerved, that a Place in which the Elaſtick Power of the Air is much weaken'd, or made a *Vacuum* in the middle of the common Air, and an opportunity afforded to the ſaid Air, to be puſh'd in from all Parts thitherwards by its Elaſtick Force, ſo that its Parts ſtrike againſt one another, a great Noiſe is cauſed thereby; for if you put the two Braſs Hemiſpheres which are commonly made uſe of by thoſe that uſe Air-Pumps, upon one another, and ſtopping them very cloſe, pump the Air out of 'em, and ſo make the hollow Space therein to contain but very little Air, and that much weaken'd too; and if then thoſe Hemiſpheres, or Half Globes, be ſuddenly drown aſunder by a great Weight, and thereby an opportunity given to the Parts of the External Air to ſtrike againſt each other, we ſhall find a Noiſe produced thereby, like the diſcharge of a Gun.

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The same has been likewise remarked above, in the breaking of the Glass (*Tab.* XIII. *Fig.* 3.) by the swift forcing in of the Air into the Brass Vessel A B C D, out of which at K, there was some Part of its Air exhausted, and consequently the Elasticity of the remaining Part was weaken'd in Proportion. As it also happen'd, when instead of such a Brass Vessel, an octangular Half-Pint Bottle was placed upon the Mouth O, of the Brass Plate H I, and a little Air exhausted from the same; whereupon the Glass Bottle bursten into small Pieces with a loud Report by the Pressure of the External Air: To prevent any Danger from thence, the best way will be to cover the Bottle with a Bladder fasten'd about the Neck thereof.

Sect. XXXVIII. *Convictions from the foregoing Observations.*

We shall not here enquire farther what probable Conclusions may be deduced from these and other Experiments, concerning Bodies yielding Sounds by the particular Motion of the Parts of the Air; but this may be safely affirmed, that without Air, little or no Sound would result from the Motions of Bodies. Now can they that know the necessity thereof, maintain such a sort of Philosophy, as teaches that the Faculty with which the Air is endowed, of conveying Sounds and Smells to our Ears and Nostrils, is only owing to Chance, without any View of being serviceable to Mankind?

Sect. XXXIX. *The Use of Air in Pumps.*

Besides all these wonderful Uses and Services daily render'd by the Air to such as inhabit this Earth,

Earth, a great many more might be mention'd: And ought not then every Body that has any Sense of Generosity, acknowledge how much he is bound to give thanks, when he, without contributing any thing thereto on his own Part, finds himself surrounded with so vast a Force and Pressure of the Air, which he can make use of according to his own Pleasure, in so many Occasions for his Conveniency, and to avoid being troublesome to himself or others?

Every one who knows, that Pumps, Syringes and Fountains, and such like Hydraulick Instruments, are only render'd useful by the Pressure, that is by the Gravitating and Expansive Power of the Air, which, by the Art of Man, has been applied thereto, will be fully convinced of the Truth of this Proposition.

And those who are ignorant of it, may consider the Spout or Syringe, A B C, *Tab.* III. *Fig.* 3. (of which mention has been made above in *Contemplation* VII. §. XI.) as a Barrel of a Pump standing in the Water D C E; in which Pump, as has been there shewn, no Water will ever ascend, tho' you should draw the Piston F upwards, unless the Air G do gravitate upon the Water D E. Now that a Pump on this occasion may be look'd upon as a kind of Syringe, is known to every Body.

Sect. XL. *The Air hinders fermenting Liquors from flying out of the Vessels that contain them.*

That there are so many fermenting Liquors, such as Beer, Wines, *&c.* working in themselves, used by several Nations for their Pleasure, Refreshment, and other Ends, we ought thankfully to confess to be owing to the Goodness of our Creator; who, by placing the Air upon this Globe, and endowing it with a Gravitating and Elastick Faculty,

Faculty, causes those Liquors to stay and remain within their Vessels, which, without such a Pressure of the Air, they would burst to pieces, or run all out of the Mouth thereof. They that have a mind to make a Trial of it, let them take a Glass of our common Beer, that has done working, and is some Days old; let them place it in the Receiver of an Air-Pump, and exhausting the Air, they will presently see it rise and froth, and run over the Brims of the Glass like Bottled Beer: but by letting in a little Air again, it will presently subside, and cease frothing and working.

To take no notice, that unless the Pressure of the Air did put a stop to such Working, the Drink would immediately lose both its Strength and Agreeableness, as every body knows that has tasted Beer after such working in the Air-Pump, whereby it is rendered as flat and insipid, as if it had stood a great while exposed to the open Air.

The good Wives ought likewise to be informed, that without this Pressure of the Air, no boiling Water wou'd stay in their Pots and Kettles. They that doubt thereof, let them set a little Tea-cup full of hot Water under the Receiver of an Air-Pump, then draw off the gravitating Air, and they will find that the Water will run over and dilate itself almost like Gun-powder that is set on Fire.

Sect. XLI. *Refraction and Twilight, or Break of Day.*

Now as most of the Effects we have already mention'd concerning the Air, are produced by the Gravity and Elasticity thereof; altho' towards the Respiration of living Creatures, towards fertilizing the Earth, and perhaps too towards the Nourishment of Plants, and other Matters which are brought to pass by the Air, there seem likewise

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to be some other Faculties and Parts requisite in the same; I say, besides all this, it does yet render one eminent piece of Service to the whole World, and that upon account of being composed of a fluid Matter, denser than that which is above it, *viz.* that by the *Refraction* or breaking the Rays of the Sun in the said Air, the *Twilight* of Morning and Evening are produced; whereby a clear and full Day is prevented from being turned oftentimes in a very little time into a Night as dark as Pitch in the Evening, and so again a dark Night from being turned all at once into a bright Day, to the visible Prejudice and Weakening the Eyes of Men, and all other Creatures; it being sufficiently known to all that have tried it, how troublesome and inconvenient are such great and sudden Changes, from thick Darkness to a strong and clear Light.

'Tis owing to this Property of the Air, that the Countries which lie near the Poles, during their long and dismal Nights, do participate of the comfortable Light of the Sun many Days before it rises above the Horizon: From hence it proceeds likewise, that those Nations which lie far from the Poles, and in which the Sun daily rises and sets, do discover sooner, and are deprived later of the welcome Light of Day, which they therefore enjoy much longer than if there had been no such thing as Air about this Globe of the Earth.

To give the Reader some Notion thereof; Suppose N Z S, to be the Globe of the Earth in *Tab.* XIV. *Fig.* 3. E W H T, the Air surrounding it, and E Y, the visible Horizon of those People that dwell at F: Now the Sun would be invisible as soon as it was got below this Horizon, if there were not between the Air and the Sun at A, such a dense Substance as the Air it self, which the Ray of the Sun A H falls upon; and Mathematicians

cians know, that it must be considered as if it fell upon the Line B C, which touches the Air at H; this Ray therefore falls obliquely upon the Air, as making with the Line B C the Angle A H C.

Now it has been shewn above, when we treated about the *Sight*, in *Contemplation* XIII. That a Ray (*Tab.* X. *Fig.* 2.) coming upon a denser Matter, which is likewise transparent, does not run streight forwards to D, but is inflected towards the Perpendicular G Q; that is, being bent or refracted at H, is diverted into another Course H F; so that in *Tab.* XIV. *Fig.* 3. this Ray of the Sun A H, by such an Inflection, may reach the Eye of one that stands at F, whereas it would otherwise have passed a great way above him at D.

It is likewise plain by Optical Experiments, that a Ray, according to the Right Line H F, falling upon the Eye, the Person that sees, does always fancy to himself that the Object is in the Ray F H; for which reason, the Sun A, being really under the Horizon E F Y, they that live at F, think that they see the same in the Line F H produced, that is at R, and above the Horizon.

Now that this is so, has been briefly shewn above in *Contemplation* XII. *Tab.* X. *Fig.* 4. and from thence it may in some manner be comparatively known, how the Rays of the Sun, being refracted in the Morning and Evening Twilights, do enlighten the Earth, and cause us to see the Sun before it be really Risen, and after it is Set.

Sect. XLII. *Convictions from the foregoing Observations.*

Now can the unhappy Atheist fancy again, that this Property of the Air, with respect to Light, is likewise produced accidentally? Whereas he is nevertheless forced to acknowledge, that

it is so great a Benefit to himself, and the rest of the Inhabitants of the World, that in case he had the ordering of it himself, he would think that the Advantage which he had acquired from this one Property of the Air, was alone worth the while to encompass the Earth with such a Body.

Sect. XLIII. *The Gravity and Elasticity of the Air unknown to the Ancients.*

Before I quit this Subject, I cannot forbear saying something very remarkable for the Comfort and Confirmation of such as have not so far forgotten God, as to deny the Perfections and Attributes of that adorable Being, by whom all things have been produced; let such therefore consider, that the Gravity and Elasticity too of the Air, are new Discoveries, being accordingly so term'd by the Gentlemen of *the Royal* French *Academy, in their History for the Year* 1702, *of the first Discoveries made by Modern Philosophy about the Nature of Light*, that they were unknown for so many thousand Years to the most diligent Enquirers into Nature, and continued a perfect Secret, even to the most learned Philosophers, till the last Age. For they, and all the Ancients, look'd upon the Air to be a light Body, which would ascend of itself, at least, that it was without Gravity or Weight, to speak of that Property in the first Place; till in the last Age, the Invention of *Barometers*, together with the subsequent Experiments made by the Air-Pump, Fire, and otherwise, did furnish us with undeniable Proofs, that the Air is a heavy Body, and that we are able to compute the Weight thereof. Add to this, that the *Barometer*, (the first Instrument that has given Men a Notion of this Gravity of the Air) was not discover'd either by the Study or penetrating Judgment of the Inventer,

Inventer, *Torricellius*, who had not this in his View by any means; but (to use the Words of Mr. *de Stair*, *Physiolog. Expl.* XIX. *Sect.* 41.) was revealed by the Divine Providence in the Year 1643, and as to him, entirely beyond his Expectation.

CONTEMPLATION XVIII.

Of METEORS.

SECT. I. *Transition to the Meteors.*

BEFORE we take leave of the Air, it seems requisite to say something concerning *Meteors*, such as the *Clouds*, *Mists* or *Fogs*, *Wind*, *Rain*, *Thunder*, *Lightning*, &c.; forasmuch as an infinite Number of Wonders have at all times appeared therein; and the Almighty has thereby, in a particular manner manifested his Tremendous Power and Greatness many times to those, who as far as in them lay, endeavour to deny it; and forc'd them to own it with Fear and Trembling: Yet forasmuch as the same are mostly placed out of the reach of such Experiments as might serve either to make a just Enquiry into all the Causes thereof, or even to try the Certainty of some probable Opinions concerning them; Humane Knowledge does not extend itself far enough in these Matters to be able to say with sufficient Certainty, how they are produced, and how they operate.

SECT. II. *The Air is a Menstruum or Dissolving Fluid.*

THIS seems however to be true, that the ambient Air has the same Power and Effects upon

on many Bodies, as that which the Chymists call a *Menstruum* or Dissolving Liquor; upon which it operates after the same manner as *Brandy*, for instance, upon Spices put into it, out of which it extracts some of the Parts, and incorporates them with itself.

Sect. III. *The Air is impregnated with great variety of Particles.*

Thus we see, that all the Effluvia or Exhalations of such an infinite number of Bodies; that all the Scents, whether of sweet or stinking Bodies, the Smoak and Steam of things that are burnt or putrified, the Vapours and Fogs arising from so many Seas, Rivers, Lakes, Ponds, and other Waters, the Particles of Fire from so many Flames of Nitrous and Sulphureous, of Acid and of Alcaline Bodies, or of both of them fermented together; in a word, whatever they call Volatile, and which being exhaled can ascend, are all mixed with the Air, and collected in the same, as in a common Magazine or Ware-House. Add to all these the Rays and Light of the Sun, that move with so unconceivable a Swiftness, as we shall show hereafter, and which are reverberated, or do rebound back into the Air in infinite Streams and Numbers: To say nothing of the Planets and fix'd Stars, which how little Effect soever they may be supposed to produce, by reason of their vast Distance, yet, since these Heavenly Bodies are seen thro' the Air, and the Rays are transmitted from them with a prodigious Velocity quite thro' it down to us, we have reason enough not to pass them by in silence. To reckon every thing, would be impossible, and they who are never so little conversant in the Experiments of Natural Philoso-

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phy, well readily agree that there is such mixture of an infinite number of different Particles.

SECT. IV. *The same proved in Sulphureous Particles.*

THAT we may give an imperfect Sketch thereof to such as are Ignorant and Unexperienced; and passing by those Effluvia or Vapours that rise from Water, as being too common; that Suphureous Particles are mixed with the Air, may appear from the Scent or Smell of Brimstone that attends Lightning sometimes; besides that, several Accounts teach us, that they ascend from the *Volcano's* or *Burning Mountains* in vast Numbers, into which they are dissolved by the means of Subterraneous Fires, after the same manner as it is done in Chymical Operations: And this is also plain from hence, that even here in our Watry Country, there are Pits or Wells over which if you hold a Candle, the Air will immediately be kindled, insomuch, that whole Houses have been consumed by the firing of such Steams; and not long since, a Person was miserably Burnt in that Country which we call the *Beemster* in *North-Holland*, which is nothing but a drained Meer or Lake.

SECT. V. *The like Mixture with Particles of Fire.*

THAT Fire mingles itself with Air, appears by many Experiments, such as Lightnings, as also, that Matter which the Chymists call *Phosphorus*, which having lain many Years under Water, and being taken out from thence, immediately shines in the Dark; and with the least Warmth (even so small that it can hardly be called hot) it will burn so, as not to be extinguish'd. Such a *Phosphorus* is distilled from Humane Urine, after it has stood so long in the Air till it is corrupted: And some who have tryed it say, that in case such Urine

can be kept where no Air can come at it, notwithstanding it be so Chymically prepared, it will neither shine nor burn.

Sect. VI. *Alcali's and Acids mixed with Air.*

That *Volatile* and *Alcaline Salts*, such as those that are extracted from Soot, Harts-horn, *&c.* are dissolved in the Air, is well known to those who have smelt of the same, and have often learned to their Cost, that such Salts are in no wise to be preserved long; and Glass Phials filled with these Volatile Salts, and not well stop'd, have frequently been found quite empty, or at least have lost a good Part of them. The same has been observed as to Acid Liquors, by the sower Smell that exhales from them, such as Vinegar and other things: Insomuch, that if you set any Acids under a Copper or Brass Plate, the Vapours that exhale from them, and mingle themselves with Air, will eat through such Plates, and turn them into Verdigrease. Moreover, in distilling Spirit of Salt-petre, which comes over without any Water, we know that all the Stopples that are used to the Phials that contain 'em, are corroded by the Particles that ascend into the Air; and that the said Spirits being put into an open Bottle, do frequently emit visible Effluvia.

Sect. VII. *Burning Spirits and Oils mix themselves with the Air.*

The Air is likewise impregnated with *Burning Spirits*. This is known to every Body that has warmed good Brandy, and held a burning Paper or Candle near the Steams of it; of which those that are in the Air are immediately kindled. The same Experiment is made by the Chymists in their Distillations, when they try whether their *Lutums* (that is the

the Matter which they apply to the Joints of their Vessels) are as close as they should be; for if one holds a Candle to them, and any of the Effluvia come out, those that pass into the Air through the *Lutum*, will immediately take Fire.

Oils themselves will mingle with the Air. Wherefore, to say nothing of Train-Oil, which can be smelt so far off (forasmuch as some may doubt whether they be the oleaginous Parts themselves that affect our Nostrils) let any one take Oil of Olives mingled with Salt, and distil it with a glowing Iron Pot, upon which there is an Iron Helm or Head, with an Orifice or Hole at the Top, so as it may be shut with an Iron Cover, he will find when the Cover is taken off, in order to take some of that Matter with an Iron Ladle out of the Pot, and to put fresh therein, that the Steams (which being drawn over into the Recepient, do there make what they call an *Oleum Philosophorum*) as soon as they come into the Air, flame out, and so continue till the Orifice of the Helm be again closed.

Sect. VIII. *Other Particles do likewise mix themselves with Air.*

An infinite Number of other Particles, besides those of which we have given Instances above, are found to incorporate themselves with the Air, as with a common Menstruum or Dissolvent, accordingly it is observed by *Varenius*, in his *Geography*, (*Lib.* I. *Cap.* XIX. §. 41.) that when the Spices in the *Indian* Islands are ripe, the Seamen know it by the Smell thereof, at the distance of three or four Leagues: That in the Islands named the *Azores*, the Air is impregnated with so many Acid Particles, that it corrodes even the Iron and Stones of Houses, in such a manner, as to reduce them to Dust in a little time: whereas, on the contrary, in the Province

Province of *Chili* in *America*, the Air is so soft, and that tho' one put up a Sword without cleaning it into the Scabbard, there will never be found any Rust upon it. They that would be further informed upon this Subject, may consult the Author in the place we have quoted.

SECT. IX. *Many Particles preserve their Properties in the Air.*

AFTER all this, no body I think will scruple to acknowledge the Air to be a Menstruum impregnated with an infinite Number of Particles; only it seems necessary before we proceed, to shew, *First*, That the Effluvia of such a great Number of solid and fluid Matters, tho' dissolv'd in the Air, may yet preserve the same Properties which they had before they were mingled therewith. They that desire sufficient Instances thereof, may see what that great Naturalist, Mr. *Robert Boyle*, has writ about them in his Discourse on the *Nature of Effluviums*. This however has been experimentally observed, first in fluid Matters from a great many Distillations of Waters, of Burning Spirits, of Acid Spirits, of Spirits that have Volatile Salts in them, of Quicksilver, and almost all such like Liquors, which evaporating in the Air by Warmth, do therein so very much maintain their own Figure, that being admitted into a Recipient, and turned again into a Liquid Matter, almost all of them yield the same Fluid of which they were composed before they were mingled with the Air.

The same may likewise be observed in many solid Bodies, which the Chymists do raise, or (as they phrase it) sublimate by Fire. Thus, according to the Report of the aforesaid Mr. *Boyle*, who ought never to be named but with respect, *Sulphur*,

phur, Camphire, Benjoin, Sal-Armoniac, and even a Metal as heavy as *Tin,* may be sublimed and mix'd with the Air by the Heat of Fire; and the Parts thereof being coagulated by meeting with Glass or some other Matter, may be again changed into a solid Body, with the same Properties it had before.

And let no Man imagine that we draw out this Analogy too far, because they are not sensible of such a Heat, or of such Fires in these Climates, as might seem sufficient to dissolve these Bodies, and to cause them to evaporate into the Air, to perform which, so intense a Heat is required in Chymistry: For whoever has read any thing concerning the Subterraneous Fires that shew themselves in burning Mountains, and with how much *Sulphur, Ashes,* and other Matters, they have often filled the Air, even at the remotest Places, will find that there is not the least room to doubt thereof.

SECT. X. *The aforementioned various Particles, by their operating upon each other, cause the Air to be Wholsome or Unwholsome.*

FROM what we have shewn already, it will follow, *Secondly,* that he who knows how variously and powerfully these Particles, floating in the Air, do operate upon each other, will easily conceive, that from the different Conjunctions and Separations thereof, different Qualities of the Air does likewise result. Insomuch, that some of the Parts being wholly innocent in their own Nature, by their Conjunction and Mixture with each other, may become hurtful and even fatal; and so on the contrary, those that are prejudicial, may likewise become healthful, and thus in many Cases they may undergo many Changes.

SECT. XI, and XII. *Several Experiments to confirm this.*

THUS we ſee (to give an Inſtance of what we have aſſerted) that the Spirit of *Common Salt* and *Mercury*, neither of which are poiſonous alone, being ſublimated by Fire, are united in the Air, and then become ſuch a deadly Poiſon (to which they uſually give the name of *Sublimate*) that if it do not exceed *Arſenic* or *Ratsbane* itſelf, it may be counted at leaſt as fatal. We ſhall not here enquire, whether what has been obſerved by *Diemerbroek*, *de Peſte*, Lib. II. Cap. 3. might be ſuppoſed to have happen'd after ſuch a manner; namely, that the Fumes of *Soap* with which Linnen was waſhed, might have brought the Plague into the Houſes of *Nimeguen*, and have render'd the Air of that Town contagious; tho' it is well known, that the Ingredients of which that Matter is compoſed, have nothing peſtilential in them. This is hardly to be doubted, that when the Subterraneous Fires in the times of Earthquakes, have filled the Air with many Exhalations, thoſe Exhalations themſelves, or their Union and Co-operation upon other Particles of the Air, have often produced contagious and other Epidemical Diſtempers.

Thus we alſo ſee that great and pernicious Poiſons floating in the Air, being joined to other Matters, do thereby loſe their pernicious Qualities. And the Chymiſts know very well, that how often ſoever the aforementioned Sublimate is exhaled or raiſed up into the Air, it will ſtill remain a deadly Poiſon: But if one take an equal Weight of Salt of Tartar, and mix it therewith, and then evaporate both together, their Parts will unite themſelves in the Air, and loſing their poiſonous faculty, will produce a Medicine call'd *Mercurius Dulcis*, which is very good

good in many Cases. Some ascribe it to the same Cause, that the Plague ceases at *Grand Cairo* as soon as the River *Nile* begins to swell; so that whereas the very Day before there might die 500 Persons, the very next Day there would not perhaps die one, according to the Relation in *Sandy's Travels*, Lib. II. The above-mention'd Mr. *Boyle* confirms the same by many Instances.

That Gentleman has likewise taught us experimentally, that fluid Bodies may be changed into solid ones in the Air; for example, mix the Spirit of corrupted or fermented Urin with Brandy, which has not been entirely separated from its Water; and setting it over the Flame of a Lamp, or some other more gentle Heat, the Fumes ascending from thence will be turn'd into a solid Body in the Air, appearing at the Top of the Glass like a fine white *Sublimate*, notwithstanding that before the Distillation, each of them was a liquid Matter.

It is not our Design in this place to enquire so strictly, whether the abovementioned Phænomena at *Nimeguen* and *Cairo*, were rather to be ascrib'd to a Precipitation or Coagulation, which some of the ascending Particles might produce in the Air; but that something of the like nature may happen in the Air, whether by Conjunction orSeparation, seems to be maintainable in some manner, from the Observation of the Professor *Schagt*, at the time of the Sickness at *Leyden*, of which mention has been made before in *Contemplation* VII. and that which has been related to me by a curious and observing Gentleman, seems to confirm the said Opinion, which he says was commonly known to all the Inhabitants of *London* at that time, namely, that in the dreadful Pestilence of the Year 1665, those *Coffee-houses* that were continually filled with the *Smoak* of *Tobacco*, were almost the only places that escaped the Infection. I shall

I shall not pretend to determine, whether what we have just now mention'd must be understood to happen after the same manner, as when a good quantity of *Sublimate* is dissolved in Water, and when into the same Liquor, which is very poisonous, Salt of *Tartar* likewise dissolved in Water is poured, so long, till a reddish Powder is produced and sinks down to the Bottom, or, according to the Chymical Term, is *precipitated* ; after which it will appear, that by the Operation of these two Matters upon each other, all the Poison of the *Sublimate* will be done away : Or, whether it may be supposed to happen in Conformity to that other Experiment, and the Consequences thereof, in making of *Mercurius Dulcis*, as has been observed above. Our main Design in all this, has been only to shew, that upon considering the whole Matter, we ought to suppose this Globe of Earth, with its ambient Air, not only to be a Mathematical Machine (which may be proved by other Experiments, but even a great *Chymical Laboratory*, in which the Air represents a Recipient, in which thousands of Kinds and Differences of exhaling Particles are collected, either by Subterraneous Fires, by the Heat of the Sun, or by some other Causes ; or otherwise, as a *Menstruum* and Dissolvent, which being poured out upon innumerable Matters, extracts and unites to it self various Particles from each of them : And those Paticles being mingled with the Air, may variously operate upon each other, according to their different Natures and Properties.

Sect. XII. *Convictions from the foregoing Observations.*

Before we proceed any further, in case any body, be he who he will, that has formed a just Notion of this Constitution of the Air from what has been said already, and knows what an infinite Number, not only of the same, but even of different Kinds of Particles, do occur in the Air; after how many various manners they unite with each other; how from their Conjunction, from their Division or Separation, and otherwise, so many pernicious and fatal, as well as wholsome and useful Effects may result; I say, if besides all this, he is assured, that without Air neither Animals will live, nor Plants grow; Can he sit down easie under a Perswasion, that all things do thus come to pass either by Chance, or by Mechanical Causes, entirely ignorant of what they are doing, and without any Wisdom or Design? And that without an infinite over-ruling Power and Providence, this real *Chaos*, or confused Mass, subject to such an unspeakable number of Alterations, by the multitude and disagreeing Properties of its Parts, could have been adapted for so long a Time, and still continue so to preserve alive so many thousand Animals and Plants, and to furnish all that is particularly necessary to every one of them, with so vast a variety? And can he imagine, that it is to be ascribed to any thing but a Divine Direction, surpassing all Understanding, that these things do not fall into the utmost Confusion? Yea, can he possibly, with all his Wisdom, form any just Idea thereof? how from such a confused Mixture of all kinds of things as the Air is, and among which many indeed are serviceable and useful, but likewise many others, both prejudicial and even contagious

tagious and Fatal; I say, that each requisite Particle can discharge its Function in its Place, and all the bad ones be prevented from doing harm, were it not that the Supreme Will of our adorable Ruler did herein exert its Wisdom and Power.

Sect. XIV. *The Invisibility and Insipidity of the Air very useful.*

The aforesaid Wisdom and Goodness of God has often occurr'd to me with great astonishment, when I considered, that he has been pleased to subject to our Sense of Seeing, *Fire*, *Water*, *Earth*, *Sun*, *Moon*, *Stars*, and almost all other Creatures, excepting only the Air, which though we can feel well enough in Winds, and other Cases, yet he has thought fit to render invisible to us. And yet, how does almost every Man tremble, when he sees the Vapours and other active Particles therein, gathered together in dark Clouds, and and threatning us with Thunder and Lightning, with Storms and Tempests?

Again, If any one should be obliged to drink the Waters of *Fens* and *Marshes*, of *Ditches* and *Kennels*, mixt with Dirt and Nastiness, tho' perhaps not otherwise pernicious, how loathsome would it appear to him? Or if he should meet in it any of the *Spawn* of *Serpents* or *Toads*, tho' there were not enough thereof to poison him, yet with how much Fear and Terror would he take the Cup into his Hands? And what pains would he take to separate what was pure and wholsome from this dreadful Composition? Now, if in the same manner, all the Filthiness that is to be found in the Air, all the exhaling Particles, from foul and nasty Places, all the Vapours from stinking Puddles, or from rotten Carrion, or dead Carkasses, all the ascending Steams from poisonous Minerals, and

contagious

contagious Animals or Plants, all the disagreeable Effluvia from the Bodies of Men and Beasts, and whatever else of other Infections in the Air might be added hereto: I say, if all things were set before his Eyes in the same manner, would he not loath and nauseate the very sight of them? The same would certainly befal him, if he were capable of seeing with his Eyes, the Air that he must constantly breath, fill'd with so many impure and unwholsome Particles; would he not live in a continual fear of being poison'd by them? Would he not employ all the Powers of his Mind, even till he was tired, to find, if it were possible, among such a loathsome heap of disagreeable things, something that was clean, and could be suckt in without nauseating? Should we not see Rich Men offering more Money for Places where the Air was pure and wholsome, than they now bestow for stately Houses and Country Seats? Now it has pleased the gracious Director of all things so carefully to provide against these Inconveniences (that what befals us every Moment of our whole Lives, namely, the *Inspiration* and *Expiration* of Air, might be perform'd with pleasure, or, at least, without producing in us any disagreeable Sensations) as to render invisible to us, that Air which would otherwise set before our Eyes a perpetual Swarm of detestable Objects; and by this means only (tho' they should not be dangerous to our Health or Life) release us from incessant Cares and Fears, of drawing into the Lungs by the Mouth and Wind-Pipe such a quantity of odious things.

The like Aversion and Dread of so many Particles floating in the Air would befal us, but in a much higher degree, if they should become sensible to our Taste. Ought not then every Man to acknowledge his Obligations to the Wisdom and Mercy of the great Ruler of this World? Who, tho' he causes

causes us to *Hear* this compounded Air in *Flutes* and *Organs*, to *Feel* it in *Winds* and *Storms*, and to *Smell* it too in many Cases; yet, that he might not make us miserable, has form'd it after such a manner, that notwithstanding its being impregnated and laden with such a diversity of Parts, it can be neither *seen* nor *tasted*, except in some particular and very rare Cases; by which an Atheist may be convinced, that He who brings this about, does it of his free Will and Pleasure; but by no means can it be said to be thus order'd by necessary Consequences, and much less by Chance. Accordingly we find, for instance, that when an Apothecary has pounded a good quantity of *Aloes*, and that the finest Parts thereof fly up, and mingle themselves with the Air, their Bitterness discovers itself to the Taste of those that suck in that Air: And to shew, that the Air is likewise in its own Nature visible, we need only compress a good quantity thereof together in an Air-Pump, and then let it out again as quick as we can, and it will presently shew it self to our Eyes like a *Fog* or *Mist*.

Sect. XV. *The Observation of Meteors resumed.*

But to return to the *Meteors*; If we should attempt to shew the Causes thereof fully and clearly, we must do it by a number of Natural and Chymical Experiments, which might be render'd Analagous and Uniform to the same in Little: But this would engage us in too large a Field; we shall however produce some few, to shew how the same are generated in the Air, without pretending that they may not come to pass many other ways; for as some of these that are now known to us were hid from the Ancients, so perhaps some may be discover'd by our Posterity, of which we are hitherto ignorant.

Sect.

SECT. XVI, and XVII. *Mists and Fogs produced by many Exhalations, and by the Rarefaction of the Air, shewn experimentally.*

To say something first of *Mists* and *Fogs*: It is plain from what has been said, that unspeakable numbers of watry Vapours and other Exhalations do mingle themselves with Air, by which they render it Thick and Untransparent or Dark: As first, when they arise in too great a Quantity, and are so closely compressed together, as to fill the Air, and to obstruct a free Passage of Light. In the same manner we see in Chambers, where the Smoak does not go directly up the Chimney, as also by the thick Steams of boiling Water in Kettles, the Air render'd in some manner untransparent and foggy: The same happens by the numerous Vapours that arise in cold Weather in Winter, and here in *Holland*, upon the Breaking and Opening the Ice.

The second way of producing Fogs and Vapours is, when the Air is more rarified than usual, and thereupon becoming lighter, is no longer able to balance the more heavy watry Vapours, and to keep them floating in its own Region. A plain Instance thereof we may see in *Tab.* XIV. *Fig.* 5. by taking some of the Water out of the Glass Globe A B (from whence the Air was first exhausted, in order to fill it by the spouting in of Water, as has been shewn before on another Account in *Contemplation* XVII.) and then fastening or screwing it on to the Air-Pump at D, so that the very small quantity of Air that remain'd in it at S, will appear above the Water N P R; after which, a *Vacuum* being made in the Pump, the Cocks E and K must be open'd; by which means the Air, which at S gravitated upon the Water N P, meeting with no resistance, will drive it down towards the Pump, and

and so the Space A N P, becoming larger, the Air that is in it will be likewise more expanded or rarified. Now, as it does also become lighter thereby, the Watry Vapours in it will sink down, and produce a visible and whitish Fog in the Globe, and many times little Clouds, exactly mimicking those that we see in the open Air. But these Mists and Clouds, upon the Re-admission of the Air Q W R thro' the Water, and by the Encrease and Compression of the Air at S, do immediately disappear again, and the said Air at S, as soon recovers its former Transparency; and so, *toties quoties*, becomes foggy and cloudy when it has an Opportunity of dilating itself, and of forcing the Water out of the Globe, upon exhausting the Air; and again becomes clear and transparent, upon the letting in of fresh Air: So that clear and foggy Weather may be as alternately represented as often as you please after this manner; and even when there remain watry Vapours enough in the Air, this may be still produced, provided the Bubble be but a little moist within, tho' altogether empty of Water.

Sect. XVIII. *Reflections and Observations upon the same.*

We have made these Experiments very frequently, and from thence observ'd; *First*, that these Vapours, when the Air appear'd heavy in a Barometer, were not seen at the first Pumping, nor did shew themselves sooner, till after some Expansions of the included Air, it became lighter and thinner. *Secondly*, This Experiment did not succeed well when the Water and Air were cool; probably, because there were not watry Vapours enough mixed with the Air: Wherefore hot Water, in a little Glass Vessel (*Tab.* XIV. *Fig.* 4.) M N, being placed under the Bell, presently fill'd the Air with

the Steams which exhaled from it, but upon the admission of fresh Air, vanished as before.

It was likewise observed at another time, that no Mist appearing in the Glass Globe in cold Weather, upon making a Fire in the Room, and the Air in a Thermometer shewing itself warmer, we renewed our Pumping a little while after, and the Fog became immediately visible. *Thirdly*, We found likewise, that the Mist which had been thus produced in the Glass, subsided by degrees, and the Glass became clearer, without admitting fresh Air into it; As also, *Fourthly*, That these Mists, by letting in fresh Air upon them, and by the Wind which the same produced, being put into Motion, occasion'd an agreeable Representation of the irregular Course of the *Clouds* in the Air in the time of *Storms* and *Tempests*.

I have related this Experiment something the more particularly, because it did not always succeed, and forasmuch it seem'd to give us a great deal of Light into the Nature of *Mists* and *Clouds*.

Now that the Natural Mists, and Fogs, and Clouds are of the same kind with these Artificial ones, seems deducible from hence, that most commonly when the Air loses its Clearness, and becomes more dark and obscure, the Mercury in the Barometers descends, and shews thereby, that the Air is become lighter.

I have likewise often observed with Astonishment, that when the Air appeared clear all above and round about us, in a very short while after, the whole Heavens grew dark and were cover'd over with Clouds. Whether this may be deduced from a sudden thinning of the Air (because we know of no other Reason besides, that in so little space of time can operate so quick over the whole Face of the Heavens) I leave to others. The Barometer may be compared therewith.

SECT. XIX. *An Experiment to prove that Mists and Fogs may be produced by Effervescences.*

Thirdly, Another manner by which the Air may be render'd Foggy, will appear by an Experiment made with two little Glasses or Phials containing an Ounce each; one of which being almost filled with Spirit of *Salt-Petre*, or *Aquafortis*, or else with Spirit of common *Salt*, and t'other with that of *Sal Armoniac*; put the Mouths of both the Bottles near to each other, and you will find, that the Exhalations of both being mingled in the Air, will produce a visible Smoak or Mist, which, if the Bottles be placed far enough asunder, cannot be observed in either of them.

Now that this way of *Effervescence*, as the *Chymists* call it, is brought about by the reciprocal Action of their Particles in the Air, will be readily allowed by any one that ever saw the Effervescence or Fermentation that is caused by pouring one of these Liquors upon the other.

SECT. XX. *An Experiment proving the like Effect by Precipitations or Separations.*

Fourthly, WE learn another way from *Chymistry* of turning clear and transparent Liquors oftentimes into a thick and troubled Matter, by Separation or Precipitation: Thus Sublimate or Vitriol dissolved in Water, and filtrated thro' a Paper, does yield a clear Liquor; but pour into it either Salt of *Tartar* or *Potash*, likewise diluted in Water, both of which are transparent, and you will presently see some Parts of the first Liquor precipitated or separated from the rest; by which means the Liquors will lose their Clearness, and be changed into a dark and thick Substance.

Whe-

Whether this has also place in some of those that People call *Stinking Fogs*, I shall not enquire any farther here: this is certain, that those Stenches have often a great affinity with that which we discover in making *Milk of Sulphur*, or the *Golden Sulphur* from Antimony.

To prepare the last, they use to boil in Water the Sulphur of the *Regulus* of *Antimony* mingled with Salt of *Tartar* in the Fire, and to filtrate the same thro' a Paper, so that there proceeds from it a clear Liquor of a reddish Colour, and without any Smell; but putting in some drops of Vinegar, a grievous Stench arises from it, and the Liquors become thick and untransparent; until there subsides from it an Orange Colour and Yellowish Powder, which is the *Golden Powder*, and then both the Liquors become clear again.

I have often thought with my self, whether there were not something like this in the Air, which by way of Precipitation might produce those Stinking Fogs; *First*, by reason of the likeness of the Scent; and *Secondly*, because I have oftentimes observ'd, upon the Days succeeding these Fogs, a Reddish or Ornage Colour Scum, very like that of the above-mention'd Golden Sulphur, upon Standing Waters; which before those Fogs happen'd, were not to be found there. But I leave all this to further Enquiries.

Sect. XXI. *Fogs are Clouds.*

After having treated of Foggy and Misty Airs, it does not seem necessary to say any thing more about Clouds; because it is very credible, that what we call here below Mists and Fogs, when raised up higher in the Air, do compose the Matter of Clouds; insomuch that a Cloud is nothing but an exalted Fog; now that this is some-

thing more than a bare Supposition, appears from Experimental Trials made by many People, who having climbed up high Mountains, met with thick Fogs in their way; but when they were arrived to the Top, they observed the same floating under them like great and white Clouds. *Varenus* gives us a particular Relation thereof in his *Geography*, *Lib.* I. *cap.* 19. § 41.

The same is asserted by that great Examiner of Nature, Mr. *Mariotte*, in his Discourse *Du Movement des Eaux*, *p.* 19. That climbling up a Mountain, at one place he was in the middle of a Fog, which whilst he was below at the Foot of the same Mountain, appear'dto him like a Cloud.

Another common Experiment may be made, when Gunners are trying their Cannon, by discharging several Pieces at once: Now every one knows that the Smoak thereof seems to those that are under it like a Mist in the Air; and so it appeared to me and others that were in the Boat with me, between *Amsterdam* and *Buikslot*, like a black Cloud driving softly on; especially, after it was carried by a gentle Wind, that did not scatter it, to a good distance from the place where it was discharged, and raised up higher in the Air. So that likewise it seems deducible from hence that it is not always Watry Vapours, but also other Particles and Exhalations of which the Clouds are composed: Concerning which, as also of the Rains and Dews proceeding from the same, and other Meteors properly belonging to Water, something more subservient to our Design shall be mention'd hereafter in our *Contemplation upon Water*. To proceed.

Sect. XXII. *Wind and its Usefulness, and Convictions from thence.*

Among the most common, but not the least wonderful Motions of the Air, *Wind* has the principal place. Now it is known to every one, that the Wind is a flood or a stream of mov'd Air, insomuch that it wants no farther Proof after so many Experiments, only let us observe here first in general, that it is something, which after a very sublime manner, shews the Power and Goodness of the Great Creator.

They that have ever read of, or tried the dreadful Force of Storms and Tempests, of *Hurricanes* and *Travadoes*, will be sufficiently convinced of the Resistless Power of the Wind. But Custom makes us contemplate this great Wonder without any Emotion. But if there should be still any one so wretched as not to learn his Obligations of Thankfulness to the Great Giver of all Things from these his Works, let him for once suppose with us, that there was no such thing in the World as Wind or Motion of Air, but that it remained in a perpetual Stagnation quite round the Globe, like a Pond or Lake of thin and dead Water. Must he not then own;

First, In case that what was raised up in the Air should remain in the same place, without being carried elsewhere, or so long at least, till it grew lighter, and so ascended, or heavier, and then descended; (to say nothing of Cities and Countries, which after Earthquakes might be visited with sad and fatal Distempers, by the Corruption of the Air) that great Trading Towns and Populous Places, where the Smoak of so many Fires of Coal, Turf or Wood, the Vapours of so many stagnating Waters, the Stench of so many impure

Places, and thousands of other kinds of Exhalations proceeding from Men, Beasts *&c.* did continually and incessantly fill the Air; and the whole World too, would soon be one universal Church-yard and Burying-place; for all its Inhabitants wou'd soon perish, were it not that by the help of these Winds, so exceeding necessary towards the support of all Living Creatures, fresh Air is continually derived to them from the Hills, and other healthy Places round about them; and the unwholsome and infectious Vapours driven from thence, and dissipated in the vast space of the Skies. And can he that observes all this, perswade himself to believe that Winds are meerly accidental, and that he owes no Thanks for this great Benefit to him that made the Winds?

Secondly, If this is not enough to convince an Atheist, yet he certainly knows, that if the Vapours drawn from Water were to fall down in the same place from whence the Sun had raised them up, most of 'em being exhaled from the Sea, would likewise fall down into it again; and that the dry Land, Fruit-Trees and Plants, would never be able to share in their Moisture. Moreover the Course of Rivers running from Inland Countries and Regions remote from the Sea, into which at last they discharge themselves, would likewise in time be partly or wholly dryed up: Insomuch that Dews, Rains and Inundations of Rivers, that render the Earth fruitful, failing altogether, would make it at last unfit to feed and keep alive, by its Productions, Men and other Creatures that dwell upon it.

Now this entire Destruction of almost all that breaths upon the Earth, is solely prevented by the Winds: By Means of which those Watry Vapours, that do mostly arise from the Sea, are carried to dry Places, that they may there descend in Rains, Dews, Snows, and other Meteors, and

supply

ſupply for the moſt part the refreſhing Streams of Brooks and Rivers with continual new Matter.

Now if ſo many Men, ſo many Beaſts, ſo many Birds, ſo many Fiſhes, and ſo many thouſands of Trees and Plants, were made without Wiſdom and Deſign: Can any one ſay, without the Contradiction of his Conſcience, that the Winds, for want of which all of them would in a little time periſh by the failure of their Suſtenance, are thus made accidentally and without any determinate Purpoſe of our great Preſerver? Would he ever dare to aſſert the ſame of ſo inconſiderable an Inſtrument as even a Watering-Pot, wherewith we refreſh the Plants and Flowers of our Gardens? And ſeeing that ſuch a thing was adapted to convey a little Water from ſome adjacent Well or Brook into a Garden, and there regularly to ſprinkle the Parts thereof; would he dare to maintain, that even ſuch a contemptible Veſſel was made without any Deſign of the Artificer? But if not, how can he expect to paſs for a rational Creature, when he pretends to believe the ſame of the Winds, thoſe great Aquæducts and Watering-Pots of the whole Earth, and for that reaſon the Preſervers of his own Life, and that of all other Creatures?

Thirdly, Now to paſs by the Obligations under which thoſe Men lye, that make ſuch great uſe of the Powers of the Winds to their Advantage and Pleaſure both; ſo that where there are no Rivers to turn Mills, they can apply theſe Streams of Air to the ſame Purpoſe: Can it be imagined, that the ſaid Winds are produced accidentally, when without their Aſſiſtance the Inhabitants of the World could reap no Benefit from any of thoſe Countries that are ſeparated from them by great Seas, nor enjoy any Communication therewith?

If ſuch Powers of the Wind, (by which great and heavy Ships are convey'd ſo ſwiftly from one

Part of the World to another; by which such great Machines can be moved as shall suffice, with the Care of a few Men, to drain and keep dry so many Watry Lands, to saw and prepare so much Wood for Building) could be bought or hired with Money; Can any one believe, that besides the Merchants, almost every Body in the World would not be ready to contribute their Share, and to pay their Quota, that they might likewise partake of the good Things of other Countries, and of the beneficial Effects of Ships and Mills? Now the most gracious Ruler and Preserver of all Things does hold this great and useful Power the Wind in continual Readiness for every Man that will embrace the Advantage of it, even for nothing, and without expecting any other Return than Thankfulness: And all this he vouchsafes to do, that he may display his Wonders even to his Enemies themselves, by a Matter that is invisible; insomuch, that if one had always liv'd in a place where the use of the Wind was never known, he could hardly be induced by the strongest Arguments to give any credit to such a strange and unconceivable thing.

And can then an Atheist sit down contented, when he not only refuses to acknowledge this Benefit (but even blasphemously denies with his Mouth the great Giver of all those things, and if it were possible, wou'd most ungratefully blot him out of his Heart also) which, by the Administration of these Winds, happen to the Advantage of himself and all Mankind? Certainly, if the Winds were produced by no other Causes than mere Chance, operating now this way and then another, such a Man ought to be in a continual Fear, that the Air would become fatal and pestilential, by stagnating and putrifying, and the whole Earth a Wilderness for want of Rain, and that he himself and all Living Creatures would perish by Hunger

ger and Thirst: And if the Winds were not bestowed upon Mankind as a Token of the Mercy of its Creator, might not he himself draw this Consequence, that he could not be able to escape the Power that exerts itself so terribly in the Winds, and at some time or other he would most justly feel the Effects thereof, as a Punishment for these his Blasphemies?

Sect. XXIII. *The Trade Winds and Monsoons.*

It must indeed be allowed, That if there be any thing in the World that these miserable Philosophers may, with an Appearance of Truth, pretend to be Accidental, it is the Wind, especially after the manner that it moves and blows in these Countries; insomuch, that it even gives a Handle to that Proverb, by which, if one would express in the strongest manner the Inconstancy and Fickleness of another, we say, he is *as Changeable as the Wind.* But to convince them, that even the Winds are far from being governed by a mere and variable Chance; let them enquire into the Experiments of Sea-faring People; and they will see (and if God be gracious enough to them, they will likewise be convinced) that the Providence of the great Governour has bound these Winds, which seem to us to come from all Corners of the World with so much Irregularity and Uncertainty, by as fixed and determinate Laws, as ever any Clock or Watch made by its Artificer.

But not to speak any thing more in Confirmation of what we have now said concerning those Land and Sea Winds, which vibrating like the Pendulum of a Clock, do every four and twenty Hours blow backwards and forwards upon certain Coasts, without which many Countries would not be able to subsist, nor many Voyages be made safely and conveniently; there are besides the changeable Winds that govern in our, and other Parts of the World, two

principal

principal and well known Kinds of regular Winds: One of which does the whole Year round observe in a manner one and the same Course, always blowing from the same Quarter, without any Observation of any Return, or of any contrary Wind; and these are named by Mariners and Geographers, *Passage* or *Trade Winds*. Those of the Second Sort are such as they call by the Name of *Monsoons* or *Mousoons* (in Latin *Motiones*) and these blow one half Year from one Corner, and then another half Year from that Quarter of the Heavens directly opposite.

Without these Trade-Winds, how could they sail upon the great Ocean? How could there hardly any Ship arrive at the *East-Indies?* Since at some Degrees North of the Equinoctial you meet with a South-East or Trade-Wind, which, being in a manner directly contrary, does perpetually reign there; and as near as a Ship can sail against or bear up to the Wind, as they term it, drives it upon the Coast of *America* and to the *Abrolhos*; and whereas they endeavour to steer their Coast Eastward, they are obliged to make away so far to the West, that they may get out of the Reach of these Trade-Winds. Being come so far, they are brought by changeable Winds to the *Cape of Good-Hope:* From whence sailing into the 38th, 39th, and 40th Degree of Southern Latitude, they meet with another Trade-Wind, which blowing almost contrary to the former, and to the Northward of the West (for which reason it is called the Westerly Trade-Wind) carries the Ship to the Journeys End; and that too with so great a Force sometimes, that according to the Observations which a very curious Mariner communicated to me out of his Journal, his Ship was driven by this Wind above 50 Leagues to the Eastward in the space of 24 Hours. And when the Ships return from the *East-Indies*, the first South-

East

East Trade-Wind is again serviceable to them, to carry them some Degrees North of the Line.

Sect. XXIV. *Convictions from the foregoing Observations.*

I have often consider'd with myself the great Advantages that accrue to the *Dutch* from their Travelling in *Trek-Schuits*, or Boats drawn with one or more Horses; by which they can in a manner, throughout the whole Country, compute exactly the Time required to pass from one Place to another, let the Distance be what it will.

Will now any Atheist, how obdurate so ever he may be, dare to maintain, that those who alone enjoy the Conveniency thereof, are not the least obliged to the Prudence and Foresight of their Governours for it; who have been pleased to appoint the same for the Publick Good, in order to render the Correspondence of one City with another the most Cheap and Convenient to the Inhabitants? And that those have most Truth on their Side, who affirm, that it is by mere Chance, or at least, without any View or Design, that at every time, and as often as it is required, fresh Horses are at hand to draw the said Boats?

Now if we were to use no other Arguments; might not this Constancy in such uncertain and variable Motions as are those of the Winds, convince every reasonable Person, that the Creator and Ruler of all Things, has thereby proposed to himself certain principal Ends and Purposes? For if variable Winds and Calms should indifferently reign in all Parts of the Ocean, what Computation could be made of bringing a Voyage to any sort of Conclusion? And how many unhappy Seamen being detained in these long Voyages by Calms or contrary Winds, would run the Risk of perishing with Hunger and Thirst.

Let

Let no body think that we carry this our Aſſertion too far; becauſe the great Creator of all Things, in order to ſtop the Mouth of theſe blaſphemous and deplorable Atheiſts, and to deprive them of all Evaſions, and ſheltering themſelves again behind a neceſſary Conſequence of ignorant and natural Cauſes, has ſhown them that it was in his Power to have govern'd the Winds after a quite different manner; and particularly to have render'd the Seas impracticable and unnavigable by Calms and variable Winds.

For a Proof hereof, we ſhall make uſe of the Words of that great Mathematician, the preſent learned Profeſſor of Geometry at *Oxford*, Dr. *Edmund Halley*, who, after he had been a long time between the *Tropicks* upon the Iſland of *St. Helena* and having made diligent Enquiry into the Nature of the Winds by all poſſible Means, informs us (as we find it in the *Philoſophical Tranſactions Numb.* 183.) that about the Coaſt of *Guinea* he obſerved many Calms and *Tornado's*, which are terrible Winds, that run round the whole Compaſs; and then he proceeds, Sect. 7. *that between the fourth and tenth Degree of Northern Latitude, between Cape* Virde *and the Eaſtern Iſlands of the ſame Name, there is a great Extent of the Sea, of which it might be ſaid that there did not blow any, not even variable Winds at all; and that the Sea ſeemed to be condemned to a perpetual Calm, and was attended with dreadful Claps of Thunder and Flaſhes of Lightning, and great Storms of Rain. The Winds that are there did only deſerve the Name of little uncertain Blaſts, ſhifting hourly, and before they ſhifted, becoming Calm; ſo that ſeveral Ships before they could ſail 6 Digrees, or about* 120 *Leagues were obliged to ſpend whole Months* (*Varenius*, in his Geography; *Lib.* I. *cap.* 21. §. 16. ſays three at leaſt) *for want of a Wind.*

They

They that would be further informed of the Properties of these Winds, may meet with a great many Observations and Discourses concerning them in the Works of the Learned Lord *Bacon*, *Varenius*, *Mariotte*, and the so called Sea-Charts or *Atlas*; particularly all that relates to *Trade Winds* and *Monsoons*, is very accurately described by the said Ingenious Dr. *Halley*, and may be found in the abovementioned *Philosophical Transact. Numb.* 183.

Sect. XXV. *A Brief Description of the said Winds.*

To form a general Notion of this, let any one place before himself a Globe or Map of the World, and view that Zone that is contained between the Tropicks on each side of the Equinoctial, as Dr. *Halley* has represented it; They call it the *Torrid Zone*, by reason of the Heat. Here he will see, that the Waters of the Great and General Ocean may be consider'd as divided into three Parts, by the Intervention of Lands: The first is the *Ethiopic* and *Atlantic Sea*, between *Africa* and *America*; to the Eastward there lies the Second or *Indian-Sea*, between *Africa*, the *Indian Islands*, and *New-Holland*; the Third is the great *South-Sea*, or *Mare Pacificum*, extending itself from the *Western* Coasts of *America* along the other side of the Globe quite to the *Philippine-Islands*.

Now according to the Observations of Dr. *Halley* and others, we find:

I. That between the *Tropicks* in the *Atlantic* and *Ethiopic*, as also throughout the whole *South-Sea*, there always blows an Easterly Trade-Wind, which South of the *Equator* is something Southerly, and North thereof somewhat Northerly.

II. That these Trade-Winds do not reach farther than to about 30 Degrees on both sides of the *Equator*.

III. That

III. That however there continually blows a South-west Wind about the Coast of *Guinea* upon the Land.

IV. That in the Southern Part of the *Indian Sea*, the Wind blows always from the East or thereabouts, with as much Certainty as in other Seas. So that a constant Easterly Trade-Wind, and which surrounds the Globe, is found at all times in the Places before-mention'd.

V. But it is very wonderful, that on the North side of this said *Indian-Sea*, the Winds which do one half of the Year blow continually from the East as in other Seas, turn again the following half Year, and blow directly contrary from the Western Parts of the Heavens; and these are called the *Monsoons*. As for the other Particulars of those Winds, mention'd in the aforesaid Quotations we shall pass them by.

Sect. XXVI. *Transition to Experiments about the possible Causes of the Winds.*

It will not then be necessary for us to make a great shew, as some do, of the Knowledge we have either acquired our selves concerning these Winds, or have learned from other People: But it seems best to adore the Great Director in his unscrutable Ways and Works, as despairing ever to attain to Perfection herein. However, since a great many things appear to be sufficiently known concerning the said Winds (tho' it be very little in it self, with respect to the Importance of the Matter) to prove from thence the Wisdom and Power of the Creator; that we may not pass by all of them untouched, but furnish some Opportunity to such as have any Inclination to make further Enquiries therein, we shall briefly propose a few Experiments, which have been, and perhaps may

may still be useful to many, either for a Foundation, or at least some Direction in their Thoughts and Discourses about them.

SECT. XXVII. *The first Experiment touching the Contraction of the Space in which the Air is contained.*

SINCE the Essence of the Winds consists in a Motion or Protrusion of the Air from one place to another, it is certain, that whatever is capable to protrude the Air after such a manner, is likewise proper to cause a Wind. Accordingly we find;

I. That the Air may produce a Stream and a Wind when it is shut up any where, and the Place containing it is render'd narrower; whereupon being pressed, it forces its way thro' all the Passages it meets with, and thereby represents a Blast or Wind.

This we may see when a Man blows with his Mouth, or presses a pair of Bellows, or in the sudden fall of things that have any breadth in them, whereby they press the Air between them and the Ground, and driving it away on every side, produce a sort of a Wind. This way of Generating a Wind was known to *Hero Alexandrinus* many Ages past, by making of a hollow Vessel that was Air-tight, and had two Tubes, a great and a little one: Thro' the greater there runs Water with some Swiftness into the Vessel or Cistern, which ascending in the same, contracts the Space wherein the Air was contained, and so forces the said Air with a Blast thro' the narrow Tube, by which means little Flutes, Pipes of Organs, and Figures of Birds are made to yield a Sound? to say nothing of blowing Fires, and even smelting Metals in some Places after the like manner.

SECT.

Sect. XXVIII. *The Second Experiment with a hollow Globe or Æolipile.*

II. Some Philosophers (upon observing the Experiments of heating a hollow Brass Globe, having a little Orifice or Hole in it, and then throwing it into cold Water, to cause the Water to go into it, and afterwards making it hot again over a Fire, whereby the Vapours rush out like a violent Wind) have thought that the Wind does not so much consist in a Motion or Protrusion of the Air as in Watry-Vapours, which this Experiment of an *Æolipile* or *Wind-Globe* confirms; and have therefore endeavour'd to deduce all the Properties of the Wind for the most part from such Experiments. But we shall not here enquire either into the Probability or Difficulties of their Hypothesis. [See the Figure of such an *Æolipile*, *Tab.* XXII. *Fig.* 3.]

Sect. XXIX. *The Third Experiment. The moving of Solid Bodies through the Air.*

III. Another manner of moving, or producing a Stream of Air, is by causing a Body to pass swiftly thro' it; forasmuch as by that means the Air follows the said Body with a great Velocity, and raises a Wind behind it.

To make a very easie Trial thereof, one need only extend ones Hand, the Fingers being closed, and swiftly strike upon the Air from one side to the other; whereby one shall be aware that the following Air sensibly blows against the opening of the Hand, especially if you moisten the same with a little Water, for then you will more sensibly feel the same.

But to give a visible Proof thereof, drop some little round Bullets from any due Heighth into a Bucket

Bucket of Water; and as soon as they fall to the Bottom, you will see some Bubbles of the Air that followed 'em rising up from the Bottom to the Top of the Water; insomuch, that many times if the Bullets descend from a greater Heighth, and consequently with more Swiftness, the Bubbles will even be as large as the Bullets.

The same has been observ'd in the Force of the Wind, which some have felt to their Harm, upon a Cannon-Ball's passing very near them, yet without touching them.

'Tis the like Sort of Wind, as some think, that is excited by the rushing of great Hail-stones, as they swiftly descend.

Sect. XXX. *The Fourth Experiment; Effervescences.*

IV. We see a Wind likewise generated by mixing together two Effervescent Matters, and causing them to ferment; and it is the same thing, whether both of them be Liquid, or one of them be a Solid Body.

Accordingly, if you throw Filings of Iron or Steel into Spirit of Salt-petre, or into Aquafortis; or if you mix with the Spirit of Sulphur, Sea Salt, Copperas, or any other Acid Spirit, an Alcaline Liquor, such as Spirit of Sal-Armoniac impregnated with Potash, or Spirit of Hartshorn, Salt of Tartar, or Potash itself dissolved in Water, they will produce a Fermentation with great Violence, and exhale a Stream of Air and Vapours out of the Mouth of the Glass or Vessel that you put them in; of the Force of which Fermentation or Ebullition you will be the more sensible, if you stop the Mouth of the Glass for a little space, whilst they are working together; but you must not keep it shut too long, for unless the Glass be very strong,

it will burst in pieces as if Gun-Powder were kindled in it.

We do not here enquire after what manner the Wind is thus produced, being sufficient to our Purpose, that a Wind can be so made; and that such an Effervescence may be produced among the like Particles, even in the Air itself, has been in some sort proved above in §. XIX. about *Fogs*.

Sect. XXXI. *The Fifth Experiment, by burning Sulphureous Bodies and Salt-petre together.*

V. Some Naturalists are wont to add to these Winds, the very violent and turbulent Protrusion of the Air and Smoak that has been observed by the mixing of Salt-petre with some Sulphureous Matters, and touching them only with a little Fire.

After this manner, we shall see an Instance of it in mingling Antimony with Salt-petre, or (if we fear any danger from the Smoak arising from this Mixture) by mixing powder'd Salt of Tartar with the like quantity of Salt-petre, and then setting it on Fire with a live Coal, or red hot Iron, especially if you burn these Matters inclosed in a Vessel, out of which their Smoak may have a Passage thro' a Tube, as the Chymists do upon certain Occasions: for then you will see with how much Force and Swiftness there will be a Wind and Stream of Air produced.

Some suppose that the *Hurricanes* are generated in this manner, by the inflaming of some such Matters in the Earth. *First*, Because of the great Force and Violence of them, which must proceed from a very great Velocity of the Air-Stream which upon this occasion is very remarkable. *Secondly*, Because they do not last long, and commonly not above 7 or 8 Hours. *Thirdly*, Because they are observ'd to rule for the most Part in cer-

tain

tain Places only. *Fourthly*, Because (as we see in the aforesaid Burning Matters) the Streams of Smoak diffuse themselves on all sides, and so the Wind blows from all the Points of the Compass. *Fifthly*, Because Earthquakes are often felt at the same time in the adjacent Places, and Dead Fishes found floating in those Parts of the Sea that are nearest.

Now, that these Fires produced by Salt-petre and Sulphur, tho' kindled under the bottom of the Sea, are not extinguished by its Waters; and that the Smoak thereof forces its way upwards thro' the same, may be easily accounted for by the Fire-works, that perform their Operations even in the Water, where they will remain a great while, without being extinguished, and from whence Men may see the Smoak of them ascend. The same thing will appear as plainly, by kindling a little Squib or Serpent, as they call it, and throwing it into a Glass full of Water, where you will perfectly see the Squib burning out, and all the Smoak of it rising thro' the Water, insomuch, that if any Fish were there, 'tis likely they would all dye.

Whether this be the true or only the probable Cause of those dreadful Winds, which they call Hurricanes, we shall not enquire any farther here.

SECT. XXXII. *The Sixth Experiment, shewing, that the Elastick Power of the Air being augmented, produces Winds.*

BESIDES the forementioned Causes of the Production of Winds, the Great and Principal Property of the Air does still furnish us with another; which, tho' unknown 'till of late Years, is yet esteem'd by many, and with great Appearance of Truth, in this Age, for one of the Causes of Winds. This has been shewn before in the particular Account which we have given of the *Elastick* Power

of the Air; by which it continually endeavouring to dilate itself towards every Part where it does not meet with a sufficient Resistance, breaks forth with a great and swift Stream; insomuch, that when we take away the Balance of Force, by rendering one of the two adjacent Airs stronger, or t'other weaker, the strongest always expands itself towards the weakest, and by protruding or driving it forwards, causes that Motion which we call Wind.

VI. The Particles of the Air press upon one another in a Wind-Gun; by which means their Elasticity is augmented; and we may see that it will drive out a Bullet, notwithstanding the Resistance of the common and external Air, with such Velocity as is now well known to the Amazement of many.

After the same manner, if you blow Air strongly into a little Bottle with a narrow Mouth, and give it room to flow back again, you will find that it will rush out from thence with great Swiftness tho' it was a long time in blowing in, only because it is strongly compressed within that narrow Space. Now whether certain Sorts of very violent Winds do suddenly exert themselves like Gusts and Blasts after the same manner, because two other more gentle Winds driving before them all the Vapours and Clouds in the Air, and blowing them against each other, do compress the interjacent Air, and dispose it so as to break out with a great Swiftness for want of a sufficient Resistance, we shall leave the further Enquiry to such as think it worth the while, and may meet with Opportunities of making it.

SECT. XXXIII. *The Seventh Experiment; the Diminution or Weakning of the Air will produce the same Effect.*

VII. NOW, as we have shewn from hence with how great a Velocity the Air can be protruded as it becomes stronger in its Elastick Faculty, it being thicker and closer compressed in the same Place; the same Velocity does likewise exert itself when the Balance of the Resisting Air only is taken away either in whole or in Part, by diminishing the Quantity thereof in any Place.

Thus we see when a Vacuum is made by exhausting the Air, the common Strength of the external Air forces in with very great Swiftness. Several Experiments proving such a strong Blast, have been already quoted upon the Subject of Respiration.

Those who desire to see more Proofs may consult the Machines of Messieurs *Guerike* and *Papin*, (*Philosoph. Transact. Numb.* 121.) with which in the presence of *the Royal Society of London*, the same Force and Noise was in a manner produced by the rushing of the Air into a Vacuum, as is usually made by the compressed Air in a Gun, being let out.

However, if those that have neither an Air-Pump, nor such Machines as these at hand, are desirous to make this Experiment, namely, that the Air forces it self like a violent Wind into a place where the internal Air is either much diminish'd, or has very little Elasticity in it: Let them take a Glass Bottle, first putting a little Water into it, and tying a wet Bladder over the Mouth of it; so that turning it upside down, there may be about the Quantity of two Fingers breadth of Water in the Neck of it; then turning the Bottle right again, that the Water may descend to the Bottom of it, and the Neck remain empty: Let them make a little Hole in

the middle of the Bladder, with a Pin or Needle, and through the same suck out the Air from the Glass, as strongly as they can for several times; stopping the Hole at every turn with the Finger, that no Air may get in again.

When this is done as well as it can be, let the Bottle be inverted again, so that the Water may run into the Neck, and upon the Bladder stopp'd with the Finger; upon the removing of which Finger, the External Air, like a Wind, will rush into the Bottle thro' the Hole of the Bladder and the Water lying upon it, and rise up to the Top, where the Internal Air had been diminish'd and weaken'd by Suction.

Now, if according to the Calculations of Mathematicians, the Air, which forces it self into a *Vacuum*, moves with so much Velocity, as to advance 1305 Foot in a Pulse or Second of a Minute (See *Philosophical Transactions.*) And according to the Observation of the accurate Mr. *Mariotte*, it is very difficult to withstand, or advance against a Wind that moves 24 Foot in a Second; and that another, that runs 32 Foot in the same time, produces such a Storm, as is capable of tearing up Trees and overturning Houses: (*See his Discourse du Movement des Eaux, p.* 67, *and* 78. *See likewise the said Treatise lately done into* English, *by the Ingenious Dr.* Desaguliers.) What Havock and Destruction of every thing might we not expect from the terrible Force of a Wind, which being above 40 times as swift, would, supposing it to act upon the same Bodies, exert 40 times as much Strength as the aforementioned Storm; especially, if that Air which surrounds the whole Globe should have the Opportunity of displaying its Elastic Power upon any great Space that were almost or altogether empty of Air? Now, whether such a thing may

may be supposed to have ever happen'd, and whether Winds have been protruded after the like manner in the open Air, we shall not here enquire

But this however may be plainly inferr'd from what has been said, that the Pressure of the Air being enabled to exert itself with its utmost Force, would, by its exceeding Swiftness, produce most dreadful Effects; destroying every thing upon the Face of the Earth, in a very little Space of Time, as has been already shewn in *Contemplation* XVII. by an Experiment of the Air's Breaking a Glass, tho' the same was far from being exhausted of all its Air.

Sect. XXXIV. *The Eighth Experiment; Of producing Wind by Cold.*

VIII. We have seen that the above-mention'd Motion of the Air or Wind was produced, by diminishing the Quantity or Strength of the Air. But besides this, there is another Case in which, tho' the Quantity of the Air be not diminished, yet the Elastick Faculty thereof is weaken'd; namely, when one Air is only colder than another, which in every thing besides may be like to the First: By which means also a Wind is generated when the less Cold, and therefore stronger Air expands itself, and presses upon the more cold and consequently weaker Air.

Many Experiments proving the same, are well known to the Naturalists; and the Operation of the Thermometers, which are moved by Rarefaction and Condensation of Air, do frequently shew the same.

But to give a very easie Proof hereof, you may try the following Experiment: Bind a wet Bladder upon the Mouth C D, of a Glass Bottle F G C D, (*Tab.* XIV. *Fig.* 6.) after having pour'd so much

Water into it, as will not quite fill the Neck K C, when the Bottle is inverted. Then take a Second Bladder H K L I, cutting off the Neck of it in such a manner, that the Orifice H I, may be very large; then having made a Hole in it at K L, the Neck K L C D, will thereby go thro', and the Bladder at K L must be tied or twisted very close about it. After which, throwing in a handful of Salt, and one or two handful of Snow into the Bladder H I K L, upon the globular Part of the Bottle F G K L, stir the same together with a Stick or Spoon; when, as it is well known, the Snow will begin to melt, and the Air in the Bottle, which is encompassed with this Mixture, will become very cold; and the Water itself, if it were higher in the Neck of the Bottle than K L, would easily be frozen, which might embarrass the Experiment, and for that reason, the Water ought not to be higher than A B, or below the Bladder K L. Now that the Air in the globular Part of the Bottle F G K I, is weaken'd in its Elastick Faculty by this Cold; and that the External Air, which is not so cold, being enabled to act upon it, will expand it self with greater Force, and produce a Wind, blowing upon the colder and weaker Air at P, may appear by pricking the Bladder C D with a great Pin at E; whereupon one may see the Air forced through the Water A B C D, that is in the Neck of the Bottle with a remarkable Velocity, like a Wind, up to the Globular Part F G K L.

This Experiment having been likewise tried in the great Frost upon the 12th of *January*, 1709; 'twas observ'd, that as cold as the Air was then, yet by this Mixture, and by the greater Cold, it lost still more of its Elastick Power; and the External Air being stronger, rushing like a Wind thitherwards, shewed that a great Quantity of Air may be squeez'd together in a cold Place. That which might

might probably be infer'd from this Operation of the Cold upon the Air, concerning Winds, shall be treated of in some manner hereafter.

Sect. XXXV. *The Ninth Experiment; Of Wind produced by Warmth.*

IX. The Operation of Warmth is directly contrary to the foregoing, dilating the Air with greater Force, thereby producing a Current of Wind towards all the Places, where it meets with no Resistance.

This might likewise be shewn by the Thermometers, in which the Warmth expands the Air; but to represent it to those that have no Thermometers at hand; Set again a Bottle, in which there is nothing but Air, with the Mouth turned downwards upon a Plate or Dish, upon which you must pour as much Water as may rise just above the Brim of the Mouth of the said Bottle, and thereby prevent any Communication between the External and Internal Air. Now if you hold a Burning-Coal, and move it round the Globular Part of the Glass upwards and downwards, so as to warm the Air within it, you will see that the rarified Air rushing out in little Bubbles between the Bottle and the Plate, will produce a soft and gentle Wind.

If you have a mind to see this Experiment confirmed with a stronger Blast, you must apply a more sudden and violent Heat thereto; as may be easily done, if you make use of a Bottle encompassed with a Bladder (*Tab.* XIV. *Fig.* 6.) and leaving it open at C D, set it down upon a Plate, with Water, then pour hot Water upon the bottom of the Bottle F G, and all round it, with some Care least it burst; this increased Heat will produce a swift Current of Air or Wind, made by the Air, which rushes out as it is expanded. Sect.

Sect. XXXVI. *The Tenth Experiment; Wind produced by the Suſpenſion or Ceſſation of Warmth.*

X. But foraſmuch as by the driving out of the Air by Warmth, the ſame is diminiſhed in the Bottle, and therefore, when the Warmth that had driven it out ceaſes, the Expanſive Faculty will become weaker than it was before, whilſt there was a greater quantity of Air in the Glaſs, and whilſt it had a Communication with the ſurrounding Air. It will therefore follow, that the External Air (having the ſame degree of Cold or Heat with that which was included in the Bottle, and was diminiſhed in its Quantity by the foregoing Warmth,) will paſs more ſtrongly that way, and ſo crowd itſelf into the Bottle with a returning Wind. One that underſtands Hydroſtaticks, might demonſtrate the ſame in the preceding Experiments; foraſmuch as the Air within the Bottle loſing its greater Heat, the Water will riſe up into the Neck of the ſaid Bottle from the Plate, by the Preſſure of the External Air: But as this is writ for the ſake of the Ignorant, to make them even ſee the aforeſaid returning Wind, put into a Bottle again as much Water as will fill the Neck when it is inverted, thereby to render viſible, as above, the Diſcharge of the ſaid Wind thro' the Water; then hold the Bottle for a while over the Steams of boiling Water, to the end, that the ſudden Heat may not burſt it, and finally put it into the boiling Water itſelf, till it be very hot, and the Air ruſhes out by the Mouth of it, which is open, as is done above in §. XXV; then take a warm wet Bladder, and tie it as cloſe as you can upon the Mouth of the Bottle, and invert it ſo, that the included Water may lie upon the Bladder; then ſet it by, for a little while in the ſame poſture, till the

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Internal Air lose its Warmth, and become equally cold with the External. Now if the Bladder be tied close enough, the Expansive Power of the Air, which is in the Bottle above the Water, will become weaker than that of the External, because the quantity of the Air is diminished, and is therefore more rarified: Wherefore in case the External Air, which is strongest, can operate against the other, it will be driven with a Current or Stream against the rarified Air; which may be discover'd by making a Hole in the Bladder with a Pin, whereupon you will immediately see the External Air, like a Wind, rising up thro' the Water.

Now, whether from all these Properties of the Air, and from the Heat of the Sun operating thereupon, the Easterly Trade-Winds, and in some measure likewise, those that blow from the South in Spring and Summer, and from the North in Autumn and Winter, may be truly prov'd according to the manner of the Modern Naturalists: Those that are curious, may enquire by consulting them.

Sect. XXXVII. *The Eleventh Experiment; Wind produced by the Motion of the Air upwards.*

XI. There is still one other Motion and Current of the Air mention'd by Dr. *Halley*, in his Discourse about the Winds (See *Philosoph. Transact. Numb.* 183.) by which it acquires a Process upwards; namely, when the Air, being rarified by Warmth or otherwise grows thinner, and consequently lighter in the same place than when it is compressed and encreased by Cold (as it has been shewn upon other Occasions;) it follows therefore, that in case the Warmth descends perpendicularly from the Sun, there will be produced directly under it, a streight ascending Column in the Air, as far

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as the great and descending Heat extends it self; in which Column the Air will be much lighter than that which is about it, and which has not so much Heat. Now if we look upon this thinner Air as Oil, and the surrounding colder Air as Water, every Body must own, that as a Column of Oil placed in the middle of Water does emerge, or is driven upwards, and according to the Laws of Gravity, diffuses itself upon the Surface of the Water, the same Appearances will likewise happen in this rarified Air. Dr. *Halley* uses this Comparison, to give us some kind of Notion, tho', as he owns himself, a very imperfect one, of the Motion of the Air in the *Monsoons*.

In order to support these Arguments by Experiments, and to render in some manner visible such a Current and Wind produced in the Air, take a little Glass, E F K L, (*Tab.* XIV. *Fig.* 7.) about six Inches high, and the Mouth of it between two or three Inches broad; set it upon a Table, then take a lighted Pipe of Tobacco, and put the Bowl of it in your Mouth, cloathing it with Paper, if it be too hot, and put in the little End of it at I or K, upon the Bottom of the Glass, and blow the Smoak of it as hard as you can into the Glass, till it comes very thick out of the Orifice E F, and filling the Glass, renders it quite dark or untransparent, which it will do very soon; then take the Pipe out of it, staying till the Smoak in the Glass has in some measure lost the chiefest Part of its Motion, and stands still like a stagnating or gently moving Water, and represents a kind of a Superficies above at A B; then take a Nail G C, about a large handful in Length, and hold it with a Pair of Tongs a little above the Point C, or a little higher, (having first made it red hot for that Purpose) and place it in a direct perpendicular Posture, as at G C; then beginning, as at H, let the hot Point

of the said perpendicular Nail gently descend from H to C; and you will see as soon as the same is come from H to C, or to the Superficies of the Smoak A B, that the said Air and Smoak will creep along the Nail, and ascend in a direct Stream from C to L; which especially from C to D, or so far as it remains below the Brim of the Mouth of the Glass, will preserve its Streightness; and sometimes, even as high as at L, when the Air in the Room is very still, which otherwise is wont to scatter and disperse this Column of Smoak as soon as it rises above the Brim of the Glass. To all which Circumstances, as minute as they are, you must carefully attend, if you would make the Experiment with its requisite Niceness. Now what has been said before is made good by this Experiment.

Sect. XXXVIII. *Convictions from what has been represented about the Air in general.*

Now will any Body deny, that the Wisdom of our great Creator does in all these things far surpass the Thoughts of Men; who for so many Ages has been pleased to make use of such various Methods, and perhaps of many more too, to turn the Air into Winds; tho' it is very certain, that the Knowledge of most of these kinds of Winds, yea, of all that owe their Origin to the Gravity and Elasticity of the Air, and perhaps too of such as are produced by Heat and Cold, has been concealed till lately from the whole World; and who can tell, but that those that are still hidden, may be reserved for the Discovery of our Posterity?

At least, a generous Philosopher may learn from hence to entertain very humble Sentiments of his own Knowledge, and to see the Fallacy and Sophistry of those *strong Minds*, who fancy they can

can fathom every thing. *First*, Because we have seen so many and so famous Naturalists in those Times, treating with so much Certainty, and even with the Approbation of very Learned Men, about the Winds; who, if the Experiments of following Years, touching the Motions of the Air, had been known to them, would have even been ashamed of the Conceit of their own Skill therein. *Secondly*, Because, as has been just now hinted, even in these our Times, in which the Grounds of the Knowledge of the Winds have been so much augmented by new Experiments, the greatest Mathematicians and Enquirers into Nature, that speak sincerely, have openly confess'd how far they still are from attaining to a true Notion of these things.

But if an unhappy Atheist cannot be yet brought by these Representations of the Greatness of GOD, and of his own Meanness, to confess the Power of his Adorable Creator; let him (if this may in any wise contribute to set him right) I say, let him with us contemplate the Globe of the Earth Z F G (*Tab.* XIV. *Fig.* 3.) and observe, that there are found upon the same so many humane Creatures at F, so many Beasts at M, so many Fishes at V, so many Birds at X, so many Trees and other Plants at O, so many stately Palaces and other Buildings in Cities and Towns, at P, so many Fires for the Use and Service of Mankind at Z, so many Ships at N, which may pass from one end of the World M, quite to the other G: And to say no more, let him seriously consider all the Wisdom and Art wherewith each of these things have been made after so wonderful a manner: Further, let him suppose all those Men and Beasts to be without any Life or Motion; the Fishes divested of the Power of Swimming, the Birds of Flying, the Fire of Burning, the Trees and Plants of Growing; let him fancy all the Towns to be uninhabited, and

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all Communication between the most remote Countries interrupted for want of Shipping; Will not the whole Globe of the Earth, with every thing that is upon it, appear to him a most Melancholy and most Frightful Wilderness? But now if any one should come and tell him, and convince him too by ocular Demonstration, that it was possible to endow a certain fluid and invisible Matter surrounding this Globe with such wonderful Qualities, that by means of the same, so many Millions of Men, and other Creatures would live; that the Fishes which he now sees floating upon the Water, would subsist under them; that the Birds shou'd be able to fly, the Trees and Plants to grow for the Sustenance of such Creatures; that Fire would burn for the Preparation of Food, for Light, and a thousand other Uses; that Ships, tho' loaded with a most surprising Weight and Burden, would be carried to the remotest Parts of the World, by the strength of the said invisible Matter; not to recount all the other Services that are render'd thereby to those who inhabit this Globe: would he not, after having seriously weighed all these things, confess the Discoverer or Inventer of such a Fluid, to be wonderful Wise? Or, could he imagine that this Matter, destined to so many different and important Purposes, was capable of acquiring by Chance, and without Wisdom, the Properties necessary to produce not only so many and such great Things, but of ranging and diffusing itself, of its own accord, quite round the World? And can he then continue to affirm the same of the *Air*, by which he lives, and from which he reaps so many advantages, which does all this, and much more still? Especially if his Knowledge extends so far as to be able to compare the Structure of Men, Beasts, Birds, Fish, Plants and other things; (of which something has been

been shown already, and more will be hereafter with the Air and its Operations, and from thenc observe with what mutual or reciprocal respect they have been created.

And if this do not yet suffice, since the above mention'd benefits of the Air do necessarily brin along with them this Inconvenience, that th Force which was requisite to make the said A useful in some of the cases before mention'd, is n less hurtful in others; and would destroy or crus to pieces wholly, or in part, most of the Building and other things; let him say, whether he still be lieves that it is by meer Chance, and without an Design, that there is throughout the whol Exspanse of the Air so wonderful an Equilibrium whereby every Creature that wants Air, can l safely enjoy it; and at the same time, be secure against its raging Powers by the same Equilibriu or Balance.

Sect. XXXIX. *Convictions from the Meteors particular.*

We have dwelt long enough already upon th *Air* and its *Meteors*; wherefore we shall adjour what we had to say about *Thunder*, *Lightnin Rain*, &c. till we speak of *Fire* and *Water*.

Let me only here ask our deplorable Philoso phers the following Question: In case it is b Chance, and without a wise Direction that ever thing happens in and about the *Air*, how can the without a mortal Dread contemplate the sai Air, and the least assemblage of Clouds and oth Meteors therein, and not tremble when the think, that it is wholly accidental that the *Thu der* don't destroy them, the *Lightning* consum them and the *Hail-stones* dash them to pieces; c that the dreadful Powers of Heaven being put i

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TAB. XIII

Fig. 1.

Fig. 3.

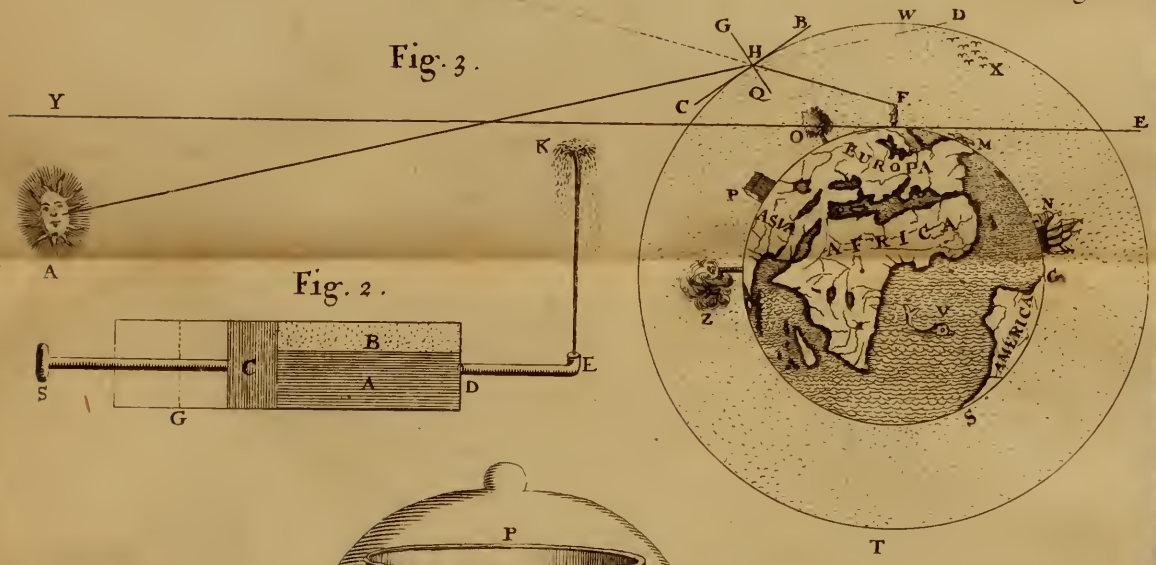


Fig. 2.

Fig. 4.

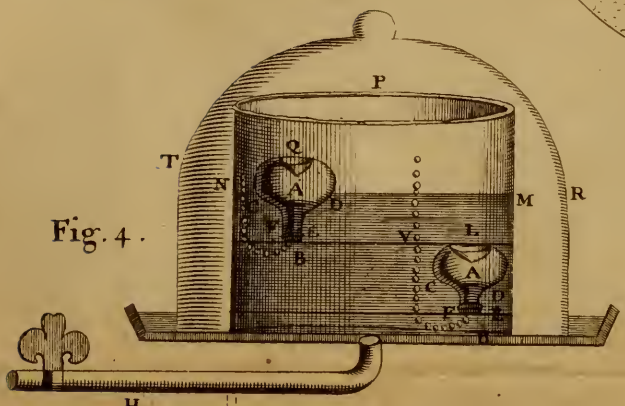


Fig. 5.

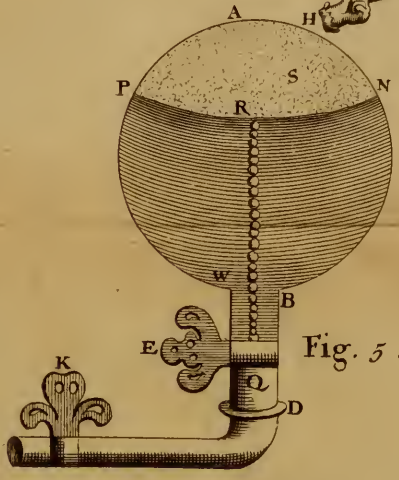


Fig. 6

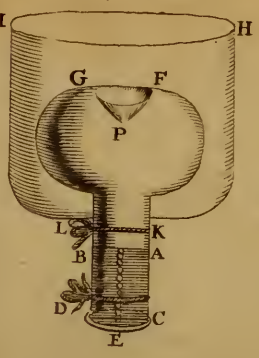
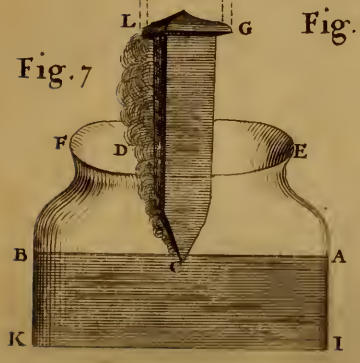


Fig. 7



Motion do not reduce all things to their native Chaos and Confusion?

Once again, miserable Atheists! who if they live at ease must renounce their own Principles; since, if all things were fortuitous, this danger would always be at hand; and since it is as great, nay a greater Wonder, that they live unharmed but one Day amidst these destroying Powers of the Air, than that the whole Globe of the Earth, and every thing upon it is not thereby overturn'd and confounded. How much more happy must not they even own those to be, who discover herein the goodness of the great Governor of the Universe; that this vast Sea of Air surrounding the whole Earth, in which there would otherwise meet so many causes of their Death, does yet concurr in keeping them alive; and that all the *Meteors* thereof produce Profit and Pleasure for them; that the *Winds* favour their Navigation, serving to bring them the Treasures and Commodities of the other Quarters of the World, and are of infinite other uses to them; that the *Rains* cause their Fruits to grow; that the *Dews* do often supply the place of the same in great Droughts; that even the cold *Snow* itself tends to fertilize their Lands; that other inflamed *Meteors* purify the *Air* of unwholsome Vapours, and that in intolerable Heats, the terrible Fires of those otherwise so pernicious *Lightnings*, help to make it more cool and refreshing; that the Sound of *Thunder* is as the Voice of God, whereby many, who too little acknowledge a Creator, are, as one may say, awaken'd from a dead Sleep. Thus Histories do testify how the most God-forgetting Atheists, that the *Caligula's*, the *Nero's*, altho' the mighty Tyrants of the World, and placed above the fear of all things, have been forced only upon hearing the Thunder, to confess in *Fact* what

they never would have own'd in Words, namely that they ſtood in awe of one that is higher than they? Let me in the laſt Place ask the Free-thinkers (as they call themſelves) whether in calmly comparing the Internal Diſpoſition of their Mind with that of Godly Men, ſo contemptible in their Eyes, they be not convinced, that they have reaſon to preferr to their own Condition the happy one of a poor ſimple old Woman that lived in a Village, who being ask how ſhe could be ſo merry, as even to ſing in one of the greatest Storms of Thunder and Lightning ſhe ever felt, anſwer'd, *That ſhe was well pleaſed, to think that the Lord of all the Earth did ſtill vouchſafe to look down from Heaven, ſpeaking in ſuch a Voice to thoſe who did not ſufficiently acknowledge his Mercies to 'em, and putting them in mind of their Duty.*

This Incident has often caus'd me to wonder how much theſe Reflections of a poor ignorant Creature could make her ſoar above the reach of the moſt exalted Philoſophy, who acquieſcing in the goodneſs of the Almighty Ruler of all things, found herſelf in ſuch a tranquility of Soul at a time when the dreadfulleſt Cracks of Thunder and of Lightning, that ſeem'd to ſet the World on Fire, made the ſtouteſt heart to tremble. Let an Atheiſt think on theſe things.

CON

CONTEMPLATION XIX.

Of WATER.

SECT. I. *Without Water every thing would dye with Thirst.*

NOW let the Philosopher that pretends still to doubt of all these most important Truths, pass on with us to the *Contemplation* of WATER; and without using any farther Preamble, we may venture to say, that he will at least agree with us, without the necessity of supporting this Truth by many Experiments, that in case there had been no such thing as Water in the World, he, and all Mankind, and most of the other Living Creatures, even in the midst of a Superfluity of Air, and other Food, would certainly perish in a very small compass of time; since Thirst, if it be not extinguished, is no less fatal than Hunger itself, and all Men and Beasts too, a few of the last only excepted, if there be any Truth in Experience, are unable to subsist without Drink.

SECT. II. *Convictions from thence.*

THIS being laid down, if it be by Chance that Water is found out, which itself is the only Drink, or at least the principal Ingredient of all other Drinks, it is likewise unquestionably by the same Chance that a Man, or any other Animal, lives a Year, or a much less time, after his Birth. And

since the most obdurate Atheist must acknowledge that all Living Creatures whatever, are of such Structure, and have the Parts of their Bodies so disposed, in relation to Water, that they are able to take and use it themselves; that they are even excited thereto by Thirst when they want it; that they can only be refreshed by Water, whether they drink it Pure, or whether they make use of other Liquors such as Wine, Beer, Cyder, and the like, of all which, it is the Foundation; and that therefore it would not be sufficient for them to have the use of all other Liquid Matters: Insomuch, that the whole Sea, and all Rivers, were made of Spirits entirely separated from their Water, or of other Liquors, in which there were not a sufficient mixture of Water, they would still all perish with Thirst. Can it then be thought, that it is owing to mere Chance, that all Creatures have the Faculty of supporting their Lives, by Water, and likewise that Water has by the same Chance acquired the Properties that are necessary for that Purpose?

Sect. III. *Without Water every living Creature would likewise dye of Hunger.*

To this we may likewise add, that without Water the Earth would not be render'd Fruitful, nor any Tree or Plant would be able to spring out of it; so that the Condition of the World would be still very miserable, if all the Men and other Creatures in it, could subsist without Water; since every living thing would soon be deprived of its Meat as well as Drink; the Consequence of which would be certain Death.

Sect.

SECT. IV. *Experiments proving that Plants consist for the most part of nothing but Water.*

LET no Body imagine that we go too far in extolling the Uses of Water: That famous Experiment of *Van Helmont* does plainly shew how much Water contributes to the growth of every thing. He took two hundred Pound Weight of Earth, first drying it thoroughly in an Oven, and then pouring Rain Water upon it, and having planted in it the Twig of a Willow, that weighed five Pounds, he found at the end of five Years, that the said Twig was grown to a Tree, weighing 169 Pounds three Ounces, without counting all the Leaves that had fallen in four Autumns; but that the said Earth being dried again as before, was scarce visibly diminished, or at most, had not lost above two Ounces of its Substance. And yet nothing more was done to it, than pouring upon it Distilled or Rain Water; for which Reason likewise, the Pot was cover'd with a thin Plate full of Holes, to prevent, as far as possible, either the Increase or Dimunition of the Earth by Winds, *&c.*

The like Experiments may be seen in Mr. *Boyle*'s *Sceptical Chymist*, Part II. where without any Diminution of Earth in one Year, at least without any that was worth speaking of, you will read of a Pumkin of a very great Weight, which was produced only with Spring or Rain Water.

The same Author does likewise mention other Experiments made upon little Plants of *Mint*, *Sweet-Marjoran*, *Purslin*, &c. which I have often reiterated with Pleasure and Wonder, by putting them into little Glass Phials, where I could observe them spreading out their Roots, putting forth their Leaves, and becoming Larger and Longer: The said Mr. *Boyle* says, that having distilled them

in a little Retort, tho' they were produced by no thing but Water, yet like other Plants of the ſame kind, that ſpring from the Earth, they yielded little Water, a ſtinking Spirit, and an Oil, the Remainder being nothing but a *Caput Mortuum* or dead Coal.

How many Trees grow in *Norway* (as Travellers that have been there relate) in Places where there is very little Earth, and hardly any thing beſides barren Rocks? Whence comes all that Wood (which no Body will eaſily aſcribe to the Rocks themſelves) but from the Rain Water with which they are moiſten'd? A like Inſtance occurs to me whilſt I am writing this, of an Elder Tree, which ſprang out of a little Cavity between two Stones of a Wall from whence the Mortar was fallen and which in the ſpace of two or three Months from a little Plant, as it appeared at firſt, ſhot out ſeveral Branches longer than a Man's Arm; and yet, when it was pulled up, in order to diſcover the Communication between its Roots and the Earth, none could be found. Now, whether this was occaſioned by the Seed of neighbouring Elder-Trees, brought by the Wind, and drop into this Cavity, I ſhall not determine; it is ſufficient for my Purpoſe, that it grew thus without any Appearance of Earth.

From whence have all thoſe juicy Fruits, as Grapes, Cherries, Goosberries, Currants, and a thouſand others, their agreeable Liquors, if it were not from Water; which by the Concurrence of other Particles, acquires ſo many various Taſtes and, as we have hinted above, produces ſo many pleaſant Drinks and Wines.

That this is true, the Chymiſts know full well who by diſtilling not only theſe juicy Subſtances but likewiſe all other Plants, from the hardeſt Wood of Trees to the meaneſt Shrubs (to ſay nothing here

here of all the Parts of Animals that are nourish'd by those Plants) even from Horns, Bones, Ivory, and other Matters, without the addition of any Liquid; do plainly shew by the Liquors coming out of them, and which the most ignorant Person cannot suspect to be in them, how great a share Water has in the Composition of the aforesaid Things.

To pass by here what some famous Chymists themselves have pretended, that the Foundation even of Metals and Minerals is Water only; which therefore, (if one may believe 'em,) as well as Living Creatures and Plants, may be reduced to an Equilibrating Water, by the help of their Renowned *Alcahest*. But we don't insist upon this, because if for many Reasons it is not to be judged uncertain, yet it is still very dark and obscure. However, this is at least an undoubted Truth, that neither Plants, and consequently, neither Man nor Beast, that uses the same for Food, can be preserv'd without Water, and that all Food does for the most part consist of Water.

SECT. V. *We do not here enquire, whether Water be a Simple or Compound Body.*

I Do not here dispute, whether Water is to be consider'd as a simple Substance, the Parts of which are all of the same Figure; and which, as happens in Ice and Snow, joining themselves together, may compose the solid Bodies of Plants; or, whether it is to be affirmed, that Water is a mixed Fluid, in which all sorts of Particles, proper for the Composition of Plants, are to be found, which, after the Evaporation of their Waters remain in the Plants, and contribute to the Augmentation of their Size and Weight, as has been attempted to be proved by Dr. *Woodward*, *Phil.*

Transactions, Num. 253. This is certain, that hitherto it could never be deduced from Philosophical Hypotheses, how it is possible, that Spirits, Salts, Oils, Earth, and Ashes, *&c.* as has been shewn in the foregoing Experiments of *Van Helmont* and *Boyle* should proceed from the same Water; and which is more, how Water can be proper, by producing so many various Smells, Tasts and other Qualities in such various Kinds of Plants, to cause each of 'em nevertheless to grow up regularly and orderly, according to its own Nature.

Sect. VI. *Convictions from the foregoing Observations.*

It is necessary to shew more fully in this Place how far the Wisdom of our adorable Creator and Preserver exceeds the Comprehension of the greatest Philosophers, who unless irrefragable Experience had taught them all this, could never have believed, nor ever have imagined that this could have been proved from their assumed Principles. If the Parts of Water, or those that are mingled with Water, are formed by Chance only, are moved by Chance, and preserv'd by the same; since Chance works without any Rule, how could the growth of Plants, that has come to pass in so exact an Order in innumerable Places, so many Ages with so much Advantage to those that inhabit the Earth, ever be expected, or ever be hoped for again in following Times, if every thing were not directed and guided by an over-ruling Providence? I know very well what is usually affirmed upon this Occasion; by some, about the Figures of *Pores* in the Plants themselves; by others, about *Fermentation*; and by others again, about a *Panspermia*, or a Disposition of the Water, containing

ing in itself the Seeds of all Things. But it would not be difficult to shew here, that all these Hypotheses, and such lofty Names, in which there is so little of Truth, are much too weak in any manner to make manifest the Ways of GOD in these Matters. And in case any one thinks he can deduce these Things, of which he is entirely ignorant (as he certainly is, of the manner how Water operates in all such Cases) from a natural and unknown Necessity, one need not prove any farther that he speaks without Foundation, since there can be no Demonstration of a thing that is entirely unknown.

SECT. VII. *An Experiment to shew that Water is changed into Earth.*

TO shew this, it is known that the Evaporation or Exhalation of Water, as also the Distillation thereof, is a continual Work performed in Nature without ceasing; at least, in Rivers and Seas, where the heat of the Sun is of any force; which causes the Matter to ascend in Vapours, and afterwards lets it fall again in the form of Mists, Dews, and Rains, and the like; after the same manner as the Chymists are wont to produce Evaporations and Distillations with the help of Fires.

Now that Water is hereby changed into Earth, has been experimentally shewn by Mr. *Boyle*; of which Sir *Isaac Newton* taking notice in his Book of *Opticks*, *p.* 319. uses these Words; *Water, by repeated Distillations, is turned into a solid Earth, as Mr.* Boyle *has discovered by Experiments:* Which is likewise confirmed by that diligent Enquirer, *Robert Hook*, and others, as may be seen in the *Philosophical Transactions*; saying, That all Waters, by frequent Distillations, are changed into a whitish and insipid Matter, which cannot be dissolved in Water again.

SECT.

SECT. VIII. *Other Experiments relating thereto.*

As wonderful as this may likewiſe appear to ſome, it may, however, be proved by this Experiment, which gives us the entire Certainty thereof.

I. Becauſe as often as we diſtil Water it always leaves ſome Earth behind it, which may render what has been ſaid before probable to ſuch as will not have the Patience to repeat thoſe Diſtillations ſo many times after one another.

II. It may likewiſe be inferred from hence, foraſmuch as every one knows that the Plants which have been already proved capable of being produced by Water only, are ſubject to Putrefaction, and are finally changed certainly for the moſt part into Earth.

III. This ſeems likewiſe to be plain, becauſe the ſaid Mr. *Hook* ſays in the before-cited place, that Sea-Water, tho' cleared as much as poſſible from all its Sand, yet being evaporated, does ſtill leave ſome behind it.

An extraordinary Account whereof was communicated to the Royal Society in *England*, by Dr. *Robert Plot*, made upon the Salt-works in *Staffordſhire*, which may be ſeen in *Philoſoph. Tranſactions*, *Numb.* 145. where one Mr. *Collins*, writing about the ſame, ſays, That the great Quantity of Sand proceeding from all Pickles, whether it be from the Salts of the Springs of the Sea, or from thoſe that are diſſolved in Common Water, was found to ariſe only from the boiling, before which there was none obſerved to be contained in thoſe Liquors: Foraſmuch as after having been filtrated or ſtrained through an eight double *Holland* Cloth, they did not leave behind them the leaſt Marks of Sand. Which Experiment, at the requeſt of the ſaid Dr.

Dr. *Plot*, having been again repeated with great Exactness, occasion'd some farther Speculation, as may be seen in the said Account.

IV. Now, that Water may likewise be turned into a solid Body by Art, is plain from the *Sal Mirabile* of *Glauber*, which, according to his Assertion, will congeal all Liquids. And I have found Rose-water changed thereby into such a hard and petrified Matter, that being shaken about the Bottle which contained it, it burst one of the sides thereof. I have not made the Experiment upon other Liquids, having no more of the said Salt by me; and a new Preparation of it required a little too much Attendance, to meet with the exact degree, whereby the Salt might be reduced to Powder without dissolving, which is however necessary in this Case.

I shall here add one instance more, that occurr'd to my late Brother; who having distill'd a Horse's Hoof, and first separated, by Sublimation, all the Volatile Salt from the Liquid Matter, which the Chymists call the Spirit, was just about throwing away the Remainder that smell'd strongly of Fire, and in which he could discover no sign of any more Volatile Salt; but however, to satisfie his Curiosity about the said Liquid, he thought fit to Distil it over again in Oven-Ashes, filling the whole *Still* with Ashes; and putting Fire under it, it yielded a very clear Liquor, which as long as the Joints were stopt, was as fluid as Water; but upon pouring it from the Recipient into a round and thick Pint Bottle, he found, that as soon as ever it was in it, it was changed into a white, solid, and hard Substance, like Marble, without the least Appearance of any Moisture or Fluidity in it; and this solid Body assumed the perfect Figure of the Glass before it, just as melted Lead is used to do

do of the Mold in which it is Cast: having viewed it many times with Amazement afterwards, whilst it retained the same Figure and Condition for several Months, at last, and by little and little (the Bottle not having been well stopt) it returned again to a liquid Substance, of a Smell exactly like, if not exceeding the strongest Spirit of Hartshorn or Sal Armoniac.

I thought fit to give an account of this matter here (since the Chymists hold that this Liquor, when all the Volatile Salt is as far as possible separated from it, to be nothing but a mere *Phlegm*, or Water, containing perhaps a few Oleaginous Particles in it) to the end, that I might shew how little Knowledge the greatest Enquirers have yet attained to, of the internal Structure and Disposition of that which they call (and justly too, according to all appearance) Water: And after how many Ways it may be proved, that the Water of which we are now speaking, is capable of being converted into solid Bodies; to say nothing here about Ice, which when dissolved, is turned to Water again, and therefore does not seem to have undergone any real Change.

SECT. IX. *That living Creatures, Plants, Minerals, and even Metals themselves are produced from Water, shewn Experimentally.*

I RECOMMEND it to the Over-weaning Naturalists, to prove how it may be consistent with their Hypotheses:

I. That from Water not only Plants, and from them, when treated after a Chymical manner, Spirits, Oils, Salts, and a Terrestrial Substance or Ashes are produced, but,

II. Living

II. Living Creatures themſelves are likewiſe beholden to Water, if not altogether, yet in a great Meaſure, for the Subſtance of which they conſiſt. This is plain, becauſe they are nouriſhed by Plants and Water; and the Diſtillation of all ſolid and fluid Parts of their Bodies, even of the very hardeſt, ſuch as their Bones, Horns, and Teeth (as has been ſaid before) experimentally ſhews, that Water is a great Ingredient thereof.

III. That beſides Plants and Animals, even Minerals and Metals proceed from Water. Thus we ſee in the aforemention'd Experiments, that Earth proceeds from it; which is likewiſe reckon'd among Minerals: And particularly by the Experiments related in the *Hiſtory of the Royal Academy of Sciences in* France, *for the Year* 170⅝ that from the Aſhes of Plants (which have been ſhewn above to grow out of Water) Iron can always be extracted by the Loadſtone. How all theſe things come to paſs, has not yet been rightly proved by any one that I know of; but this plainly follows from thence, that our Knowledge of the real Eſſence of Things does not extend itſelf very far; and that the moſt haughty and ſtrongeſt Mind muſt be forced to acknowledge here, that there does daily appear in Nature a Manner in which Plants and Animals are what they are, and according to which, Water does likewiſe operate, which is impoſſible to be deduced from any of their Hypotheſes or Principles.

I beſeech them therefore once again to conſider with themſelves, whether they have any cauſe to lean ſo much upon their own Underſtanding, which has not hitherto been able to teach them how a Plant grows, and of what it conſiſts, and what Uſes ſo common a Matter as Water, which has been examined and enquired into after infinitely

infinitely different Ways, has in the World; and therefore, whether they can think that they judge wisely, that this their Understanding does not only instruct them of the Nature and Disposition of that Universe, containing all these particular Matters that are unknown to them, but moreover, that it is capable to determine whether the said Universe were Eternal, and how it subsisted from all Eternity, or whether it had a Beginning; in which they act just as wisely, as he that pretends perfectly to understand the whole Structure of a Watch, and yet is forced to confess, that he is ignorant how the least Wheel thereof is made. However, the Labour that is bestowed in the Contemplation of WATER (as much of it as there remains still unknown) will be abundantly compensated, if it only serves to convince Philosophers of the weakness of their Understanding; whose great Presumption is oftentimes the only Stumbling-Block over which so many have fallen.

SECT. X. *The Ascent of the Water into the Air.*

BUT to go on to something else:

Could any Body, that had never seen it, believe that this Water, which, on account of its greater Weight than the Air, is seen to descend in Rain, Dew, Snow, and other Forms, can be made to ascend into the Air, and there to form the Clouds? 'Tis true, that as in many other Matters, so likewise in this; the Custom of seeing a thing frequently happen, makes it seem to be the less strange or wonderful; but it must however be confessed, that this is justly reckon'd among the Wonders of the Almighty in many Parts of the Sacred Writings; as in *Psal.* cxxxv. 7. *Jer* x. 13. and li. 16. *He causeth the Vapours to ascend from the Ends of the Earth; he maketh Lightnings for the Rain: He bringeth the*

Winds out of his Treasures. If ever he took the trouble to consider the various Opinions of the greatest Naturalists thereupon, we need only read what Mr. *Mariotte, Mouvement des Eaux, Part* 2. *Discourse* 3. and Dr. *Halley. Philosoph. Transactions, Numb.* 183. have said upon this Subject, to convince us, that the Cause of this Ascent of Vapours is not so easie to be discover'd as some have imagined.

Sect. XI. *How such an Ascent happens.*

I Shall not here enquire, whether this Opinion of Mr. *Marriotte* in this Matter be the most probable, namely, that there are little higher Cavities or Holes in the Air, thro' which the smallest Particles of Water being raised upwards, perhaps by the Pressure of the lateral Air, may pass, but not which the biggest are stopt: Nor, whether we may more rightly suppose with Dr. *Halley* that a little Particle of Water may be so far rarified and blown up as a Bladder, by a warm Matter, that its Diameter, in Breadth, Length, and Thickness, may be ten times as large as it was before; in which Case this Particle may fill a Space a thousand times bigger than the former; retaining nevertheless the Weight only of one Particle of Water, which had been found to be but eight hundred or nine hundred times as heavy as just so much Air in Magnitude; and therefore, according to the Laws of Hydrostaticks, as long as it remained thus rarified, it would continue ascending in the Air, exactly after the same manner as a solid piece of Glass, which in such a Condition would sink down into the Water, may be blown up into a round Bubble, and thereby with the same Weight, occupying more place in the Water, would ascend and float upon it.

I leave the Arguments of theſe great Men to their own Weight; but foraſmuch as the Authors of them acknowledge, that they believe, that there may be other ways, by which the Aſcent of Water, which is heavier, into the Air which is lighter, may be explain'd; the following (which I therefore take the liberty to propoſe here) ſeems likewiſe to be one of thoſe; the rather, becauſe it is not ſo much founded upon an Hypotheſis, as upon Experience.

Sect. XII. *Experiments ſhew that Air does likewiſe adhere to other Matters.*

To ſhew the ſame, it is known:

I. That Fire is lighter than Air: This wants no farther Proof, foraſmuch as we ſee with how great Velocity all Flames aſcend into the Air.

II. That lighter Matters can ſtick and faſten themſelves to heavier: This appears in moſt Liquids, which adhere and hang upon other Matters heavier than themſelves.

Accordingly we ſee, that the Air (which, tho' fluid, yet very moiſt) does cleave to many other Subſtances. To prove this, we need only throw a few ruſty Nails into a Glaſs of clear Water; and if you view them ſidewiſe, you will ſee many little Air-Bubbles cleaving to them.

And to the end, that it may not be thought that this adhering Air proceeds from the Water itſelf, I find by my Notes of the 21ſt *January* 1696 that ſome little pieces of Ruſty Iron and Braſs were thrown into Lye, in which there is no Air, and preſently ſome Bubbles appeared upon them; and upon exhauſting the external Air, which gravitated upon them, the ſaid Bubbles became larger, and by their Expanſion, ſhewed themſelves to be Air; and this appear'd the plainer, becauſe if on rubbe

ubbed off with the Finger, those Air Bubbles that emained upon the Iron whilst it was under the Lye; one saw, that how much so ever the incumbent Air was drawn off with the Pump, there did not appear one new Bubble; so that it is plain from hence, that the Air will cleave to solid Bodies, and even to Metals themselves, which perhaps may also be the cause of Rusting.

Now that Air does likewise adhere and mix itself with Water, is sufficiently known to those that have ever seen what a Quantity of Air-Bubbles appear when the Pressure of the Air is removed by the Pump from off the Water.

Sect. XIII. *Experiments to shew that Fire will cleave to solid Bodies.*

III. Now as Air, so likewise can Fire cleave heavier and solid Bodies. This appears from flint-stones, and other Bodies, not easily reducible to Fluidity when they are made red hot. For that the Heat thereof is to be attributed to the adhering Fire-Particles, and not, as some Philosophers think, to the swift Motion of the small and fine Parts, whereof these and other Bodies are compos'd, appears from hence, that in case the Parts of the Flint itself should be put in such a violent Motion, it would lose its Solidity and be dissolved.

But for a farther Certainty of the Matter, one need only read what Mr. *Boyle* says in his Book *de Considerabil. part. Flammæ*, upon several Experiments there recited, where he shews, that even Copper, Iron, Steel, Silver, Pewter, burnt Hartshorn, Chalk and Coral, become heavier by the Particles of Fire that cleave to them. And to know that this encrease of the Weight, did not so much proceed from the Parts of other gross Bodies mingled with the Fire,

as from thoſe of the Fire itſelf; one may ſee there that ſome of thoſe Bodies being wholly ſhut up in Glaſs, became heavier only by the pure Flames of Brimſtone, or of Spirit of Wine; which could not happen otherwiſe than from the ſmall Fire-Particles that muſt firſt have penetrated the narrow Pores of the Glaſs. [See the ſaid *Boyle de penetrabilitate Vitri à ponder. part. Flam.*]

Sect. XIV. *Fire will likewiſe cleave to Water proved by Experiments.*

IV. Now that Fire can likewiſe join itſelf to Water, may be ſhewn by ſetting a Glaſs, or rather a little Tea-Cup (to prevent the breaking of it) full of very hot Water under the Receiver of an Air-Pump; when you will often ſee at the very firſt Exhauſtion, if the Water be hot enough, or at leaſt at the ſecond or third, ſo great a Motion in the Water, that, like boiling Water, it will run over the Brims of the Veſſel. This Experiment may be very eaſily made by all that uſe Air-Pumps.

When we tried this upon the 24th of *December* 1705, there was a little Glaſs full of cold Water put under the Receiver at the ſame time, which according to Cuſtom, did indeed diſcloſe a few Bladders or Air-Bubbles, but no kind of Motion that was any ways comparable to that of hot Water; ſo that this laſt Motion ſeems to be more properly owing to the Fire than to the Water.

But to be aſſured thereof, and to ſatisfie the Objection, whether the Heat of the Air might not likewiſe be the cauſe of this more violent Motion in the hot Water, on the 21ſt of *January*, 170 we heated ſome Lye, in which there is no Air, and put it into a little Glaſs under the Receiver; and to prevent the Pump from being ſpoiled, if it ſhould chance to run over, we put the firſt Glaſs into

second: And we observ'd upon the second turn of the Pump (tho' there was no Alteration at the first) that the Lye, with a sudden bursting, flew out above both the Glasses; which can only be ascribed to the Particles of Fire contained in it; forasmuch as no Air ever mingles itself with this kind of Liquor.

Afterwards, upon the 7th of *June*, 1709, making the same Experiment again with Water, we filled two equal Tea Cups at the same time with boiling Water; and putting one of 'em under the Receiver, we found that the Receiver itself, upon taking off the Pressure of the Air, and during the Motion of the Water, was very hot at the Top. Now, whether this proceeded from hence, that the Fire Particles being freed from the Pressure of the Air, and extricating themselves by their Motion from the Water, rising up to the Top, and passing thro' the Glass, render'd it hotter there than in any other Place; or, whether it be only to be ascribed to the Vapours, we shall not here dispute; but this is true, that the Water, which had undergone so many Motions in the Receiver, being taken out from thence, was much colder even to the touch of all that were then present, than that which was never put under it: Whereas, if it be supposed, that the Heat were caused alone by a greater Motion of the Parts of the Liquor, and not singly by those of the Fire, the Water that had been under the Receiver, and had been put into such violent Motion, should have been much hotter than that which had suffer'd none.

And thus it seems to appear from hence, that the Water under the Receiver had therefore lost more of its Heat than the other, because the Fire-Particles, by taking away the Pressure of the Air, got an Opportunity of freeing themselves by their

own Motion from the Water, from whence, being flown out, the Water remained less warm than that other, in which the pressure of the Air had hinder'd the Fire Particles from separating themselves so suddenly from the Water.

Now whether this adhesion of the Particles of Fire to Water may likewise be supppos'd to contribute something, and to be the cause either alone or jointly, of that Property of the Water whereby it extinguishes the Fire, I shall not examine any farther here; forasmuch as the giving a true Reason of such Extinction, as common, and therefore as unheeded as it may appear to many, does (if I may speak my Mind freely in the Matter) require a great deal of Consideration.

Sect. XV. *Three Consequences from the last Experiment.*

To proceed; I have noted three Things, that seem to follow from the abovemention'd Experiment.

First, That as Water and Air are particular Substances, it seems, that we might conclude from hence, that Fire also should be esteemed as such, and not be look'd upon, consider'd as only a swifter Motion of the Parts of all other Bodies. This may be inferr'd from the Waters becoming colder, after it has been just put into Motion, as has been shewn, therefore need not be here repeated. It likewise seems to appear from hence, that cold and hot Water being at the same time put under the Receiver, and the Pressure of the Air remov'd, the hot Water, immediately after its great Motion, did not shew the least moving Particles, whereas there were several Stirrings observed in the cold, by the Rarefaction of Air, a good while after. Now 'tis known, that by Boiling and Heat, the Air flies out

out of the Water, so that these Risings and Ebullitions seem not to be imputable to any other Cause than to the Fire-Particles that succeed and cleave to the Water, and which, by flying away, leave the Water at rest.

Secondly, From hence it likewise seems to appear, that the Fire-Particles are very Elastical and Expansive: Forasmuch as we see, that by removing only the Pressure of the Air that keeps them down, they exert their Motion of their own accord, which is also a Property of an Elastick Body.

Thirdly, The last thing that may be inferr'd from this Experiment, and may likewise be of use, is, that the Fire which sticks close to the Water, as soon as it comes into an Air which is thinner and less powerful in its Pressure, abandons the Water and flies away from it.

Sect. XVI. *Water and Fire seem to produce a Composition lighter then Air.*

From all this it is to be observed, that Fire and Water being united and mingled together, may make a Composition lighter than so much Air, and which can ascend in it; just as Iron and Cork being fasten'd together, will float upon the Water, tho' the Iron be heavier than the said Water. I remember to have seen an Experiment very analogous to this, by throwing a Clod or Lump of unrefined Brimstone, and letting it sink in Lye, to discover whether it contained as much Air in it as Salt-petre, in which we found a great deal; but having taken off the Pressure of the impendent Air, we did not only see some little Bubbles swelling up, but what is chiefly remarkable here, some of the little Bits of Brimstone that were broken off, were driven upwards

by these Bubbles, and when they burst, the Brimstone sunk down again. I have observed the same when Water was thrown into Salt, and the Pressure of the Air removed. From whence may be inferr'd, that a lighter fluid Matter may joyn itself to a heavier, and make one Compound therewith, and ascend and float in a Liquor, in which the heavier, being alone, would sink. Thus Experience likewise teaches us, that a small Heat, and consequently a little Fire, can make Water evaporate and rise upwards, even without boiling: And so we also see all volatile Salts, such as those of Sal-Armoniac, of Hartshorn, *&c.* ascending by the Warmth of a Fire that is hardly sensible. The same does happen too in pure burning Spirits, and in all other things that are esteemed the most volatile by the Chymists.

And if this Adhesion of the Particles of Fire to these Matters, be not the only Cause thereof, it may at least be supposed from what has been said before, that it may be reckon'd a concurrent Cause: And it even seems to be more credible, that this Cause is more common than that by which the Water, before it is capable of turning itself into Vapours, must be rarified into a nine or ten times greater heighth, length and breadth: Which is no ways, at least very rarely, experienced in Substances that evaporate with so small a Heat; and in others, such as Volatile Salts, can hardly be supposed to happen.

SECT. XVII. *Water must be divided into exceeding small Particles, in order to be Evaporated.*

THE last thing that is required above all the rest, as being the chiefest Occasion of the Rising of Water into the Air, is, that it should be divided into

into exceeding small Particles; that it may be so much sooner enabled, in Conjunction with Fire, to make a compound Body lighter than so much Air. Thus we see in all Distillations, that there do not ascend great and entire Drops, but only very fine and small Particles. The same is plain in all Chymical Sublimations; as likewise in the Smoak of Fires made of Coal, Wood, Turf and the like, which being divided into very minute Parts, are carried up into the Air by the adhering Fire: But being collected into a greater Body, when they are turned into Soot, they become so heavy, that they will not ascend, till they be reduced by other Distillations, for instance, to Bodies of a much smaller size.

Sect. XVIII. *Vapours ascend both by Heat and Cold.*

But to make an end of this Enquiry; whatever may be the Cause of the Ascent of Watry Vapours, this is certain, that Water being heated, either by the Sun, or by our Common Fires, tho' in itself it is so much heavier than Air, yet it will be carried up into it.

Now, whether we are likewise to suppose that there are particular Particles which produce Cold, as Fire does Heat, and which cleaving to the Water, make up a Body lighter than Water itself, and so cause it to ascend in Vapours, we shall not here dispute; this is certain, that we see Vapours ascending from the low Grounds in the coldest Weather, and when the Water is frozen hard, and that even Ice and Snow are lighter than the Water of which they are composed, and consequently must evaporate: But of this hereafter.

Sect. XIX. *The Laws of Hydrostatics.*

To proceed; it is well known to such as understand the Laws of Hydrostatics, that,

I. If a Body is to be carried upwards in any Liquor, an equal Bulk of the said Liquor must gravitate or weigh more than such a Body.

II. That in order to cause a Body to sink in a Liquor, an equal Bulk of the said Liquor must weigh less than the Body.

III. If you would have the Body neither to rise nor fall, but preserve its Place in any Part of the Liquor, an equal Quantity of the said Liquor must weigh equally with the Body, which may be easily proved by Experiments.

Sect. XX, and XXI. *The Vapours in the Air adapt themselves to these Hydrostatical Laws; as appears by several Experiments.*

Now, if we suppose, that *Tab.* XV. *Fig.* 1. represents the Globe of the Earth, WPQRS, surrounded by the Air as far as B A D; which being heavy in itself, and thereby capable of being compress'd, grows continually finer from below at P, upwards thro' *g*, and F to B, and consequently lighter; because its Elastick Faculty dilates it more in proportion as the Pressure of the superiour Air is diminished, and, as it scatters the Parts of the Air from each other, renders it lighter in an equally large Space. And if we now suppose farther, that this same Air is heavier below, at that Part of the Globe that lies between F and P, and lighter above between F and B, than the Water evaporated or mingled with Fire; so that about FGH, the said Air is of equal Gravity with it, it will follow from what has been just now mention'd,

that the Vapours between F and P will ascend; that being raised to the Bounds of the Equilibrium, F G H, they will float like Clouds at F and I G; and being æquipois'd, will neither rise nor fall; but when raised higher, to B F, or H D, they will descend.

This will happen much after the same manner, as when you pour Quicksilver and Water into a Glass, and then throw in a piece of Iron, which will sink down into the Water, but float in the Quicksilver, till it arrive at the place between both of 'em, where it can meet with its Equilibrium, and there it will remain between the two Fluids, the uppermost of which, Bulk for Bulk, is lighter, and the lowermost heavier.

We must not imagine that these Notions of the Air are supported only by mere Hypotheses: *First*, Because it has been experimentally proved above, that the Air is of such a Property, that when it is pressed by any weight, the Parts of it are squeez'd closely together, and so taking up a smaller Space, the same Quantity becomes heavier. So that it having been proved before in *Contemplation* XVII. §. XX. by a Tube I F, (*Tab.* XIV. *Fig.* 1.) filled with Quicksilver, that the same Air, which without Compression is above of the bigness of F, when squeez'd closer by the weight of the Quicksilver, will lie in so much a smaller Space below at I, and consequently becomes heavier in proportion to its Bigness; so that, for instance, if we suppose that F above, is ten times as large as I below, a Cubical Inch of Air will press or weigh ten times as heavy at I as at F; since, by the Compression below, there is ten times the Quantity of Air contained in the same Space I, as above at F.

And, *Secondly*, which may serve for an Experimental Proof, because such as have clim'd those high

high Mountains, find it to be true, you may se among many others, a remarkable Account ther of in *Varenius, Geograph. Gener. Lib.* I. *cap.* 19. §. 4 Where somebody that climb'd up one of the *Ca pathian Mountains* in *Hungary*, which are muc higher than those of the *Alps*, saw the white Clou floating in the Air below him, some of which we however higher than others, according as th Matter whereof they were composed, being light or heavier, determined their Equilibrium high or lower; for that numerous Particles, and co sequently of different Weight, are raised up int the Air, under the Denomination of Watry-V pours, or other Exhalations, has been shewed bove in our Discourse upon METEORS. The sai Person did likewise observe the Air in which h was, to be so Calm and Serene, that it did not pr duce Wind enough to move the least Hair of h Head; notwithstanding that he had been sensib of a strong Wind in the lower Parts of that Mou tain. But that which seemed to be the cleare Proof of a greater thinness of Air, was, that in di charging a Musket, at the very Top of the Mou tain, the Report or Sound of it was no loude than that which is produced by the breaking of little Stick. Now how much the Rarefaction, c Thinness, of the Air contributes to the Diminut on of Sound, appears by hanging a little Bell i the Recipient of the Air-Pump, and exhausting th Air from it; of which more largely in *Contemplatio* XVII. §. XXXVI.

SECT. XXII. *After what manner Vapours float.*

NOW, to draw a Conclusion from all this, it i easie to be understood, how the Waters, by be ing united to the Sun-Beams or Fire thereof (t say nothing of the Exhalations in great Frosts) ar raised

raised up into the Air in Vapours, where, according to the Laws of Hydrostaticks, they are driven and remain pendulous in a lighter Matter, as the Air is in this Case, without subsiding by their own Weight: But it would be of very little Use to all the Inhabitants of the Earth, both Men and Beasts, in case these Watry-Vapours should continue always floating in the Air, without ever falling down from thence. Now to form some Conception, how this floating of the Air may happen; Let us again suppose that from the Sea P, in the thick Air F P, (*Tab.* XV. *Fig.* 1.) there are some Vapours raised up to F; that at the Distance of F I G, from the Earth, the Air becoming something thinner, yet retains so much Density or Thickness, that tho' these Watry-Vapours, by reason of their not being rare or thin enough, cannot rise up higher to B, yet they are hinder'd by a sufficient Weight and Thickness of Air from falling down, and collect themselves there in high-flying Mists, which when seen from the Earth, are called Clouds, as has been already experimentally shewn; whilst others that are heavier, cannot ascend farther than to K *d*; because, if they came into a higher Air, which was lighter, they would fall down again.

SECT. XXIII. *Experiments to shew how the Vapours can descend.*

I. IF now two Winds blow these Mists or Clouds with any Force, as I G, or F, from opposite Quarters, and thereby compel them to run against each other, it is easie to conclude, that they will be there collected into Drops, and so becoming heavier than the like Quantity of Air, will fall down; and the rather, because by the Motion of these Winds, the Fire that render'd them

them lighter (after what manner soever it happens) gets an Opportunity of separating itself from them.

According to the first manner, we see in Distillations from Retorts or Glass Helms, when in the narrow Parts of their Necks, the Vapours are compressed together, that they run into Watry Drops, and so descend; tho' just before, having Room and Liberty, they did ascend, and would have risen yet higher, without these narrow Passages.

'Tis likewise well known to every one, that a hot Liquor in which there are many Particles of Fire, becomes colder by the Breath or Wind of Peoples Mouths. Now that this happens, because the Fire-Particles are by such a Motion separated from thence, seems probable for the following reason; namely, that otherwise, if the greater Heat did consist only in a greater Motion of the samll Parts of a Liquid Matter, the same, according to this Hypothesis, by the blowing, which encreases the Motion of the Liquor, would become hotter, and by no means colder, whereas common Experience teaches us the contrary.

Sect. XXIV. *Vapours descend by the Separation of the Particles of Fire from them.*

II. In case one only Wind be of so much Strength as to be able, by blowing from I to G, (*Tab.* XV. *Fig.* 1.) to drive forwards the Vapour or Cloud I G, in a streight Line I Z, and so can protrude the whole or a part thereof to Z; it is plain, that the said Cloud is higher from the Earth, at Z, and consequently in a thinner Air. From whence it will follow, according to the above-mention'd Experiments made upon hot Water and hot Lye, in the Air-Pump, that the Fire, which by

by sticking to the Particles of Water render'd them lighter, will extricate itself from them, and ascending by its Lightness, the Water will become too heavy, not only to remain in this thin and light Air, but even in a thicker and a heavier near the Earth, and so will be turned into a descending Dew or Mist, or Rain, Snow, or the like, according as the Watry-Vapours are either rarified or compress'd.

SECT. XXV. *Experiments, proving the Descent of Vapours by the Air's becoming lighter.*

III. NOW, that the Air (which being near the Earth at P, is otherwise heavy enough to keep up the Vapours, and to cause them to float about F) is likewise frequently, for other Raasons, turned into a thinner and lighter Substance, and so gives an Opportunity to these Vapours to descend, has been already shewn in the preceding *Contemplation*, §. XVII, and XVIII. in the Glasses of the Air-Pump; and the Barometers do upon many occasions, furnish us with Experimental Proofs thereof; in which the Quicksilver descending commonly upon the least Weight of the Air, does prognosticate, that the Watry-Vapours are about to descend in Fogs or Vapours, or otherwise from the Air.

SECT. XXVI. *Cold will produce the same Effect: Shewn experimentally.*

IV. BESIDES this, the sudden Cessation of the Warmth of the Air seems to give an Opportunity to the Vapours, which, by the said Warmth, had been raised up in great Quantites, to be precipitated by the Cold, and to be turned into Fogs or Rain. Analogous Example thereof may be seen

seen in Distillations that are performed by Spir
Pipes, or *Worms*; and something like it is al
found in Chymical Crystalizations; in which w
see, that the Salts that float and are dissolv'd
the Water, whilst warm, do coagulate and subsi
assoon as the same becomes cold. But whether
happens so in the Air, or after what other mann
it is done there, since the Nature of Cold is n
yet so fully known to us as many think, we sha
not enquire farther here.

Now how many Causes soever there may b
besides those that we have already mention'
whereby the Watry-Vapours that are raised up i
the Air may be made to descend; this is certai
that both their Ascent and Descent are owing to
wonderful Law of *Hydrostaticks*.

Now can any one imagine, that all this come
to pass without a wise Direction, and that it
by mere Chance that so vast an Army of Vapou
in the great Space of the Air are every wher
subjected to the most exact Hydrostatical Rule
in such an infinite number of Occasions and Ac
cidents? Is there no want of an Intelligent Be
ing to oblige such a prodigious Quantity of Wa
ters, turned into Clouds, to remain floating i
the Air, which are often observed to descend i
mighty Showers, in rainy Springs and Harvests
or other Seasons? To say nothing now of the va
rious Ways and Forms in which they descend
and whereby so many Cisterns and other Recep
tacles of Waters, as well as Ditches, Canals, and
Ponds, are filled in so small a time: But which
is a great deal more, by which such vast River
swell so suddenly, and over-flowing their Banks,
do frequently cover whole Districts of Land.

SECT. XXVII. *The Motion of Vapours from one Place to another, is necessary.*

BUT now if these Vapours had no other Quality or Property in them than barely an Ascent and Descent to and from the same Place, and that those, for instance, represented in *Tab.* XV. *Fig.* 1. by F, having been exhaled from the Sea at P, should fall down again in the very same Place; and that every Place were to be moisten'd only by no other Watry-Vapours than such as are drawn from its own Bosom, there would very little Advantage accrue to its Inhabitants from thence. How many Rivers would then be quite dried up, which at present have their Rise, or at least receive an abundance of Water from the Rains and Snows that descend from the Mountains? How should the wild Beasts in *Arabia*, and such like Countries of *Africa*, which thro' their Drought afford no Water at all, assuage their burning Thirsts? What Fruits would the now most fertile Places produce, in case none of the Water, which by the Heat of the Sun is exhaled in other Parts of the World, were brought, and made to fall down upon them?

Can a miserable Philosopher think again, that he owes no Thanks to his Creator, that the Waters which are exhaled in the *Torrid Zone*, and other hot Countries, are, by the Winds that drive Clouds, brought home to him, yielding him Drink, and making fruitful that Part of the Earth where he inhabits?

SECT.

Sect. XXVIII. *An Experiment, shewing that the Watry-Vapours leave their Salts behind them.*

Now since most of the Vapours that are so beneficial to the whole World are chiefly exhaled from the Sea, and yet those Waters, by reason of their Saltness, are unfit for the Purposes to which they are destin'd; insomuch that Men would die of Thirst in the midst of the Sea, and no Herb or Plant, to which the Salt-Water should be applyed, could live and grow therewith, as by sad Experience is but too well known in Lands that have been overflow'd by the Sea; Can any one again imagine, that it is by mere Chance or ignorant Causes, that the Sun does only exhale the Fresh Watry-Vapours out of the Sea, and collect them into Clouds, whilst the Salt, with which they were at first impregnated, by reason of its being so much heavier than Water, is left behind?

That this is true, may be proved not only from the Freshness of Dew, Rain and Snow, but one may see, whenever one will, a like instance, by setting Salt-Water upon the Fire, and causing it to exhale in Vapours, or by drawing them off in Distillation; in which Case you will find the Salt remaining at the Bottom. The same we see happen in Salt-works by the Sun's Heat, and in the Salt-works with our common Fires. So that after this manner two great Things come to pass, without which the whole Race of Mankind would soon be extinct; namely, that *First*, Sea-Water is divested of its Salts, and render'd fit for Drink, and so many other Uses; and *Secondly*, that the said Salt becomes very serviceable to Men.

SECT. XXIX. *If the Earth were mathematically round, the Rains would seldom fall where they were wanted.*

NOW, if what has been said before be not sufficient to convince our unhappy Atheist, let him stop here a little, and seriously reflect with himself, after what manner those Countries that lose their Moisture by so violent and continual a Heat (and which are therefore so dry and so barren) can be brought into a Condition to support their Inhabitants with Meat and Drink: And in case he could order Matters as he thought fit, what Methods would he take, constantly to provide the same with a sufficient Quantity of Water from the Heavens, and to collect the Vapours in that vast Ocean of Air, and make them descend upon those Parts of the Earth only where they are chiefly wanted. And that we may not give him the Trouble of charging his Imagination therewith; let him but say, whether he should not esteem that Man as a very understanding Person, who had invented a way, which as long as Heaven, Earth, and Sea remain as they are, will always be useful, and whereby those dry and uninhabitable Countries might be so well water'd, as to be equal in Fruitfulness to any others.

SECT. XXX. *Convictions upon Occasion thereof.*

TO give an Instance of such a Case; Let a Man cast his Eyes only upon the Island of *St. Thomas*, which is under the Line, or upon that of *St. Helena*, lying between the Tropics, where the Heat of the Sun is exceeding strong; since all the Vapours that ascend from the surrounding Seas, seem to be more likely to fall down again directly into

the ſame, than upon either of theſe Iſlands, th
ſolid Parts of which reflect the Rays of the Su
with greater Force than the fluid Parts of th
Sea: Can any one think, that it happens witho
the wiſe Deſign of the Creator, that there a
high Mountains found upon thoſe Iſlands, where the
Vapours are collected in ſo vaſt a Quantity, th
they are capable of rendring whole Brooks a
Rivers ſufficient to provide Drink for Anima
Nouriſhment for Plants, and Fertility to t
Earth, in ſuch burning Regions, in great Abu
dance?

Sect. XXXI. *Mountains ſerve to collect Wat Vapours from the Air.*

Now, that all that is here ſaid is true, (wh
ever different Sentiments ſome People may co
ceive about the Mountains) can be proved
a Cloud of Witneſſes, as well as Trials and E
periments.

Let us only peruſe the Deſcription of the Iſla
of *St. Thomas*, in the *little Atlas* of *Mercator*,
which we ſhall find theſe Words; *In the Middl
this Iſland there is a Mountain very full of Woods, c
continually cover'd with ſuch thick Clouds, that fr
the ſaid Woods there proceed Streams and Brooks ſu
cient to water all the Sugar in the Plantations; a
which is very remarkable, when the Sun is at the hi
eſt, this Mountain is moſtly cover'd with Clouds.*

The ſame Thing is related by Mr. *Robbe* in
Geography, concerning the Iſland *Madagaſcar*, t
that notwithſtanding that it is ſo ſcituated, as
be expoſed to the ſtrongeſt Heat of the Sun, wh
as at *St. Thomas*'s, is twice a Year perpendicu
over the Heads of the Inhabitants; and one wo
therefore be apt to think, that every Thing is
ſtroyed with Heat and Drought, yet in the m

dle thereof, there are a great many Mountains and Woods, from whence many Rivers are observed to run on all sides.

I find the same noted by Mr. *Warren*, or rather in his Extract in the *Act. Lipsi.* 1691. *p.* 98. *That the Clouds and Fogs hanging over and about the Mountain, called the* Pike of Teneriffe, *do run down every Day about Noon, in so vast a Quantity, that they do abundantly supply the Place of great Rains, which never fall upon other Parts of that Island.*

To instance in no more; that this is a useful Phænomenon in Nature, may appear from *the general Geography of Varenius, cap.* 9. §. 9. who proposes this Question, *Why there are often observed Rains, Fogs and Snows upon the Tops of Mountains, whilst in the adjacent Valleys the Weather is bright and clear, and none of these Meteors are to be found?* And then he proceeds to say; *This is confirmed by such as have travelled over the Mountains in* Asia, Peru, *and other Countries*, viz. *That they frequently observed Rain, Snow, and thick Fogs upon the Tops of those Mountains, but when they descended into the Valleys, they met with nothing but fair Weather: We find the same sometimes in the Mountains of our own Country.* Accordingly, Mr. *Ysbrantz Ides*, observed in a certain District upon the Frontiers of *China*, that the Clouds shewed themselves over the Mountains, but not farther.

SECT. XXXII. *Fountains and Rivers proceed from Mountains.*

MOREOVER, that Fountains and Rivers proceed from that Collection of Vapours which is continually made upon Mountains, is very learnedly proved by that great Mathematician Dr. *Hall*, whose Dissertation thereupon has been published in the *Phil. Transactions*, Numb. 189. the

Subſtance whereof is briefly as follows; *This Speculation about Fountains is by no means a bare Supposition, but is founded upon Experience; to the acquiring of which, my ſtay at the Iſland of* St. Helena *(which is likewiſe under the Torrid Zone, and one of the hotteſt Parts of the Earth) gave me an Opportunity where, upon the Top of a Mountain about* 2400 *Foot above the Sea, the Vapours and Dews of the Night even when the Sky was clear, deſcended ſo thick and ſaſt, that I was forced every Quarter of an Hour to wipe the Glaſs of my Teleſcope, and my Paper was in a moment ſo damp, that it would not bear Ink. From whence one may conclude how great a Quantity of Water muſt be collected upon thoſe Mountains in a very ſhort ſpace of Time, which are much higher and larger than this is; and which are obſerved to run in a long Ridge ſo long as to fill whole Countries, ſuch as the* Pyrenean *Mountains, thoſe of the* Alps, *the* Apennine *and the* Carpathian, *in* Europe; *the* Taurus, Caucaſus, Imaus, *and others, in* Aſia; *the* Atlas, *the Mountains of the Moon, and many more that have no Name, in* Africa; *from whence proceed the Rivers of* Nile, Niger *and* Zaire *in* America; *the* Andes *and the* Apalatian *Mountains, each of which do far exceed the common Heighth to which Vapours of themſelves do aſcend, and upon the top of which the Air is ſo cold and rarified, that it can ſupport very few of the Vapours floating in it, and which are driven thither by the Winds.*

Sect. XXXIII. *The Furniſhing us with Springs and Rivers is a principal Uſe of Mountains.*

The above-named Gentleman is of Opinion, and that not without weighty Reaſons too, that one of the chiefeſt Uſes of Mountains is to collect the Vapours in the Air, and to turn them afterwards into Fountains or Springs, then into Brooks

and last of all into Rivers, and so to transmit them from their respective Heighths.

I shall not here enumerate the Difficulties that are proved by the said Dr. *Halley*, to stand in the way of those that pretend to deduce the Origin of Rivers from other Causes: Wherefore he seems to lay down the aforesaid, as almost the only ones. And it suffices for our Purpose, that tho' there were any others, yet these at least may be esteemed some of the chiefest. I have dwelt the longer upon this Matter, because it seems to serve for a great Proof of the Wisdom of the Creator to such as will consider the whole without Prejudice.

Sect. XXXIV. *Convictions from the foregoing Observations.*

Now, if there should still remain any of those unhappy Persons, who endeavour to maintain that every Thing has acquired its Form from necessary Causes, or mere Chance, upon the following or the like Hypotheses; namely, that so many and such amazing great Bodies as the Mountains, are of no use at all; and who, if they had had the fashioning the Globe of the Earth, according to their own Humours, they would have made it without them, and have given it a perfect round Figure, without the least Inequalities: Let them but once seriously consider the above-mention'd Experiments, and from thence learn, *First*, the great Necessity of these protuberant Parts of the Earth; without which the Globe would altogether, or at least in a very great measure, be deprived of Rivers, Things so useful, and which are such great and noble Tokens of the Goodness of our Creator. And *Secondly*, Let them ask themselves, whether they must not be convinced thereby, that those speak nothing but the Truth,

who affirm, that all these Arguments about the Usefulness of such Glorious Parts of the World, have no manner of Foundation in the Things themselves, but only in the Littleness of the Understanding of these Cavillers; and that if the Ends which the Creator had in view, were made known to them, what they urge against the Greatness of that Supream Director, would become a Demonstration of his Goodness.

Sect. XXXV. Egypt *moisten'd by the* Nile *without Water.*

I Must confess, that it has many Times appeared to me as a sensible and visible Proof of the gracious Providence and Government of God, namely, what has been published and confirmed by the General Testimony of all that have travelled there, concerning the particular State and Condition of *Egypt:* This Land, which is all Flat, and without any Mountains, as *Monconys* and others write, is seldom or never water'd by Rain: it lies in the middle of dry Countries, and is almost surrounded with the most barren Desarts, insomuch, that of itself it is entirely unfruitful, and consequently would be uninhabited.

Now can any one imagine, that it comes to pass by mere Chance, that the Mountains of the Moon are placed in those Parts of *Africa*, where the Countries are burnt up with the Sun, and that from the said Mountains there flow such mighty Streams, which, being collected together, make the Sea or Lake of *Zaire*, from whence proceeds the River *Nile*, which running thro' all *Egypt*, discharges itself by many Mouths into the *Mediteranean* Sea; and, which is most for our present Purpose, that it yearly swells and rises over its Banks, and overflows all the Country; so that the Towns

Towns that are built upon any Eminences, appear like so many Islands, whilst the Flat Country lies under Water; and by such Inundations, this Country, which is otherwise dry, and almost burnt up, becomes as fruitful as any other that is usually water'd with Rains.

Sect. XXXVI. *The Fertility of* Egypt.

It is wonderful what the Geographers, and among them Mr. *Robbe*, in his Description of the World, mentions of the Fertility of this Country; namely, that these Waters of the *Nile*, with which all *Egypt* is over-flown, are wont to leave such a Slime and Mudd behind 'em, as being dried, renders the Ground so very fertile, that the Trees are almost laden with Fruits; and that if the *Egyptians* themselves were not so lazy, but would Cultivate and Sow their Lands after the first Harvest, and Collection of the Produce, they would yield a second Crop in the same Year: This is certain, that by reason of the Strength and Fatness of their Country, the Inhabitants are oftentimes obliged to moderate the same, by mixing Sand with the Earth. Many do likewise attribe it to this Cause, that their Flocks are more numerous than in other Countries, and that their Sheep bring forth Young twice a Year, and the like: Some Authors say the same of their Women, that they have often Twins, and sometimes more at a Birth.

Sect. XXXVII. *Convictions from the foregoing Observations.*

To return now to that Cause of the Rivers, the Collection of watry Vapours upon Mountains: They that are still so stark blind or stiff-necked,

that they cannnot, or will not, ſee any Tokens o Divine Wiſdom and Goodneſs in each of thes Wonders; Let them again Contemplate ſome o them with us, and return to *Tab.* XV. *Fig.* 1.

Let them then ſuppoſe, that upon the Glob W K R S, there dwell a Number of Men and othe Creatures, in the Structure and Compoſition o each of which there appears, as has been ſhew before, an amazing Skill and Contrivance.

Let them next own, as it is true, that unle the Earth C X Y T, were moiſten'd with Wate and that freſh too, the ſaid Earth would be entire ly Barren, and all the Living Creatures upon i would periſh with Hunger and Thirſt; and tho an abundant Procreation might ſeem capable o making good the Loſs, yet not one of their Youn could live a Month after it was brought forth.

Let them conſider, that thoſe great Seas, an vaſt and deep Lakes C W S, how great a Quan tity ſoever of Water they may contain, would no be able to render the ſmalleſt Tract of Land fruit ful; nor to afford to one ſingle Man or Beaſt ſ much Drink as were neceſſary to keep them alive by reaſon of their Saltneſs.

Can they then in this diſmal State of Affair imagine, that it is by Chance, and without an Wiſdom, that ſuch a glorious Body as the Sun beſides the Light and Warmth it communicate to us, does alſo render us this Service, that th Waters of the Sea at P, being rarified by it Beams, are exhaled and aſcend in Vapours to and F; and leaving their Salts behind them fo other Uſes, do compoſe the Clouds, F, I, G, K above in the Air; which falling down again i Rains or Fogs, in Dews, Hail or Snow, affor a freſh and fertilizing Moiſture to the Earth, an Drink to Men and Beaſt?

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Can he daily see this Ascent of Watry Vapours, and say, that it is performed by Chance and without Wisdom? Notwithstanding the Manner by which 'tis brought about, is allowed to be wonderful, by the greatest Naturalists, such as those learned Persons, Dr. *Halley* and Mr. *Mariotte*, who are not ashamed to acknowledge the weakness of their Understanding in that Matter, and so must every one besides. And yet all this great Preparation would have been in vain, if a certain fluid Matter, which we call Air, had not been placed round the Globe at B A D.

But that which here seems to prove undeniably the Being of a God is, that notwithstanding the Terrestrial Globe be thus surrounded with Air, and that the Sun does continually shine upon the Sea and the Rivers, yet there would scarce arise from thence the smallest Vapours, if the said Air were as thin and as much rarified below at F P, as it is above, between B and F; and on the contrary, if the Air were as thick above, between B and F, as we now find it between P and F, few or none of the exhaled Vapours would ever descend in Rain or Dews, but floating in the Air, like Oil upon Water, would continue there; in which case also, the whole Earth would be dried up, and every thing living perish with Thirst.

Let me now again ask these miserable Philosophers, whether they can imagine, that all these things are thus disposed by mere Chance, and without a View towards any End? And that the Air, by its Weight and Elasticity, becoming more Compressed and Thicker below than above, was thus disposed with respect to the exhaled Watry Particles, that the Vapours would be seldom or never in an Equiponderating State therein, before they be raised to the heighth of the Clouds F or K. Whereas otherwise, in case the Air were

were of the same Thinness at P, or just above the Earth, as it is higher at F, to say nothing of the Distempers which would be occasion'd thereby, the continual Cloudy Weather, Fogs and Mists, would take away, or at least embarrass the use of our Sight.

To add one thing more; Is it brought about by ignorant Causes, and without Knowledge and Foresight, that whereas so many other Kinds of Salts are incomparably lighter than Water, yet the Sea-Salt is heavier? which would otherwise, by ascending along with the Vapours, render all the Waters of Rain and Rivers useless and unnecessary, both to Living Creatures and Plants. Is it by Chance, that the Sun is placed at just such a Distance from the Globe, as to be able by its Warmth to cause the Waters to ascend in Vapours; and yet not so near as to singe and burn up those tender Plants which received their Nourishment and Encrease from those Waters, and do chiefly consist thereof?

Have the Sun, the Sea, the Air, and the Salt, met one another in so small a corner of the World, which, with regard to the whole Extent thereof, is but a Point; I say, have they thus met by mere Chance, in order to furnish all the Inhabitants of the Earth with Meat and Drink? Is it owing to Ignorant Causes, that they are endowed with so many necessary Qualities as have been before enumerated, and as are required for this only Purpose? If this be not sufficient; if no other Causes concurred, in order to water the Earth with the Vapours descending from the Air, than the Lightness and Thinness of the said Air, or the Winds that drive them together, it is plain to every Body, that all the Parts of the Earth, without any Difference, would be equally water'd; and that the Sea, which has no occasion for these Vapours,

as

s well as those other Parts of the World, which or want of 'em would be uninhabitable, would ach receive their Share; and it may be, those hat least want them would enjoy the most.

Once more, let those Philosophers with whom ve have here to do, judge themselves, whether t be owing to mere Chance, that to the end, that hose Countries which stand in most need of be-ng water'd, may enjoy a greater share than others, ich great Bodies as the Ridges of Hills and Moun-ins, are placed in or near the same. The Use f which, as has been said before, is to intercept e Watry Vapours floating in the Air, to collect em in a particular manner upon their Summits Tops, to derive them down from thence, and to furnish such a Quantity of Water as may ompose the requisite Brooks and Rivers which ntribute so much to the Benefit of the Earth and e Inhabitants thereof; and which running down om these Hills, from whence they derive their ource and Beginning, they moisten the surround-ig Lands, which would otherwise be barren thro' eat and Drought, and render them fit to sup-ort their Inhabitants with Meat and Drink.

To say nothing here of the number of Fishes d other Productions in these Waters, by the lp of which the People, thro' whose Countries ey flow, can communicate their Fruits and erchandizes to each other.

ECT. XXXVIII. *The Mountains collect Watry Vapours, first by the Winds.*

HERE we seem to have a proper Occasion to quire into the Manner and Causes, how and hy the Mountains are able to collect such a vast uantity of Waters, to the end, that what has been

been said before upon this Subject, may be th more clearly understood.

How the Vapours are raised from the Sea, fro P to *g* and F, *Tab.* XV. *Fig.* 1.) by the Warmt of the Sun (and under the Poles, by Cold too pe haps) has already, in some manner, been ende vour'd to be shewn; as also how they are enable to float in thin Air, as in different Stages and D grees of Heighth, as *g*, K, *d* and F, I, G; an moreover, why the said Vapours, being raise higher up to Z, by the Winds, or driven again one another by contrary Winds, and for oth Reasons, do descend in Rain, Snow, and th like.

Dr. *Halley* subjoins another Manner to these namely, that a floating Vapour or Cloud in I being driven against the Mountain Q N R, by th Winds at E, ascends to the Top N, and the being got into a lighter Air, cannot be any longe sustain'd, but falls down in small Drops upo the Head of the Mountain, and from thence ru ning down, fill the Cavities of the Mountai (which are supposed to be there, and so are ofte found to be) with Water; which running cont nually thro' the Orifice M, produces the litt Brook M *e* T, or M *e* V; which joyning themselv with others of the like Nature, form a larg River.

It appears by this way, why the Waters are a sembled in greater Quantities upon the Mountain foraſmuch as opposing their Tops from Q R t N, against the Winds which drive the Cloud *m* E, K *d*, *&c.* they serve for Barricado's or Cro Trees, and so do either force the Vapours t ascend into a Lighter Air, or forcing them again those Tops, squeeze 'em together, whereby the become heavy and fall down again.

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SECT. XXXIX. *Secondly, Vapours are collected by the Coldneſs of the Mountains and Superior Air.*

AND as it is credible, that this does often happen, it ſhould ſeem that the Winds are neceſſary thereto; and that in caſe they failed, ſo great a Quantity of Water, according to all Appearance, would not be collected; whereas the above-mention'd Experiments teach us, that the Tops of the Mountains, even in hot Countries, are not only encompaſſed by Winds at certain times, but continually with Fogs and Vapours; ſo that beſides this, it ſeems that a more ſettled Cauſe, and which does not always depend on the Motion of the Winds, muſt obtain here.

Now, whether this can be deduced from the Cold of the Mountains themſelves, and of the Superior Air ſurrounding their Tops, and to which the Reflection of the Sum-Beams does not reach; or, whether it muſt be aſcribed to their Heads being always hid in the Clouds, I leave to ſuch as will enquire more ſtrictly: This is certain, that by reaſon of the Cold, they are often cover'd with Snow, and *Varenius* ſays, that excepting in the Months of *July* and *Auguſt*, there is always Snow upon the *Pike of Teneriff*; tho' none can be found in this and the other *Canary* in *Iſlands*.

SECT. XL. *Thirdly, Vapours are collected by Shadows, ſhewn Experimentally.*

WE have not here undertaken to write largely upon Natural Knowledge, nor to repeat the whole Hiſtory of Nature; but we cannot forbear obſerving however, that the great Shadows which theſe Mountains produce, do occaſion a continual Cold

Cold Air about them. Thus we read in the *Extract of the History of* Bohemia, *Act. Lipſ.* 168: *p.* 244. That in a certain Valley of the Giant Mountains, at the hotteſt Time of the Year, there are very deep Snows, and that they have laſted there for 16 Years together, the old being of browniſh Colours, by which it is diſtinguiſhed from the latter Snows that are white and clear.

If then we ſuppoſe the Sun to be at O (*Tab.* XV *Fig.* 1.) and a Mountain QNR, caſting its Shadow, as at QEX; where the Sun-Beams are hinder'd either by other Mountains lying about it, or, becauſe the Sun ſeldom ſhines upon that Side, from ever heating the Air to ſuch a Degree as is found in the next adjacent Air: It is plain, that the Air within the Shadow QEX, will be a great deal Colder than that which encompaſſes the Mountain out of the Shadow. Now it has been proved experimentally in the foregoing *Contemplation*, that a warmer Air having acceſs to another which is Colder, if they be not of a too different Thickneſs, will be rarified and driven with a Wind and Stream towards the cold Air. Now if this ſhould be applied to the Air, which is here not only below, but alſo above, and on the Side, or rather round about the Shadow, we ſhall ſee how this Air, with all the Vapours in it, are driven to the Shadow: for that the Vapours floating in the Air do continually follow its Courſe, is plain, and will appear from a boiling and ſteaming Pot of Water, ſet in a place where there is no Wind; from whence then it may be concluded, that the Air with its Vapours, coming into ſuch a Shadow, and being there deprived of its Elaſtick Force by the Cold, will be immediately followed by more Air which is warmer, and conſequently whoſe Elaſticity is ſtronger, and ſo produce an entire and gentle Stream of Air and Vapours,

Vapours, if not prevented by other Winds, and moisten those Places with continual Vapours.

SECT. XLI. *Fourthly, Other Shadows likewise give occasion to the Concourse of Vapours, proved Experimentally.*

NOW, that this also, among other Reasons, must be laid down, why the Vapours seem to be drawn in a continual Stream to the Mountains (but really and properly are pressed thicker from all Sides) and why the Mountains are many times observed to be clouded (of which we have given several Instances above) every one that understands the Properties of the Air, may easily inferr from what has been said. That in Shadows the Vapours of the Air are collected, does certainly appear from the Night, which is nothing but the Shadow of the Earth, and in which it is well known, that the Vapours and Dews fall thicker than in the Day-time. Thus we see the Descent of Vapours in the Night-time was observ'd by Dr. *Halley*, in the Island of St. *Helena*. And we find in the *Memoirs of the Royal Academy of* France, for the Year 1699. *p.* 128. a Method invented by Mr. *de la Hire*, to hinder the Dews of the Night from sticking to the Glasses of the Telescopes. Now Experience teaches, that in the Mornings too, the Mountains are moisten'd with Vapours (*see Varenius's General Geography, Lib.* 1. §. 5. *p.* 157.) because those Places that are within the Shadow of the Mountains, are much Colder at Night than other Places that are out of the Shadow. Thus we likewise see from what has been said, that in the Islands of *St. Thomas* and *Madegascar*, the Mountains which collect the Waters from whence the Rivers are produced, being cover'd with Woods, and consequently more shady, do make

make the Air more cool and more elastick; b
which Means the Waters are yet more encreas
upon the same: And that it may not be though
that this is inconsistent with what has been sai
above, of the Descent of the Waters more strong
ly at Noon, from the Mountain called the *Pike*
Teneriff; let it be consider'd, what was farthe
said about this Mountain, namely, that the Snow
which cover'd the Top of the same, being melt
ed by the Heat of the Sun at Noon, caused th
Waters to run down more violently at that Time

I think that these Experiments may serve fo
Proofs, that the Cold produced by the Shadow
of the Mountains in the Air, may justly be ac
counted one of the Reasons why so many Watr
Vapours are carried thither in a continual Strean

Sect. XLII. *Vapours sufficient to produce Rivers*

The only Difficulty that seems to remai
how there can ascend so great a Quantity of Va
pours as may suffice to produce great Rivers: T
answer which, we do not here pretend to mai
tain, that all Rivers proceed from these Vapour
or that they are the only Cause thereof; sinc
perhaps, according to the Opinion of others, th
Sea entering into Subterraneous Caverns, ma
by way of Filtration, leave its Salts behind i
and so produce Sweet and Fresh Fountains: An
besides, it may be, the Subterraneous Fires m
cause these Waters that come from the Sea int
the Cavities of the Earth, to exhale and ascen
in Vapours, which being again turned into Wa
ter, by the Cold which they meet with abov
may produce Fountains. But it is however a su
ficiently probable Truth from what has bee
shewn before, that the said Vapours may justl
be reckon'd among the principal Causes of Ri
ver

vers. Since the Sea, and other Waters exposed to the Sun, do continually transmit Vapours upwards, which, being collected upon the Mountains, and coming down again in Rain, Snow, or Hail, are proper to produce Rivers which may flow a long Time without ceasing, and supply great Streams. This may be in some manner inferr'd from the Observations of Mr. *Mariotte* in his Treatise *du Mouvement des Eeaux* (*Engl.* Translation, p. 18.) who says, that at the lower end of a heap of Rubbish, which was about three Foot high, and whose Superfices was about 500 *French* Fathoms (forasmuch as the Rain that fell upon it, and ran down upon it from the Tops of the neighbouring Houses, could not soak thro' by reason of the Hardness of the Ground) there was a continual little Stream of Water.

But the same will be yet better shewn hereafter, from the Calculation which the said Mr. *Mariotte* makes, concerning the Waters of the *Seine*, compared with the quantity of Rain falling upon those Tracts of Land from whence this River has its Origin. *See the said Treatise*, English *Translation*, *page* 22, 23, 24.) by which it is proved, that in case there falls so much Rain-Water every Year upon these Lands, that in case it remained there, would rise to the Heighth of 15 Inches, there would be 6 times as much as is requisite to run down the *Seine* in one Year; and in case the Heighth of such Rain-Water should amount to 18 Inches, there would be 8 times as much; as likewise, if you should suppose it to rise to 20 Inches, there would fall 9 times as much Water upon those Places as flows thro' the Bed of the said River.

Sect. XLIII. *The Method of computing the Quantity of Rain-Water falling in a certain Time.*

The Method which Mr. *Mariotte* makes use of to compute the Quantity of the said Rain-Water is this; he took a square Vessel, which, for instance was two Foot in Length, and as much in Breadth, which was raised upon a Horizontal Iron in such a manner that no Water could come in it, but what descended immediately from the Sky into the Square of the Orifice thereof. This Water was conveyed by a Tube down into a round Vessel, from whence it would not be evaporated so, that by Gaging the Water in the said round Vessel, it could be known, how high it would have risen from the Bottom of the Square Cistern. And supposing that there fell as much Water in one Year upon one Place, as upon another, one might compute pretty near the Depth of the Rain that would fall upon the circumjacent Land in the space of one Year.

Sect. XLIV. *The Rain of* Paris *compared with that of* Lisle.

Mr. *Mariotte* says farther, that this Experiment having been made at *Dijon*, he found it to amount to 17 Inches; and another Person that tried the same, computed it to 19 Inches 2 Lines. But they that desire to see a very accurate Calculation and Comparison thereof, may find the same in the *Memoirs of the Royal* French *Academy*, 1699. *p.* 2 for 6 Years following, one of which was made by Mr. *Vauban* at *Lisle*; and t'other by Mr. *de la Hire* at *Paris*, in the following Manner:

Yea

Years	*Lisle.* Inches	Lines	*Paris.* Inches	Lines
1689	18	9	18	11 ½
1690	24	8	23	3 ¼
1691	15	2	14	5 ¼
1692	25	4 ½	22	7 ½
1693	30	3 ½	22	8
1694	19	3	19	9
	133	6 ½	121	9

And thus the Rain-Water that falls at *Lisle* every Year, amounts to the Heighth of 20 Inches and Lines, as that at *Paris* does to 20 Inches 3 ½ Lines, or at Medium of both, 21 Inches.

Sect. XLV. *Rain-Water alone sufficient for Rivers.*

From hence, tho' it be plain, that there falls more Rain in one Place than in another, within the same Space of Time, yet to make a general middle Computation, it may be safely advanced, that there falls about 20 Inches of Rain yearly upon the Earth, and consequently 9 times as much as was necessary to fill the River *Seine* in one Year. So that, tho' we should deduct from thence all that is serviceable to other Uses, and to the moistening and fertilizing the Ground, and all that evaporates from it as soon as it is fallen; yet the Rain alone, without the help of other Vapours, furnishes Water enough to maintain a far greater River than the *Seine*; which, if it happen'd in all Places of the Globe, and that many of these little Streams should be collected into one great and common Stream, they would together make up mighty Ri-

vers. Accordingly, we find by Experience, that by reason of the Quantity of Waters which they bring with them, famous Rivers are produced by the Concourse of several others that are lesser which the Rain-Waters falling upon, many great Parts of the Earth, discharge therein.

Sect. XLVI. *There is more Water in the Air than what descends in Rain.*

We may now infer from what has been said that the Vapours which descend in Rain only seem to be more than sufficient to supply the Rivers; but that, besides this, the Air does yet abound with a very great Quantity of Waters, may appear:

I. Because those Waters disclose themselves in Mists, Dews, and Nocturnal Moistures, and oftentimes do likewise descend in invisible Vapours.

II. Thus we find in the making of the *Hygrometers* or *Notiometers*, or those Machines by which we measure the Moisture of the Air, as we do the Weight thereof by *Barometers*, and the Warmth by *Thermometers*; that the Strings of Musical Instruments, Ropes, Wood, and other Things, do undergo continual Changes by these Vapours floating in Air, according as they do more or less abound.

III. The Chymists are particularly sensible thereof, who, when they have reduced their lixivial Salts to pure and true Ascaline, as they call them, with all their Caution can hardly prevent them from being dissolved by the aforesaid moist Vapours.

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And I have often thought, when I found good Salt of Tartar within Doors, and in a Laboratory, turned into a clear Liquor, that there must be a very great quantity of these invisible Vapours continually floating in the Air, since, that in so small a Place, in so short a Time, and in so little an Orifice or Mouth, as that of the Glass containing the said Salt, there could be so much Water gather'd together; for which reason Mr. *de la Hire* himself (*see the Memoirs of the Royal Academy, for* 1703. *p.* 78) seems to suspect, that Stones likewise, in which there were found any Salts proper to draw Waters to them, might serve to collect the like Vapours into Springs or Rills: at least, the Experiment which he there relates, that even in Places where it does not Rain at all, as in a Cellar, for instance, a considerable quantity of moist Vapours may be found.

V. But this appears yet more plainly from what the said Mr. *de la Hire*, *p.* 77. says farther, that there were a great many Experiments made, by which it was proved, that if you set a very large Vessel with Water in the Air, there will much more Water evaporate out of it than can descend from the Air upon the like Breadth.

Sect. XLVII. *Exhalations from Canals and Ditches.*

To make a rough Guess thereof, a certain curious Miller, whom I asked, How much he thought the Water in the Meadow where his Mill was could be diminished in one Day by the Heat of the Sun? Answer'd me, that in a very warm Day there was (to speak within Bounds) at least the quantity of an Inch in Depth, especially, if the hot Weather continued any time, and by that means his Waters could not be much encreased by those that ran

down from the Lands about him; for otherwiſe it did not appear to him, that he loſt ſo much Water: But thoſe who have ever ſeen how much Water is exhaled from the Canals or Ditches in a very little ſpace of Time, eſpecially when the Ground is dryed by a continual Heat, will not judge, that we exceed the Truth, in allowing an Inch a Day in very hot Weather.

For this purpoſe, in the beginning of *June*, 1710 I filled a flat Earthen Pan with Water, and ſet it in the open Air in a bright and clear Day, and examining it after four and twenty Hours, I found that there was a full Inch loſt in the Depth of it by Exhalation.

Now, if we ſuppoſe, that the Evaporation of all the Waters throughout the whole Earth be equally great, and amounts to an Inch a Day, according to this Calculation, there would be every Year 365 Inches in Depth drawn into the Air. All which, ſuppoſing it to fall down again in Rain, would be capable of overflowing the whole Superficies of the Earth 365 Inches high in one Year.

Sect. XLVIII. *Experiments to ſhew, that Evaporations are likewiſe performed by Cold.*

Let it not be objected againſt us, that there cannot be ſo much Water exhaled under and near the Poles, by reaſon of the Coldneſs of thoſe Parts of the World, becauſe,

I. In the very ſharpeſt Froſts, Vapours do continually aſcend from our Canals and Ditches upon breaking the Ice: Now in order to enquire whether this, as ſome think, might likewiſe proceed from the Subterraneous Heat; upon the 14th *January*, 1709, which, as every Body knows, was a violent and uncommon Froſt, I took

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an Earthen Bason, and pouring 40 Ounces of Water into it, put it into Scales in a Room where there was no Fire at all made, and found that upon its freezing, it had lost in 17 or 18 Hours, above a quarter of an Ounce in Weight; having taken care to prevent the breaking of the Vessel upon the Waters freezing, by keeping a little Hole in the middle of the Ice always open; thro' which the Water being continually pressed from under the Ice, it made a great Convexity and Protuberance above the Superficies of the said Ice; a sure Sign that Water is both moved and rarified even by Cold. And so before, upon the 8th of *January*, in the same Year, a quantity of Snow being put into the Scales, suffer'd a visible Diminution of its Weight; notwithstanding that it had fallen above three Days before, and lain all the time in the Air; and that which is more, we find even Ice itself will evaporate in the coldest Nights; as has been likewise observed by Mr. *Boyle*, in his Book, *de Athmosphær. Corp. Consist.*

And whilst I am writing this, a Person that has been one and twenty times in *Greenland*, tells me, that when the Weather is Calm, and without Wind, the Sea frequently smoaks and emits a visible Steam, which *Varenius* does also confirm, *p.* 361. where, speaking of the Seasons in the *Frigid Zone*, he says, that a heavy, foggy and thick Vapour floated over the Water, insomuch that Peoples Sight was intercepted thereby: From all which it follows, that a great quantity of Vapours ascends from Water in the coldest Regions of the World.

Sect. XLIX. *Objections Answer'd.*

Now if it should be supposed and granted, that the Waters produced by the Exhalations of these Vapours, do not near amount to the quantity of an Inch a Day, as in our warm Climates; we may set against it, that the Heat of the Southern Regions, quite as far as the *Equator*, is much greater than that of ours. And again, that the Superficies of the Earth between us, who lye in about the Latitude of 52 Degrees, and the North Pole, is much smaller than that which is between the Parallel inhabited by us, and the *Equator*: Wherefore, the Parts of the Earth, where the Air is much hotter than with us, are incomparably larger than those where it is much colder. So that we shall not seem to have made any great Mistake in taking the quantity of our own Exhalations, or that of an Inch a Day, for a Medium common to the whole Superficies of the Earth.

But, forasmuch as the Terrestrial Globe is not cover'd with Water all round, let us, for greater Certainty, suppose farther, that the Seas, Rivers, and Lakes, do take up no more than half the Superficies thereof: Then the Vapours that are daily attracted, to the quantity of one Inch in depth, will cover the whole Face of the Earth, when they descend in one Year no more than the half of 365, that is to say, only 182 ½ Inches deep.

SECT. L. *A Calculation after the Rate of an Half-Inch daily Exhalation.*

NOW if the daily Exhalation of one Inch should appear too large a Computation, let us suppose it to be half as much.

This seems to be the more probable, for the following Reasons: *First*, Because Dr. *Halley* (by keeping a Thermometer with Salt-Water continually in that Degree of Warmth in which he had observ'd the Air to be in a hot Day) found upon Trial, and by Weight, that the Superficies of that Water was in the Space of two Hours taken $\frac{1}{18}$ of an Inch, that is in 12 Hours $\frac{1}{9}$, or in 25 Hours $\frac{1}{4}$ of an Inch, supposing the Exhalation to be always equal.

And again; Forasmuch as the above-mention'd Miller had, at my Request, with great Exactness observed, that from *Tuesday* the 7th of *June*, 1712, to the same Hour the following *Fryday* the 10th, the Water in the *Purmer-Meer*, or Lake, had lost of its depth $1\frac{1}{2}$ Inch; that is to say, every Day half an Inch, tho' the Weather was then much cooler than the preceding Days; and he would have proceeded farther in these Observations, if the Weather had not begun to be rainy and windy. After which, the Air being again warmer and calmer, he informed me, that in three other Days there were evaporated two compleat *Rynland* Inches, which is so much more than half an Inch a Day; and therefore, if we suppose the Quantity of Exhalations to amount to no more than half an Inch every Day, and the Superficies of Land and Water to be exactly equal to one another, the Rain that will fall upon the whole Earth, will amount to the half of one $181\frac{1}{2}$, that is about

90 Inches

Inches in Depth; in case all the Exhalations should fall down again in Rain.

But now Experience teaches us, that the quantity of Rain does not amount to more than about 20 Inches. Wherefore there must be $4\frac{1}{2}$ times as much Water exhaled as descends in Rain; for $4\frac{1}{2}$ times makes 90. So, that if the Rain be subtracted from thence, there will still remain 3 times as many Vapours floating in the Air, in order to come down from the Mountains, and to serve for the Uses of Plants and other Necessaries.

So that from hence it may appear in Gross, not only, that besides the Rain there is a large Army of Vapours, of three times as great a quantity continually floating in the Air, but also a superabundant Number of Exhalations from the Water which alone rising to the heighth of 20 Inches, as we have shewn before, yield nine times as much Water as is necessary to supply the *Seine*. So that that the same being increased to 90 Inches, are adapted to afford above 40 times as much Water as the said River requires.

Wherefore, altho' the Plants stand in need of a great Quantity of Water, and indeed of more than one could imagine, as well as more than all the Rain can supply (as may be seen by the Experiment made by Mr. *de la Hire*, and recited in the *Memoirs of the French Academy*, 1703, *p.* 73, *and* 74.) nor could the Rain-Water, according to the Observations of that Philosopher, sink deep enough into the Earth; yet the Mountains, by this Surplus of Vapours, seem adapted to supply and maintain the Rivers.

SECT.

SECT. LI. *Convictions from the foregoing Observations, and a Word about the Air-Salt.*

NOW to make an end of this Matter; let the miserable Caviller, who hitherto would not own that there is a GOD that governs the World, seriously reflect upon this astonishing Circulation of so vast a quantity of Waters, which ascending from the Seas, Rivers and Lakes up into the Air, are there preserv'd in Clouds; and passing a second time thro' the said Air, are made to descend again, partly in the form of Mists, Hail, Snow and otherwise for various Purposes; and partly coming down from the Mountains, make up those great Rivers, which again discharging their Waters into the Sea, and from thence again being raised up in Vapours, have incessantly, and for the Space of so many Ages, taken the same Course, and thereby supply'd all living Creatures with Drink, fructified the Ground, and render'd innumerable Services to the whole World. And can we still imagine, that it is without a Design, since the whole Ocean, by reason of its Saltness, is entirely useless for these Purposes, that by the Warmth of the Sun (to say nothing here of other Causes which may likewise concur) the Waters of the said Ocean being divided into the minutest Particles in their Ascent, leave all their Salts behind them for other Uses; which Salts would be prejudicial to most of the Fruits of the Earth, and render the Water useless for quenching Thirst, or affording Drink to Animals; and farther, that the said Water passing thro' the Air in Rain, Dew and other Forms, should impregnate itself with the Salts of the Air and other Parts thereof, in order to become more useful for the aforemention'd Purposes?

Now

Now, whether this Salt of the Air be only Ni trous, as some pretend, we shall not here dispute but shall take some notice of it hereafter: This i certain, that Salt-petre is likewise produced b the Air, and that the same does contribute, *Firs* to the rendring the Water more fructifying, whic the Ancient and Modern Gardeners knew we enough, and of which we may see a remarkabl Experiment in the Transactions of the *French* Aca demy 1699, *p.* 74 and 76. And, *Secondly*, tha this same NitrousSalt, how much soever it has c the Nature of Salt, is yet a principal Means for e tinguishing Thirst, as most Physicians know ver well. Let the Atheist consider all this with him self, and see whether he can, with a good Con science, pretend to reconcile it with mere Chanc or Ignorant Causes.

Sect. LII. *The Wonders of the* Nile.

And now we are speaking of Salt-petre and c Rivers; can one believe that it is by Chance tha the *Nile* in *Egypt*, which overflows and render the Country fruitful without Rain, carries s much Salt-petre with it, that a great quantity there of may be made only by evaporating the Water of the said River; (*See de Stair Physiologia de Nitro* insomuch, that this exceeding dry Land become so fruitful, as to exceed most of the other Parts o the World. Now if any King or Prince had bee so fortunate as to have brought this to pass, an to have found out a Method of watering such a vast Extent of Land every Year with so fructifyin a Liquor, and without any Labour of Men, woul not this have been recorded to his Praise, as a Won der of Wisdom, by the latest Posterity? And no that we see this happen in the most glorious Man ner, exceeding the Power of the greatest Sove reigns

eigns, and with so much Advantage, as to pre-erve the Lives of thousands of Men, and to ender this Country, which in its own Nature is ne of the most Barren Parts of the World, ma-y times a Magazine and Granary for other Na-ions, that have been distrest by Famine (as we re informed by History;) Can any Body satisfy hemselves in affirming, that this was done without Design, and by mere Chance? Let such an Infi-el or Sceptick only compute how many Things nust here concur, to render a Country so dry as *Egypt*, and which is never moisten'd with Rain, fruitful and Plentiful to so high a degree. 1. There nust be Water, and in so hot a Country, that Wa-er must be brought from some other Parts. 2. For hat reason this Country must be lower than almost ll the rest of *Africa*, where the *Nile* has its Rise, n order to be over-flowed by that River. 3. And n other Parts it must be higher and more raised, o the end, that during the Inundation People may nhabit there; and so it is observed to be about he Places where their Towns are built, which at he Time of their over-flowing appear like so ma-y Islands. 4. There must be so much Water, in order to run over its Banks, and to drown the whole Country. 5. After the Inundation, it must ie a while upon the Ground, to the end, that du-ing its Stagnation, it may deposit the Slime or Mud which it brings along with it. 6. The Wa-ter, that it may occasion so great and uncommon Fruitfulness, must be impregnated with a suffici-nt Quantity of Salt-petre, but not with too much of it; which does not happen in Places where it rains enough, or in any Rivers that I ever heard of. 7. This Water must likewise run off again of itself from the Lands which it over-flow'd, and leave them dry, in order to produce their respe-ctive Fruits.

Now, if we should allow that all these Qual ties are not peculiar to the *Nile*, forasmuch as w read that the *Indus*, *Ganges*, *Niger*, *Zaire*, and o ther Rivers, do fertilize also their adjacent Cou tries by Inundations; will any one infer from thenc that because there is a GOD who has exerted h Wisdom, Power and Goodness in more Places tha one, therefore he is endow'd with none of tho Perfections?

SECT. LIII. *Convictions from the foregoing Observations.*

BUT to return from this small Digression, an to shew with how glorious a Lustre infinite Wi dom appears in the Use of Mountains, and the Be nefit it communicates to the World by this Circu lation of the Waters, and Production of such ne cessary Rivers; Let a Sceptical Philosopher lay be fore himself a Map of all the Countries of th World, and attentively view the numerous River therein, which are dispersed throughout like s many rich Fish-Ponds; which, by their sweet Wa ters, furnish all Things living with Drink, and a ford an Opportunity to the most distant Countrie mutually to communicate their respective Prod ctions: And let him tell us, whether, if ther were no such thing to be found upon the Earth he would not be obliged to own, with us, tha the World would be in a very miserable Conditi on. And altho' the same Quantity of Water we to be met with in some stagnating Lakes and Ma shes in the lowest Countries of all, is it not plain that the higher Regions, at least where it neve once Rains, as *Egypt*, *Peru* and the like, would b ruin'd with Droughts: Not to mention, that i a great Collection of Waters, by reason of thei stagnating, in process of Time, an unavoidabl

Destructio

Destruction would hang over their Heads. Again, can it be pretended, that it is by mere Chance, that there are such a number of Fountains found in all Parts of the World, out of which at first little Rills and Brooks proceed, which joining together, compose great Rivers; by which means the very driest Countries are furnished with Water, and that with Running and Living Waters too, which, by its continual Motion, is preserv'd from Corruption? Now this could by no means happen, if there were not Mountains in some low, and even high Countries too, upon which the Vapours being collected, were sufficient to supply the Matter for all these Rivers.

SECT. LIV. *The Disposition or Fitness of Mountains for the aforesaid Purposes, and Convictions from thence.*

NOW, can this be ascribed to any other Being, than to a Wise, Powerful and Gracious GOD?

I. That we find such great Bodies as the Mountains distributed throughout the whole Earth.

II. That most of 'em are found in the highest Countries, in order to transmit these Rivers from thence to the Distance of hundreds of Leagues sometimes.

III. That the whole Superficies of the Earth is adapted thereto, which grows gradually lower on all Sides where it is washed by the Sea, as is plain from the Course of the Rivers that mostly discharge themselves therein; since every Body knows, that Water, by reason of its Weight, always runs to the lowest Places.

IV. Do we not herein see a wise Direction? that there are always so many Mountains made for this Purpose, namely, to produce such mighty Rivers as the *Rhine*, the *Danube*, the *Rhone*, the *Boryſthenes*,

Boryſthenes, &c. (*See Varenius's Geography, lib.* 1. *ca.* 16. §. 3.) and they that deſire to have a larg Account thereof, and to know how the Mountai run in Ridges thro' the Earth, may meet with th ſame in the ſaid *Varenius, cap.* 10. *lib.* 1; as al in *Burnett's Theory of the Earth, cap.* 9. who, th their Heighth bears very little Proportion to th Bigneſs of the Globe, is yet of Opinion, that th Space which they take up, may amount to a ten Part of the ſolid Land thereof: They that wou form a Notion thereof, may conſult the Figur which this laſt Author has made, tho' he uſ them to a contrary Purpoſe, notwithſtanding th he has left out ſeveral and very large Mountain on account of the ſmallneſs of his Draught, ſuc as the *Apennine*, and other Mountains of *Italy*, &

V. Now it ſeems ſtill neceſſary, that in the Pr montories, or Parts of Lands, running into th Sea, ſuch as *Italy* itſelf, and others likewiſe, Mou tains are particularly placed for this Purpoſe, th the Vapours ariſing from the Sea, ſhould not nee to be carried far over Land, before they may mee with Mountains, where they may be turned int Water and run down again.

VI. The Iſlands alſo ſeemed, above all the re to want Mountains; foraſmuch, as being ſhine upon by the Sun, they were hotter than the Se Waters wherewith they are ſurrounded, and there fore were not likely to receive much Rain thenc To be convinced hereof, let any one view in Map, the aforemention'd Iſlands of *St. Helen St. Thomas*, &c. and conſider, whether it be pro bable, that ſuch little Plains and Spots of Lan in Compariſon of the circumjacent Seas, an which, for the aforeſaid Reaſons, does ſo far ex ceed them in Heat, could entertain the leaſt Hope of receiving Water enough from Heaven, if G o had not been pleaſed to provide for them afte

ſo

so particular a manner by the help of Mountains.

Now if any Body that reads the following Passages, taken from the Describers of the World, as first from *Burnet*, p. 47. *There is no solid Land either of the old or new World, or no old or new Island, but what has its Mountains.* Secondly, From *Varenius*, *lib.* 1. *cap.* 10. §. 2. *In most of the Islands, and in Promontories, the Mountains are situated so, as to run thro' the middle of 'em, and divide them into two Parts*, which he confirms by many Examples. I say, can he that reads this continue to believe that it happen'd so by Chance? Tho' he is forced to acknowledge, that if a Man were in the highest manner concerned for the Preservation of those Islands, he could not dispose the Mountains thereon after a more useful Manner, to make them serve for Watering-Pots to the Country round about them, and for collecting those Vapours, which would otherwise be scatter'd by the Winds, exactly in those Places where they would be most useful. Must not every Body see the Power and Goodness of the great Creator and Governor of all Things, shine out most brightly, who, in order to sweeten the Sea-Waters, which of themselves are salt and barren, and to distribute them throughout the Earth where-ever they may be useful, has daily forced Bodies, so considerable in size and Strength, to contribute thereto; who has order'd the Seas, the Mountains, the Air, the Vapours, the Winds and the Sun itself, that they might bestow these great Benefits on the Inhabitants of the Earth, not only to concur in general, but that each of them should likewise afford the most proper and most requisite of all their Faculties; so, that if the Sea had not been sufficient in its utmost Breadth and Depth, if the Mountains had not been high enough, and placed so conveni-

ently; if the Air had not been elaſtical, and there fore denſer below than above; if the Vapours ha not been light enough; if the Winds had not bee ſtrong enough to drive them along; if the Sun ha not been fixed at ſo juſt a Diſtance, as to yiel neither too much nor too little Heat, this grea Work of the Circulation of the Waters, and wit it almoſt all Creatures had long ſince been at a end, and the whole Terreſtrial Globe become Wilderneſs?

Sect. LVI. *Rivers require a Place wherein to di charge their Waters.*

Having thus far traced the Rivers to the Origin, if we now contemplate their Number their Largeneſs, and their unconceivable Quantit of Waters, which for ſo many Thouſand Years d inceſſantly paſs along with them for the Benef and Happineſs of all that dwell upon the Earth every one muſt be convinced of the Neceſſity very large and deep Spaces where theſe migh Streams may rendezvous and meet with ſuch a R ceptacle, as to hinder them from overflowing th dry Ground.

Is it then by Chance, that there are prepared the Earth ſuch unfathomable Depths, as may co tain the whole Ocean, and into which all the R vers may diſcharge their Waters, and witho which all the Power, and all the Skill that h been employed in the Frame of the World, a of the Plants and Animals upon it, would be a in vain?

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SECT. LVII. *Salt preserves the Sea from Corruption.*

LET now an unhappy Atheist Contemplate with us this great Collection of the Waters, these vastly extended Seas, and say, whether in case the same did consist of nothing but fresh Waters, brought into them by the Rivers and Rains, he can even suppose, that it would have been possible for them, after having been exposed so many Ages to the Action of the Air and Sun, to have been preserved from Corruption and Stinking. Now if that had happen'd, let him consequently consider how grievously the whole Mass of Air, surrounding the Globe of the Earth, would have been infected by such a stinking Lake, and thereby produced innumerable and fatal Diseases. Let him represent to himself in this Case, all the Waters of the Sea so corrupted, that hardly any Fish could live in them. Must then again mere Chance, or something else that does not know whether or how it operates, have the Honour of what we are going to say, namely, that just at the bottom of this great Receptacle or Pit, there grows, or is placed, such a quantity of Salt as is capable of converting all the fresh Waters that run into it, into a Pickle, and so to preserve it from Corruption, as well as to hinder the Waters in many Places from freezing; for if a Frost should happen as easily in the Sea, as it does in Rivers and fresh Waters, it would not only render the Sea many times unpassable, but by stopping Ships in the middle of it, cause an infinite number of People to perish with Hunger?

And yet no Man can shew any Necessity, why there should be such a vast quantity of Salt found in the Sea rather than in other Places, since there are likewise Mines and Pits thereof to be met

with in many Parts of the Land. Thus we read, that they dig Salt out of the Earth in *Poland*, in *Transylvania*, in *Tyrol*, in *Spain*, in *Lesser Asia*, in *Persia*, and upon the Banks of the *Caspian* Sea, which last is carried throughout all *Russia*. There is a Mountain of Salt in *Cuba*, and the Island of *Ormus* in the *Persian* Gulph, is said to consist for the most Part of nothing but Salt; in all *Africa* they use such Mineral Salt; in *Peru* there is an unfathomable Mine of it; in the Kingdom of *Masulipatam* in *India* they dig so vast a quantity thereof, that all the *Indians* furnish themselves from thence. See this more largely in *Varenius*'s *Geography*, lib. i. cap. 11. §. 1.

Can we then, since Salt may justly be reckon'd among the Minerals and Productions of the Earth, ascribe to Accidental and Ignorant Causes, the great Benefit that hereby befals the whole Earth, namely, that the Sea does also abound in it? Wherefore, if one were to see a quantity of Flesh put into a Vessel of Pickle, by which it is preserved from Putrefaction, would any one say, that the Salt grew there, and that the Flesh was put into it by mere Chance?

Sect. LVIII. *Bays and Gulphs of the Sea for the Reception of Rivers.*

If this be not enough to shew the Hand of God to unhappy Mortals; yet an Atheist must at least acknowledge, that a great Part of the World would be render'd uninhabitable by the Inundation of Rivers, if the Earth were not washed round about by the great Sea, and which is very wonderful, if the Sea did not transmit great Branches, Arms, or Bays, from itself into the Land, in order (besides other Uses) to receive likewise the discharged Waters of the Rivers into its Bosom,

mix therewith the Great and Salt Sea, and so to yield new Matter for Vapours, and thereby for Rain, and for continuing the Circulation of the said Rivers. From whence it comes, that this whole Structure and great Work would have been still in vain, if the Coasts adjacent to the Sea, and to these Bays and Gulphs, were not lower than the Inland Countries and Regions remote from the Sea. Now shall it be said, that a Matter of such Importance, and upon which the Preservation and Welfare of whole Nations depend, is brought to pass without a wise Design?

To give an Instance thereof: In case the mighty Arm of the Northern Ocean, which is commonly called the *East-Sea*, lying between a great Number of Countries, were not, as one may say, dug out and prepared on purpose to receive likewise all the Rivers that discharge their Waters into it, (and which *Varenius* terms, exceeding great ones) how difficult would it have been to them to have found their way into the Ocean; and how many Provinces would it have render'd uninhabitable by their Inundations, if the Streights of the *Sound*, and those of the *Great* and *Little Belt*, were stopt, and all the Rivers cease falling into the said *East Sea?*

The same would happen, if those rich and noble Coasts of that great Gulph which is commonly called the *Mediterranean*, and which Coasts are of so vast an Extent, were not so low, that the Rivers by their Weight could run down thither, and from all Parts discharge their mighty Streams, as it were into a Common Drain formed for that Purpose.

For these Reasons it is, that the Passage thro' the *Dardanells* to *Constantinople* is so very difficult, on account of a Current occasion'd by the Discharge of such great Rivers as the *Danube*, the

Nieper or *Boryſthenes*, the *Tanais*, or *Don*, and others, which carry their Waters thro' theſe Streights. See *Robbe's Navigation*, p. 84.

Now all theſe Waters ſeem to diſcharge themſelves finally into the great Ocean through the Streights of *Gibralter*; and, as at the *Dardanells*, do there likewiſe produce a continual Current outwards.

But I was very much ſurpriz'd at what one of the Principal Sea-Officers of *Holland* informed me of; namely, that having often paſſed the ſaid Streights, beſides the known Currents in the *Mediterranean* Sea, which run Eaſtwards along the Coaſt of *Barbary*, and Weſtward on the oppoſite Coaſt, it was experimentally known to all Seafaring People, that there was a continual Current from the Ocean through the ſaid Streight, ſetting inwards. This they infer; becauſe thoſe that will go into the *Mediterranean*, can always paſs through this Streight by Laveering or Tacking, even tho the Wind be contrary; and yet, in the ſame Circumſtances, can they paſs from the *Mediterranean* into the Ocean, but with much Time and Difficulty.

And when I enquired of that Gentleman, what became of that vaſt quantity of River Waters which are continually diſcharged into the *Mediterranean*, and which ſeem to have no other Out-let but through the aforeſaid Streights; he was pleaſed to anſwer me, that ſome were of opinion, that either the Heat of the Sun exhaled thoſe Waters from the Sea, or as others thought, that there were in the ſo named *Gulph* of *Narbonne*, or in other Places, ſome ſubterraneous Cavities at the Bottom of the Sea, whereby theſe Waters were diſcharged; at leaſt it was experimentally known, that there is an uncommon Motion of the Sea-Waters,

ters in the said Gulph more than in any other Places.

Now, whether this or any thing else be the Cause why the *Mediterranean* Sea, which on the East-side, and all round, does perpetually receive the Waters of such great Rivers, and on the West-side those of the Ocean, has not in so many Ages been so far filled therewith, as to overflow the adjacent Countries: This is certainly true, that the Divine Providence does herein display itself after a wonderful manner, whereby GOD has given a convincing and ocular Demonstration, that he will not be bound by any necessary Laws of Nature, but is able to perform all things according to his own good Pleasure, producing in such a little Corner of the World, as is the Distance of the Streights of the *Dardanells* from those of *Gibraltar*, such an amazing Work as the making Place for the Discharge of those mighty Rivers, after two such different and unaccountable Ways. Numberless would be the Wonders that might be produced upon this occasion from the Natural Histories of the Seas and other Waters; we shall therefore refer our Readers to those that have given Relations and Descriptions of the Sea and Land, all which if we were to repeat, would be an endless Work.

SECT. LIX. *The Uses of the Sea.*

BUT because we have been prolix enough upon this Subject, let the Atheist go farther with us, and observe, how the Sea does not only surround the whole Earth, in order, as has been said before, to receive into its Bosom the Rivers and fresh Waters, and preserve them from Corruption by its Salts, till they become useful again, but likewise, how the said Seas are the only Means by

which Commerce and Traffick can be carried on and each Part of the Globe, that has the Advantage of lying near them can enjoy, by the help of Shipping, all the Advantages and Conveniences of the most inland Countries: So that the Great Creator has vouchsafed not only to take care of those that lye near the Sea, but likewise of all that live in the very Heart of the Continent by the means of Rivers, and by the imbaying or breaking of the Ocean many Leagues up within the Continents themselves; Instances of which have been given in the East and Mediterranean Seas.

Let us produce another Example: If *Holland*, which has hitherto been so signally blessed by GOD, but which is surrounded with unfruitful Countries and barren Heaths, had been obliged to have fed its Inhabitants with nothing but what itself produced, perhaps there would not have been a more miserable and defective Nation in all *Europe*: Whereas now, by the help of the Sea only, every thing that the old or new World can afford, either for Necessity, Convenience, or Ornament, are brought hither in great abundance. Can then a *Dutchman* ever look upon the Sea without thinking at the same time, how much he is indebted to him that made it?

SECT. LX. *The Force of the Sea in bearing Burdens, and Convictions from thence.*

WERE there no Sea, what vast Machines should we stand in need of? What a Strength of an inexpressible Number of Men and Beasts would there be wanting to bring home to us those mighty Burdens which an *Indian* or an East-Country Fleet does now supply? the more because the Merchant must then have been obliged to pass thro' the Countries of other People, it may be of Enemies

or of such Nations, who, like the *Arabians*, live upon Plunder; insomuch, that besides the Numbers of Men, they would likewise be forced, for their own Defence, to carry with them great Trains of Artillery, and all other kinds of Ammunition and Provision: Whereas now these heavy Ships, containing all these great Burdens, are so easily born by the Sea, and driven forwards by small Blasts of Wind, and very long Voyages performed with much Conveniency and little Time.

If an Atheist should still maintain, that all this is so disposed without any Wisdom, let him contemplate a well-equipp'd Man of War, or even an *East India* Ship, and let him be ask'd, what Means could possibly have been invented to have put a Machine of so great a weight as such a Ship, with all its Lading and Cannon, into such a Condition, as to cause it to move with a very small Force, without the Assistance of Water, or any other liquid Matter? The only Answer, if he were a skilful Mathematician, that he should be able to give, would be; That such a Ship must be put into a sufficient Equilibrium, in which case the least additional Force would be able to move it; just as if it were hanged by a Chain or Rope to a Crane or to one Arm of a Balance, which had an equal Weight fastened on the other Arm; or after such other manner as a Mechanick could propose to himself. But then it is no less certain, that among all the known Materials, none could be found sufficiently strong to serve for Instruments to such Experiments; much less could they frame any Idea of bringing a Ship from the *Indies* in such a manner.

Now in these Circumstances, if any Man should tell him, that he knew a way how to carry so vast a Burden some hundreds of Leagues, and to keep

keep it in a conſtant Equilibrium, without ev changing its State, ſo as to be able to move with a very little Force which way he pleaſed, a cording to all the Points of the Compaſs; wou he dare to anſwer, that ſuch a thing could be pe formed without a wiſe Contrivance?

Sect. LXI. *The ſame Arguments enforced.*

This would be the Time to ſhew the une preſſible Footſteps of an adorable Creator mo clearly than at Noon-Day; and to ſay ſomethi of thoſe Laws of *Hydroſtatics*, which are mo wonder'd at by every one than as yet underſtoo in relation to their way of working; but we ſha do this more largely in its proper place; and w beg thoſe that read it, to apply what we ther ſay, to the Powers of the Sea, to the end, tha they may be more fully convinced, even with A ſtoniſhment, of the Wiſdom and Power of th Great Creator.

To ſay one word or two of it here; Can on judge, that there is no Knowledge or Contrivanc required to raiſe up one of the greateſt Men o War by the help of a few Tuns of Water, whic for Weight are by no means comparable to it And yet it is plain, that this may be done, if ſuc a Ship, drawing 20 Foot of Water, ſtood upo dry Ground, and that there were made abou it a Dock or Sluice of about 21 Foot in Depth, i ſuch manner that there ſhould not remain mor than the Breadth of half a Foot, or a good dea leſs, between the ſaid Ship and Dock. For in caſe this Interſtice betwen the Ship and the Dock (which being about half a Foot more or leſs in Breadth, would contain very little Water) were filled up to the Top with Sea-Water, every body knows, that the aforeſaid ſmall quantity of Water being

being so disposed, would raise up and put into Motion, so prodigious a Weight as that of the whole Ship.

This must not be ascribed to the Lightness of the Wood alone, as if the Water had but a small share therein: Forasmuch as we hope hereafter experimentally to prove the contrary, when we come to treat about the Laws of the *Hydrostatics*.

Can then any rational Creature be so deplorably blind, as not to see in this mighty Violence of so surprizing a Force as is here exerted by the Water, and which is yet so absolutely necessary to put any the Ship in a Capacity of sailing; I say, as not to be convinced of the Wisdom of the Creator? Can meer and stupid Chance ever subject such a Matter as Water, ignorant of its own Nature and of every thing besides, so accurately and nicely to the Laws of Mathematicks; insomuch, that before it recedes from them in the least point, it acts inconceivable Wonders? But more of this hereafter.

Especially when a Man sees, at the Arrival of the Fleets, a great number of Ships lying almost close to one another before the City of *Amsterdam*, and how such a small quantity of Water so easily bears this prodigious Burden, without appearing to suffer any Violence, and keeping them in an *Equilibrium* by an incomparably smaller Force, makes them capable of Motion on every side. Further, when he reflects with himself, that if the said Water were by any means drawn from under them, and that all those Ships sat dry, what an Apparatus, what Machines, what a Force of numberless Men and Horses would be wanted to move them only one Foot from their Place. Would it not seem a most inscrutable thing to him, that an ignorant passive Matter, such as Water, could so easily bear such an amazing Weight on its back,

and

and waft it along by a gentle Current only, many hundreds of Leagues?

I have dwelt somewhat the longer upon th Subject, because if ever the terrible Power a adorable Wisdom of that God who orders things in the World, appears in its greatest Lust it must be confessed to do so in the prese Case; and it seems to me, that if this astonishi Force of the Water (by which it holds such in mense Weights, in its hand as it were, and offe to Men to bring them any way according to the Will) if it be but well consider'd by a doubtin Philosopher, is alone sufficient to prove irrefrag bly the Presence of a God who is dreadful in h Power, and great in his Wisdom and Goodnes I say, all this would appear even to a Demonstr tion, if he would but divest himself of that carele manner in which Custom makes them look upc all, even the greatest things, without Attention and if they could rightly contemplate so stupe dous a Work.

Sect. LXII. *The Fishes of the Sea.*

Can a Man now that has any thing of Grat tude in him, perswade himself, that he has no C bligations to that God, who has surrounded th whole inhabitable Earth with these Waters, an holds them every where in a continual Readines that their mighty Strength may be serviceable t Mankind? If he can, let him go one step farthe with us, and contemplate the Depths of the Sea which in so many Places is unfathomable. It wa not sufficient for the Great Creator to preserv the Ocean in such a State, for all the above-men tion'd Purposes; but that this great Space of Wa ters should not be without further Uses, and t the End, that the Hand of its adorable Make might

ight be manifested as well by the deepest Cavi-ies as by the vastly extended Superficies thereof, He has been graciously pleased to furnish it with ich innumerable Kinds of Fishes, and other Ma-ine Creatures, by the multitude of which so ma-y Men are continually fed; insomuch, that where o Bread can be procured, but with great Trouble nd Charge, the same being dried, does likewise ipply the Want thereof. Not to mention here he inexpressible variety of Fishes, by which the Appetite and Palates of so many Eaters are grati-ed; will an Atheist dare to mention, that the Sea kewise, in this case, with all its Fishes, were nade without Design? Whereas he himself, and ll Land Creatures, could not be able to remain a quarter of an Hour under Water without dying: s there then no Knowledge required to form so nany Creatures after such a manner as to be able ot only to live always in the Water, and as ther Creatures find their support in the Air, they, n the contrary, get their whole Subsistence in the Water, but likewise bring forth their Young there n so great abundance? Further, let us consider, ow much the Structure of the Eyes of Fishes dif-er from that of the Land-Creatures, the first being adapted only to see in Water, the other in the Air. Let him also consider the Shape and Form of Fishes, where he will plainly discover all those Qualities hat are requisite to support them in Water. And ince some of them can live only in salt and others n fresh Water, let him observe with wonder, that Care is taken for the first by the Sea; and for the ast, by Rivers and fresh inland Waters. And if he desires to be further informed of the Relation which the Fishes and Water have mutually to one an-other; let him turn to what is said here below concerning the Fishes, and compare it with this Dissertation about the Sea.

SECT.

Sect. LXIII. *Convictions from the foregoing Obſervations.*

If now, after having ſeen and underſtood this, any one can pretend ſtill to remain unconvinced of the Wiſdom of a Being which has form it all, let him only examine himſelf, whether he really diſpoſed or not to be convinced; if not, can do no more than only to pity his moſt miſerable Condition; but if, contrary to his own Will and ſincere Endeavours, he perceives that is not ſatisfied, there ſeems no other wholſom Counſel for him, than moſt humbly to implore th God, by whom he deſires to be convinced, th he would vouchſafe to bleſs thoſe Studies whi he employs in contemplating his Creatures, a enable him to prove his Exiſtence by his Work with the ſame Acquieſcence and Conviction whi he finds in himſelf, when by ſeeing a curio Piece of Workmanſhip, ſuch as a well contrive Watch, a convenient Houſe, a Ship with all i Tackling, *&c.* he concludes, that theſe thin were made by a skilful Artificer, for certain wi Ends. Which Method, to my Knowledge, Go was pleaſed to ſanctify to a great but unhapp Philoſopher, in his laſt and Death-bed Sickne

Sect. LXIV. *The Circulation of the Waters d likewiſe preſerve the Land from overflowing.*

To add ſomething farther, which ſeems to gi ſuch as are not entirely hardened, an irrefragab Proof of a God that rules the Sea; Can any o ſee, without the utmoſt Amazement, that ſo grea ſo extended a Space, in which ſo dreadful a quan tity of Waters is contained, as the Ocean, do

ot overflow the dry Land, and especially where : is so low, as that of *Holland*; since there is such Concurrence of Circumstances that seem to ren- er it unavoidable, unless a greater Power and Visdom had intervened.

To shew this, let any Man tell us how it is pos- ble, that such an innumerable Company of Ri- ers, and among them, such great ones as *Vare- ius* mentions in his Account of Rivers, §. 27. do Day and Night continually discharge into the Sea ich an unconceivable Quantity of Waters, and ill do the same so many Ages without ceasing, id yet not fill the Sea, nor force it to exceed its ounds, and overflow the Land.

This would be unintelligible to every one, were not that all these Waters did constantly observe ie Circulation we have shewn before; whereby ose Waters that are brought into the Sea by the ivers, and increase the same, are again attracted y the Heat of the Sun, and do rise up into the ir under the Form of Vapours, and there they, r at least great part of them, are collected upon ie Tops of Mountains, or descend again in Rains, nd become little Brooks, which, by their Union, ake up the same Rivers that carried them into ie Sea. Thus performing their continual Circu- tion from the Land to the Sea, and from the ea thro' the Air into the Land again.

ECT. LXV. *Convictions from the foregoing Obser- vations.*

Now let me ask an Atheist, whether besides ll that we have already said about the *Sea*, he magines that these things have come to pass vithout any Direction; and that all that contri- utes to this great Circulation, has acquired so ppposite a Constitution without a determined

Purpose? Why then is not the Sea quite exhale and dried up? Why is it not increased by the R vers? Either of which would produce the certa Destruction and Ruin of the whole Earth. A whence comes it that the Sun has continued s so many Ages in such an exact degree of Heat, to leave in the Sea always about the same quanti of Water, without our being able to discover a remarkable Diminution, or Augmentation there And after many of the like Questions, which o might easily put on this Occasion; can any re sonable Man believe that a blind and ignora Cause, a meer Chance, (which may every Minu act after a different manner) has had the Direct of it? and which has been able to confine such infinite Host of so many Millions of watery Pa ticles to such fixt and so necessary Laws, for t good of those that inhabit this Globe, without t least Deviation; and to make those Particles alwa return to the Sea from whence they came?

Sect. LXVI. *The Dykes or Banks of* Holland.

If any one desires to see a further Proof of t manifest Government and Direction of the Gre Creator, let him pass along the Dykes of *Nort Holland*, and there take notice in how many Plac the Waters of the *Zuider*-Sea are higher than t Lands that lie within the said Dykes. Let hi farther contemplate the Smallness of these Dyke in comparison of the great Extent of Sea, whic lies and presses upon them; Let him observe th amazing Power and Strength of the Sea; by whic tho' cover'd with Ships, it so easily bears the u expressible Burden, and upon the least stirring of i Waves, can move and lift them up. Would h if he did not know those Laws to which the Gre Ruler has subjected these watry Deserts, woul

h

ie not consider it as a continual and unconceivable Miracle, that those Dykes, so small and slender in respect to the Waters that press upon them, have not been overturned and carried away long ago by the Weight thereof, and the adjacent Land turned into Sea: At least it appears from hence, that there is need of more than humane Assistance to preserve such a Country from Inundations.

For instance; Let us suppose A B (*Tab.* XV. *fig.* 2.) to be the Breadth or Extent of the aforesaid *Zuider*-Sea, and if you please too, cover'd with Ships, which, by their prodigious Weight, do press the Waters forward on all Sides; Let A C and B D, be the Dykes (which we only represent here in their height by a Line) which hinder the Water from overflowing the Lands I K, that lie behind them. Now if one draws the Line C B, 'tis plain, that all the Waters at A C B, would press against the Dyke A C; in case the Waters observed the same Laws in gravitating as solid Bodies do. Now, let any one imagine this whole Body A B C, to be cover'd with Wood, and the whole Superficies thereof, A B, with tall and well-built Ships instead of Water, as has been here supposed. Now, if this great and heavy Body would slide downwards so smoothly, and without any Friction or Resistance, along the Oblique Line B C, as the Water can do, and could press after the same manner upon the Dyke A C, one need not ask, whether the Dyke could stand against it only one Hour. Now, since Water is incontestably heavier than Wood, 'tis plain, that the Still-standing Sea would act with greater Violence against the said Dyke than the Wood A B C, in case the Water should operate according to its Weight, after the same manner as the said great Body: The Consequence of which would be, that

no Land in the World, which lay lower than the Sea, could be defended againſt it by any Dykes.

Now let the moſt ſubtil Atheiſt inform us after what manner he can deduce this Diſpoſition of the Particles of Water, not only upon the Principle of a fortuitous Concourſe of the Parts, or from ignorant Laws, but even from his own preſumptious Wiſdom and Philoſophy; as alſo after what manner Water, tho' it preſerves its Gravity, ſhall yet be ſo reſtrain'd as to its Preſſure, as to ſuffer itſelf to be contain'd within ſuch narrow Limits as are our Dykes.

To account for this Difficulty in ſome meaſure here (ſince we ſhall ſpeak more fully of it hereafter in its proper Place) is it without Wiſdom that the whole Sea A B C D (*Tab.* XV. *Fig.* 2. cover'd with this vaſt Weight of ſo many great Ships, and of the Breadth of ſo many Leagues does not preſs ſtronger againſt the Dyke A C, than the ſmall but equally deep Ditch A E would do which is no broader than a Rod, and a good deal leſs?

Wherefore, tho' the Dyke A C, conſiſted only of thin Glaſs, the whole Sea A B C D, would not be able to break it with all its Preſſure, if there were only behind the ſaid Dyke at G H C A, a little Water, no broader than the length of a Rod or Perch, but as deep as the Sea.

Now, that this is true, they that underſtand Hydroſtatics know very well: We ſhall alſo ſhew it more largely hereafter. And the ſame is the only Cauſe why the whole Sea, cover'd with thouſands of Ships, if it be calm and not too deep (ſince it is by the Depth only, and not Breadth that its Preſſure is increaſed) is often bridled by a ſlight Dyke, and prevented from overflowing ſo many Countries, and drowning Men and Beaſts

Sect. LXVII. *Sand stops the Sea, and proceeds from it.*

But now, if any one goes farther, and has ever contemplated this dreadful Abyss in its wild Motions, when excited by Storms, or its Waves rising to incredible Heigths, and threatening to inundate and swallow the dry Land: Can he then think it is by Chance, that the mad Waves of this terrible Heap of Waters are to this Day contained within its Bounds? And he that has ever seriously and earnestly reflected upon the whole, must he not entirely justify the Discourse of the Great Creator of all Things, when he sharply rebukes the careless *Israelites* for their Blindness and Dullness in the following manner, by the Prophet *Jeremiah*, c. v. ver. 21, 22. *Hear now this, O foolish People, and without Understanding, which have Eyes and see not, which have Ears and hear not, fear ye not me? saith the Lord: Will ye not tremble at my Presence, which have placed the Sand for the Bound of the Sea, by a perpetual Decree that it cannot pass it; and tho' the Waves thereof toss themselves, yet can they not prevail; tho' they roar, yet can they not pass over it.*

Shew any one that has seen a stormy Sea rolling its Waves in its full Course, a handful of Sand; and tell him, that such small, such contemptible Bodies, which one may blow away with ones Mouth, can restrain the Rage of those watry Mountains; will he not look upon it as a Wonder: But tell him moreover, that the Sea itself does, according to all Probability, produce that Sand, and thereby becomes itself a Bridle to its own fearful Powers, according to the above-mention'd Experiment of Messieurs *Hook* and *Plot*, where it is shewn, that by the Evaporation of Salt-Water (which is con-

tinually performed by the Heat of the Sun upon the Sea) a great Quantity of Sand is produced. Can he likewiſe think that a blind and ignorant Nature has beſtowed this Property upon the Salt-Water of the Sea, and thereby only preſerved ſuch flouriſhing Kingdoms and ſo many Provinces from Inundations, with caſting up whole Mountains of Sand out of the Sea, in Places that otherwiſe, by reaſon of their Flatneſs and Lowneſs, might daily expect to be ſwallowed up? Can he look upon the double Sand-banks placed along the Coaſts, which are like ſo many Walls and Bulwarks againſt the Incurſion of this all-deſtroying Sea-Enemy? Can he obſerve the oblique Aſcent of the Shoar, in order to break the Force of the Sea, or the Heighth of the Downs that lie behind, without being obliged to own, that a great and adorable Engineer has vouchſafed thereby to fortifie this Country againſt an Invader, powerful beyond Conception, and which aſſaults them continually? The rather, becauſe one cannot imagine how it ſhould be poſſible that ſuch looſe Heaps of Sand are not entirely ſcatter'd by the Winds when we ſee ſo often ſuch great Quantities there of raiſed up and carried thro' the Air. Again will any one ſay, that it is by mere Chance, that in theſe dry and barren Sands (which otherwiſe are hardly capable to produce any Plant) certain Herbs or Weeds do not only grow, but are likewiſe proper to be tranſplanted, by Means of which theſe Sand-banks are defended againſt the ſcattering Winds, and the Downs brought and continued in their Places where they can be moſt ſerviceable?

Sect. LXVIII. *The Sea-Weed the Support of Dykes.*

In other Places, where the Sand is not in so great Plenty as in the *Zuider-Sea*, which is supposed to be formed by an Inundation from the Ocean, and which is only bounded by Dykes; Experience shews, that no better can be found for the making thereof, than that Sea-Weed which we call *Wier*. Now can any Body imagine, that the *Hollanders*, in this Case, speak without Reason or Grounds, when they fetch from thence a Proof of a God that preserves their Country? Forasmuch as they see, that this Weed is produced even by the Sea, in great abundance, and the Dykes thereof are maintained by it.

Sect. LXIX. *The* English *Channel preserves* Holland.

Yet more; Forasmuch as all this does hardly seem sufficient to secure our Low-Countries from being buried under the Waters of the great Ocean, can any one imagine, that it is ordered by Chance that the Promontory of *France*, and that great and noble Island of *Great Britain* make between 'em a Streight or Channel, which is broad enough for a Fleet of Ships to pass thro', and yet narrow enough to hinder this dreadful Ocean, when it ascends in its Flux, from discharging with full Strength his watry Mountains upon the Coast of *Holland*: Since either by wanting too much Time to pass thro' the Channel, it is carried back by a seasonable Ebbing, or, as others think, because the North-Sea growing continually wider on this Side, the Waters that flow thro' the Channel cannot continue at such a Height. Accordingly, Ex-

perience teaches us, that for this laſt Reaſon the Tide of Flood runs five or ſix Times as high at *Calils* as in the *North-Sea*; which is obſerved by Mr. *Hartſoeker*, in his Treatiſe of Natural Philoſophy.

Sect. LXX. *The Cauſe of Ebbing and Flowing omitted.*

We ſhall paſs by the famous and great Motion of the Sea in its Flux and Reflux, or Ebbing and Flowing, as well as others that are not leſs wonderful; foraſmuch, as the Cauſes thereof ſeem to be kept among the inſcrutable Secrets of the Creator; referring thoſe that deſire farther Informations, to the Opinion of the great Naturaliſts, ſome of which ſeem to carry along with them a great deal of Probability.

This is certain, that the Waters of the Sea, under the Moon, or nearly under it, do on both ſides of the Globe raiſe an exceeding great and convex Mountain, which daily ſurrounds the Earth. Now, that this cannot happen without diſturbing the Sea, even in its deepeſt Cavities and Abyſſes, is plain enough.

Mr. *Mariotte* has ſhewn (in his Book *Du Movement des Eaux*, p. 217, &c.) experimentally, that in running Waters, unleſs ſome particular Occaſion intervenes, the Water at or near the upper Superficies, runs much ſwifter than that in the middle, or at the bottom; for which reaſon, in great Depths of the Sea, notwithſtanding the Currents and Motions that may prevail at Top, it is credible, that the loweſt Waters are quite ſtill, or move but very little; ſo that the ſame having ſtagnated for ſo many Ages, might eaſily be corrupted.

Now,

Now, whether the Great Ruler does not likewise make use of those Motions and Tossing of the Waves, to preserve the Sea-Water from Corruption, even to the very Bottom of them, to keep the Fishes and other Creatures alive, and the Air it self pure and sweet, which might otherwise be infected thereby, we leave to the Judgment of the Learned: At least 'tis well enough known, how very useful the Flowing and Ebbing of the Sea is to Mariners, particularly, when they sail out or into their Havens, where otherwise there might be great Danger. You will see below, in *Contemplation* XXV. something more relating to this great Phænomenon.

SECT. LXXI. *Water bestowed in such great abundance, and for so many Ages* gratis, *to Living Creatures.*

BEFORE we quite leave this Subject, let us in the last place, beseech all unhappy Philosophers, seriously to consider, that this Water, which brings along with it so great and so many Advantages, is to be found in such great Plenty, and to be procured by those that want it, almost in all Places, for nothing. Cannot we see herein the Goodness of the Giver! And he that knows not how sufficiently to value the Benefit, let him only represent to himself the exceeding Trouble and Concern that all Men are in when they apprehend a Scarcity thereof, as it happens sometimes in besieged Towns, and to the Ship's Company in a long Voyage. But besides this, does not the Wisdom of a Divine Direction appear herein, that this Water is always abounding, and never fails, notwithstanding that we might justly fear, that considering all the Occasions whereby the Water

may be either lessen'd or corrupted, every Living Creature would perish with Thirst?

How many Years, yea Ages, has this Water been moved by the Winds? been rolled along hard Beds? dashed against Rocks? used in extinguishing Fire? served for Drink to so many Creatures? drawn up into the Clouds? fallen down into Rains, and, by reason of its Weight, driven violently down Walls, Houses, Mountains, Rocks, and other hard Bodies? been congealed into Ice, Hail and Snow? And finally been moved and handled in the roughest Manner by different Powers? And may not every one then, with great Probability, suppose, that the Water, after having undergone all that is abovemention'd, for so many thousand Years, should be worn out and have changed its Figure, or, which is the same thing, its Properties. So that any Body who knows how much all things are worn by a continual Use, by which they are certainly render'd less fit for Motion, could hardly be induced to believe, that one and the same Substance, after having withstood so many and so great Shocks, between five and six Thousand Years, should be able to preserve the same Figure. Notwithstanding which, we are taught by daily Experience, that the Waters of the Sea, of Rivers, and of Rains, have remained always unchanged, and preserved their Nature and Properties. Can we not then observe herein a Government, a Providence, not only surpassing all humane Power, but even all Opinions and Arguments? And is not the mighty Hand of a Great Preserver visible enough to all that will consider this without Prejudice?

Now if any Body should object against this, that Water, as well as all other Substances, does undergo an Attrition; but, that there is continually as much new Water produced by other Causes, as

that

hat which is worn away and otherwiſe waſted; et that wo'nt leſſen the Wonder, nor in the leaſt nervate this Proof: For if it be allowed, will here then be no want of a wiſe and powerful Di-ection to ſubſtitute continually an equal Quantity f Water, to that which is loſt by Attrition, and ithout which the whole Earth would fall into iſorder? And can any Body, upon ſuch an Hy-otheſis, pretend that it comes to paſs by Chance r ignorant Cauſes, that there is juſt as much Wa-r produced as was worn away, or conſumed, y the various Uſes thereof? Why then is not ere more produced than was loſt? And why are ot the Rivers, in ſo many thouſand Years, in-eaſed to ſuch a degree as to overflow the moſt art of the dry Land? Or, on the other Side, why not the Water diminiſhed? Why is not there ore corrupted or waſted than is produced? nd why are not the Seas, and all the Collections Waters, evaporated or dried up in ſo many ges? Moreover, in caſe the Particles of Water ere anywiſe Angular or Oval, why are they not come quite round, by a perpetual Attrition gainſt each other for ſo long a time, that being e laſt Figure aſſumed by moſt Bodies after the ttrition of their Angles? And if theſe Particles e globular, why are they not entirely crumbled Atoms by this inceſſant rubbing, and wearing, nd ſtriking againſt each other, or, as ſome Philoſo-ers fancy, turn thereby into the Subſtance of ire? At leaſt, if the Eſſence of Water conſiſts in determinate Figure of its Parts, how can ſuch an ttrition happen without any Change in its Pro-erties at the ſame time that the Figure thereof is hanged? And why is not Water, for theſe Rea-ons, repreſented to us now under a quite different appearance from what it was ſeveral Ages ago? f we now add to what has been already ſaid, and

if

if we conſider how much Water (according to th abovementioned Experiment of Mr. *Boyle*) can ar will be turned into Earth by a continual Diſtill tion cauſed by the Sun and the ſubterraneo Fires; how much is fixed and incorporated wit or converted into thouſands of Plants; how muc is uſed in the Compoſition of the Bodies and Hu mours of ſuch an infinite Number of Creature might we not with great Reaſon judge, that th continuing for thouſands of Years, and the gre number of things which are made up of Water a great meaſure, being likewiſe conſider'd, it mu have been long ſince exceedingly diminiſhed, it had not quite failed. Nevertheleſs, we ſee, th this Water remains in the Quantity that is nece ſary for all our Uſes.

Now let a Philoſopher, of what Sect ſoever h be, ſhew us, whether this can happen and cont nue unvariably (which alone is a Wonder) witl out the Direction of a ſuperiour Power and Wi dom: For if the Care of a ſupreme Director ev appear'd glaringly, it is certainly in this Caſe, which he will not ſuffer his Creatures to want wh is ſo neceſſary for their Preſervation. And wh does not he argue juſtly, who thinks that at ev ry Draught we take for extinguiſhing our Thir (which, whatever you pleaſe to call it, conſiſts or is derived moſtly from Water) that we a bound to return our Thanks to the Giver of th ſo wonderful, ſo agreeable, and ſo uſeful a Ble ſing, which he deals out with ſo much Wiſdo for the Preſervation of all that live; to ſay no thing of our own Impotence, as big as we appe in our own Eyes, who can't produce one ſingl drop of this Element. Let then the moſt preſum ptuous Atheiſt tell us how he, with all his imag nary Wiſdom, can prevent the entire Deſolatio of this Globe, and the certain and unavoidab

Deat

)eath of every thing that breathes: And in case
e finds himself unable to perform this small Mat-
r, can he still imagine that he is only beholden
) a meer and stupid Chance, to Causes ignorant
their own Effects, and operating without Know-
dge or Wisdom, not only for the Discovery,
it also for the bountiful Participation of this
ost unvaluable Present; and that those, as igno-
nt as they are, have been able to suppeditate a
leans of furnishing the World with Water?

If now the very Atheists themselves shall own
to be unreasonable to think thus of Matters,
in truth they must, if they pretend to maintain
eir Title to Wisdom, what need have we of
ore Arguments to confute them?

CONTEMPLATION XIX.

Of the EARTH.

SECT. I. *Transition to the* EARTH.

NOW, if after having contemplated the Air and the Water, we pass on to the EARTH, e cannot help affirming, that whosoever shall aintain that all the Qualities and Properties that e to be found therein, are to be only ascribed mere Chance, or ignorant Laws of Nature, erating without Design, must cleave to a won-rful kind of Philosophy, if he does not affirm e same against the Contradictions of his own onscience.

It

It is true, that the Earth, as such, and so lo as it remains in its natural State, cannot ser either for Meat or Drink to Men and Beasts; b however, that every thing living is supported a preserved by its Fruits, is plainly taught us Experience.

Sect. II. *The Earth produces Grass, Corn,* &c.

Let an Atheist, to fetch no Proofs from t Depth of Nature, cast his Eyes, *First*, upon th common Herb, that contemptible Grass wh springs so abundantly out of the Earth, and fe such a number of Cattle: And, *Secondly*, upon t various Kinds of Corn, whereby such Numb of Men are likewise nourished; and then let h consider with himself, whether it be by Cha that the first grows of its own accord out of t Earth in such an infinite number of places, a serves for Provision to the Cattle. And in c there were not such a Disposition in the Ear that it produces Grass in so vast a Quantity alm every where, without the least Labour, or wi out any Cultivation, what possible Means co have been invented for the nourishing and pre ving alive so many Millions of living Creatu which in themselves have not the least Fitness tilling and sowing the Earth?

Sect. III. *Beasts are Kitchens for the Grass.*

Furthermore, since he cannot deny n ther, that tho' the whole World were full of Gr yet all Mankind might perish with Hunger, si sad Experience has frequently taught us, in b ren Years, that no body can live of Grass; v he again say, that this is likewise accidental, a without a wise Direction, that the Earth is adap

) produce Corn and other things, which ſerve Mankind for Food? And ſince Graſs of it ſelf ; not fit for that purpoſe, that by being eaten of eaſts, it ſhould be changed into their own Subance, and ſo become uſeful not only for Food, ut even for Dainties too: Inſomuch, that we may ook upon Oxen, Sheep and all other Creatures, that e taken by Men for Food, as ſo many living and alking Kitchens, in which is prepared the otherife unprofitable Graſs, which thereby becomes ood, wholſome, and palatable Food.

Sect. IV. *Convictions from the foregoing Obſervations.*

And whereas the greateſt Philoſopher, with all s Wiſdom, cannot produce one ſingle Grain of Wheat, or the ſmalleſt Leaf of Graſs out of the arth, nor even inform us with Truth, how they row and ſubſiſt, and much leſs, what is the Cauſe at Graſs ſerves for Food to the Cattle, and yet n nouriſh no Man before it becomes Milk or eſh by the Changes it undergoes in their Bodies; an he then perſiſt in ſuch an Opinion, that it is ithout any Deſign, or Knowledge, of a Providenal Being, that there is this analogy found in Beaſts d Graſs, in Men and Corn, by which both are pported; and that it is one and the ſame Earth hich produces them both?

If this can be maintained, I don't ſee why one ay not ſay, with as great an Appearance of Reaon, that a Lock and the Key that is made and dapted to it, are both of them produced by the me Iron, without Underſtanding and without Deſign.

Let thoſe that would make uſe of ſuch Evaſions, nſider only how many other ſorts of Herbs daily me out of the Earth; and ſince there are pro-

duced Thorns and Thiſtles (to ſay nothing of Poi ſonous Herbs) as well as Fodder for Beaſts, and Bread for Men; let him ſhew us the leaſt reaſon why the firſt, namely Graſs, grows almoſt every where without any Trouble even in the moſt ſo litary Wilderneſſes, where it feeds Harts and Hinds, and other Graſs-eating Creatures, in grea abundance; whereas, on the contrary, to produc Corn and humane Food from the Earth, there i required ſo much Plowing, Harrowing, Sowing Weeding, Mowing, and ſo much other painfu Toiling?

This has frequently put me in mind of the Ac compliſhment of that Threat which GOD pro nounced to Man, at the Beginning of the World *Gen.* iij. 17, 18, 19. *Unto Adam he ſaid, becauſe tho haſt hearken'd unto the Voice of thy Wife, and haſt eate of the Tree of which I commanded thee, ſaying, Tho ſhalt not eat of it: Curſed is the Ground for thy ſake in ſorrow ſhalt thou eat of it all the days of thy lif Thorns alſo and Thiſtles ſhall it bring forth to thee: an thou ſhall eat the Herb of the Field. In the ſweat of t Face ſhalt thou eat Bread till thou return unto the Groun for out of it waſt thou taken; for duſt thou art, and un duſt ſhalt thou return.* Now all this is true by ſa Experience; by which we are taught how muc Pains are required to clear the Ground fro Thorns and Thiſtles, that it may be fitted for th Support of Mankind.

SECT. V. *Different Productions and Powers fro the ſame Earth.*

STRONGER Demonſtrations of a wiſe an gracious GOD, no Man can juſtly require, tha that which the Earth may teach every one wh Contemplates the Properties thereof. Nor

here any deep Philoſophy neceſſary for ſuch Con-
ictions.

Bring a Man only into Meadows where the
Graſs ſprings out of the Earth for the Cattle; or
nto plowed Lands, where the Corn grows for
Mankind; into Gardens, where one ſees ſuch noble
nd refreſhing Fruits; into Woods, where one
nds innumerable Trees which furniſh Materials
or Building; into a Kitchen and Phyſick Garden,
here are a number of Plants and Herbs, ſome of
hich ſerve for Food, others for Medicines in the
)iſorders and Diſtempers of our Bodies, and for
ther Uſes; into Flower-Gardens, where there
ppears an infinite Quantity of the moſt charming
olours and Smells of various Powers and Effects.
hen ask him, Whether he or any Body elſe, ever
nderſtood the Manner in which all this is pro-
uced in the Earth; and whether thoſe can be
ought to argue ſo improperly, who maintain that
l this ſeems to them one continual Miracle and
)emonſtration of a terrible, but no leſs bountiful
GOD, who, from one and the ſame Earth, is able
produce ſuch an unconceivable Variety of Plants.
et them freely maintain, purſuant to late Diſco-
eries and Experiments, that there are Seeds,
ants and Stamina in all Seeds and Buds, which
e expanded and augmented by additional Juices:
ut how will he be able to deduce the Diver-
y of Powers from the ſame Earth, after ſuch
manner as may give entire Satisfaction to the
earned?

SECT.

Sect. VI. *Convictions from the foregoing Observations.*

Now if there should be shewn to one of the unhappy Philosophers, who had never seen an Earth, a piece of black and uncomely Matter would he not, upon contemplating all the before mention'd Operations and Effects, take it for one of the most wonderful things in the World? And further, if some Body that were the only Possessor of this Earth, should declare, that he had the disposed it by his Wisdom, and would generously present him with a small Parcel thereof, would he not reckon this noble Gift among his most valuable Rarities, and shew it to other curious Persons as a very precious thing? And if it should so happen, that one of those to whom he should shew it, should say, that he did not think the Person that had prepared it, to be wise or knowing; and that altho' he had made such a Mixture, it could not be ascribed to his Skill or Judgment, but only by mere Chance, or some other ignorant Cause; would not even this Philosopher declare, that great Wrong and Injustice was done to the Maker of such a prolifick Matter; and that from the Aptitude and Property which this Earth has to produce so great a diversity of Plants, an irrefragable Proof may be drawn, that he who invented and compounded such a Mixture, must have had not only a particular Knowledge thereof, but likewise of all the Herbs and Plants which such a Matter produced; and consequently must be wiser than Thousands of other Men, who, how learned soever they may be, if once the Earth should fail, could never inform us whereof it properly consisted, and wherein lay its Power or Faculty to produce all Sorts of Plants.

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Let a deplorable Atheist himself make the further Application to what has been said: And forasmuch as he will find that this Earth is disposed in so great an abundance, and for the service of all Men throughout the whole inhabitable World; far from being any Want or Defect thereof, this noble miraculous Matter is trod under foot by Men and Beasts, and serves for Ways to Travellers: And whereas we should have acknowledged an unconceivable Wisdom in the Preparation and Disposition thereof, if there had been but a very small Quantity of it in the World; shall we now doubt of the Wisdom and Goodness of the Great Creator, only because he has been so bountiful and liberal thereof, and has communicated this wonderful Gift in so great an abundance to Mankind.

To say a little more upon the same Subject: Whereas every one would stand amaz'd if he had seen but one Tulip, one Rose, or one Lilly only growing out of such contemptible Matter as the Earth appears to be, and could never be tired in raising the Wisdom of Him who had found out the way of producing those noble Flowers; shall we therefore now be more backward in acknowledging the Great Creator in his Perfections, because instead of disclosing to us one Wonder in one Plant, we daily discover a thousand Wonders in as many Plants.

I have often consider'd with wonder, the Obdurateness and Insensibility to which the Custom of continually enjoying a thing is able to bring Men's minds; that can make an unhappy Atheist believe, that such innumerable Trees, innumerable Flowers, and innumerable Plants are produced by meer Chance, at least without Wisdom; whereas he must own, even against his Will, that the Man who could but find out the way of making one only Julyflower or Tulip spring out of its Onion

or Bulb, and the Structure of it, was endow'
with a wonderful Understanding, and great In
sight in the Laws of Nature.

I leave it now to their own selves, whethe
such a Behaviour can be called reasonable; an
beg them, in order to be in some measure affecte
herewith, that they would contemplate the Eart
and its Productions, not slightly and after the usua
manner, but single out any Herb, Flower, c
Tree; and then taking in their Hands some of tha
Earth in which they grew, compare it with th
said Herb, Flower, or Tree; and finally fixi
their Thoughts upon one of those particular O
jects, ask themselves, how many thousand sever
kinds of Plants spring out of the said Earth? an
I don't think, at least I don't hope, that they wi
consider it otherwise than as an unconceivab
Wonder of Wisdom. And since neither they, n
any one whom they know, can produce one sing
Clod of Earth no bigger than a Man's Fist, wi
all their Skill, and that if this Earth were not b
stow'd on them with a bountiful Hand for their us
all things living would perish with Hunger, oug
not this Favour of the great Benefactor to stir the
up to Thankfulness? What then is able to do i
Certainly, if it had not been a gracious and powe
ful God that made this World with a wise Desig
and who still preserves it in so proper a State, wh
does not this Globe of Earth consist in all i
Parts, as well as in some, of barren Sands a
Rocks? And why are Men and Beasts (as h
been formerly observ'd) of just such a Structur
as to be fed and preserv'd by the Produce of t
Earth, and hardly by any other thing besides?
a Man be to be convinced, one would think it i
possible for him to contemplate all these thin
without seeing the Folly and Unreasonableness
Atheism.

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SECT. VII. *Earth is never consumed, nor becomes entirely barren.*

WHEREAS now this Earth feeds every Creature, such as Men in all Places; the Cattle in Meadows and Stalls; the Wild Beasts in Woods and Deserts; Birds, Fishes; all sorts of Insects and creeping Creatures, such as Worms, Catterpillars, Flyes, *&c.*; in a word, every thing that has Life; for altho' some of them may make use of others for their Food, yet those that serve for Food to others, are themselves nourished by the Fruits of the Earth. Moreover, whereas this Earth does daily bring forth from its Bowels an infinite number of Herbs, Flowers, Plants, Shrubs, and Trees, for such various Purposes, and has done the same for so many thousand Years; can any one without Astonishment reflect, that since so much Earth has been made use of to the said Purposes for so many Ages, yet in so great a Series of Time it has never failed, nor entirely lost its Fœcundity? For that otherwise the Fruitfulness of the Earth is lessen'd by the continual Use of it, is well known to those who have seen the same come to pass in Land frequently sown, more often than they are willing.

SECT. VIII. *An Experiment to shew, that Air makes the Earth fruitful.*

ASK now these Philosophers, so wise in their own Conceit, how they pretend to avoid these Mischiefs, which seem impossible to be obviated; and so to preserve themselves and all other Creatures from certain Death? And tho' some of these should acknowledge on any other account, yet; can he think that it happens without Wisdom and a de-

a determinate Purpose, that the Earth, which having lost its Fœcundity by too long an use, is rained upon from the Clouds, and by being only turned up several times, and exposed to the influence of the Air, recovers the said Fœcundity again? What is otherwise laying the Land fallow, than turning frequently the Parts of it upside down, and so affording an occasion to the Air to fructifie the same? Now, whether this happens by the means of a Nitrous Salt, which is so much extolled by all the Gardeners on account of its Fertilizing Powers and which is produced in the Earth by the Air we shall not here dispute: But the matter of Fact has been experienced by me several Years ago namely, that the barren Earth of a Garden, that had been long sowed, lying fallow for a Year and having been frequently broke into small Pieces caused the Seed with which it was sown the following Year, to grow very thick and strong, without using Dung or any thing else to it, that we might be most certain of the Tryal.

Sect. IX. *Convictions from thence.*

Now if a Man would but only consider these Methods of fertilizing the Ground, and afterward earnestly weigh the following Particulars: *First*, That Air and Rain have the necessary Faculties of being subservient to this Purpose. *Secondly*, That this is frequently performed by both of them, without the Concurrence of any human Labour or Pains. *Thirdly*, That hereby the Earth in Woods and Deserts, remains in a Condition, tho' uncultivated, to supply the wild Beasts feeding therein with sufficient Fodder: I say, after having understood all this, can he accuse another of Stupidity for humbly acknowledging the Goodness of the Great Preserver and Provider of all Creatures

because he will not suppose, (without Reason, as he himself does) that all this comes to pass by Chance, and that no Wisdom has been here used, or need to have been, to impart to the Air, to the Rain, to the Earth, to the Beasts, all the requisite and particular Qualities, by a particular renewed Fertility of the one, to afford a constant Support to the other?

SECT. X. *It should seem as if the Earth would be render'd Loathsome, by Filth and Nastiness.*

IF all this be not sufficient to make a deplorable Atheist observe the Finger of GOD; let him tell us himself, whether he could have order'd the Structure of the Earth and of the things that are produced from it, with greater Wisdom than that which he now sees, at least he cannot deny but that,

I. ALL Plants, Men, and Beasts, proceed from the Earth: The first is plain in it self; and to prove it of the last, are not all living Creatures formed of the Fluids or Juices of those that procreate them, or at least expanded and rolled out to their respective Magnitudes? Do not these Juices proceed from their Food? the Food from Herbs and Plants? and these from the Earth? So that a continual Experience teaches us the same. Even Creatures that stand in need of Cloaths and Covering, receive it only from the Earth; the Wooll of Sheep, the Skins of Beasts, Flax, the Leaves and Barks of Trees, do all proceed from the Earth.

II. THAT nothing is everlasting; and that every thing living undergoes a kind of Death, and thereby is abandon'd to Stench and Corruption, is no less certain than the foregoing. So that every

thing, when it has served the Purposes for which it was made, seems to be nothing more afterward but an useless and loathsome Balast of the World and fit to render the most agreeable Places (where Numbers of Men and Beasts do reside) deserted and uninhabitable by the Stench of so many dead Bodies and Carkasses.

III. THAT (to speak only of living Creatures) all the Meat with which they are fed, is converted in their Bowels to a loathsome Dung and Excrement, can be denied by no Body. Now if all that has ever been thus discharged by so many living Creatures as have been upon the Earth in so many Ages, should so remain in its disagreeable Form and Qualities, without any Change; must it not be confessed, that it would have been sufficient to render the whole Earth, and the Air surrounding it, exceeding nauseous and loathsome to the Inhabitants?

IV. ADD hereto, that so many Millions of Men and Beasts, that do only consist of the Productions of the Earth, have been so many Ages in the World, that it would not have been possible, without the intervening Care of a superior Wisdom, but that the fruitful Earth would have been very much diminished and consumed: So that altho' this Globe had no Destruction to apprehend otherwise, yet every thing that lived upon it would finally perish by the failure of the Earth's Fertility, and consequently of Food.

SECT.

SECT. XI. *This Loathsomeness prevented, and Convictions from thence.*

ASK now an Atheist, whether he could sufficiently praise the Wisdom of such a one as had found out a Method to prevent all these nauseous and loathsome Inconveniences? And if he himself could have done it, or could have taught Mankind the way whereby all corrupted Plants, all the Carkasses of Men and Beasts, in a Word, all other putrified Bodies could be converted to a most profitable Matter, and to a most fruitful Earth, and even to such a one as should be capable of restoring Lands that were quite worn out and spent, to their former Fertility: I say, if he himself could have found out such a Way, would he not think that he had laid a perpetual Obligation upon all Mankind?

Now this is what we daily see come to pass, and that without any Pains and Trouble on our part.

SECT. XII. *The Circulation of almost all things from Earth to Earth; and Convictions from thence.*

CAN it be then thought that such ingeniously contrived Bodies of Men, of Beasts, and of Plants, proceed all from the Earth, without the Concurrence of a great Director? and having appeared in such Forms, after a little while are turned to Earth again; which brings forth more, that are likewise to undergo the same Fate. And can an Atheist be so void of all Reason, as to conceive, that such a wonderful Circulation and Revolution of Things, during so many Ages, can come to pass without a wise Direction? Whereas, if he were required to perform the least thing analogous thereto by his

Wisdom, he would be forced to confess, that his Understanding did not extend near so far.

Sect. XIII. *Several Texts of Scripture proving the same, and Convictions from the whole.*

The Wisdom of the Almighty in his Holy Word has often plainly occurr'd to me, in which this unconceivable Circulation of Things, from Earth to Earth again, is mention'd with great Energy. We shall not now speak of the first Production of all Things, according to which, Grass, Herbs and Trees, *Gen.* i. 11, 12. Living Creatures, *ver.* 24, 25. and *Gen.* ii. 7. Man was formed from the Earth: Since this was done in a particular and unintelligible manner; but only observ from thence, that an Infidel has not so much reason to look upon any thing mention'd in this Chapter as impossible, forasmuch as we are taught by Experience, even now, that all these things come out of the Earth; and that what we daily see with our Eyes, does at most, only differ in the Manner from what is there related by *Moses*.

Now it is very credible, that an Atheist, by whom the Manner how this was brought to pass has never been comprehended, would not make less Difficulty in admitting, that all these things proceeded from Earth, now at this time, if any one assured him of the Truth of it, than he does that it was so in the beginning, upon the Words of *Moses*. From whence certainly appears with how little Ground these unhappy Men contradict Divine Revelation, only because that they don't understand it. And this their Blindness is so much the more to be pitied, forasmuch, as if they only attended to modern Experience, they would necessarily be of another Opinion, and acknowledge that there daily happens before their Eyes some thing

hing analogous to that which their Creator aſ-ured them of in the foregoing Text of *Geneſis*, but vhich they would not believe upon his Word.

To illuſtrate the foregoing by other very plain Texts; Could *Solomon* ſpeak otherwiſe than he does, bout the Production of all things from Earth, and heir Return to the ſame, in *Eccleſ.* iij. 20? *All go in-o one place; all are of Duſt, and all return to Duſt gain.* And in Chap. xij. 7. in the following Vords; *Then ſhall the Duſt return to Earth, as it was:* vhere he calls Human Bodies (becauſe they pro-eed from Earth, and after Death are turned into it gain) even by the name of Duſt. At the ſame ime acknowledging, that that which the great ehovah had ſaid to the firſt Man, *Gen.* iij. 19. *Till hou return unto the Ground; for out of it waſt thou aken; for Duſt thou art, and unto Duſt ſhalt thou re-urn*, appeared even in his time, to a diligent Ob-erver, to remain in the full force of Truth. So kewiſe the the Compoſer of the 104th Pſalm, ounting this among the Wonders of the moſt ligh, in *ver.* 29 where ſpeaking of Men, Beaſts nd Fiſhes, he ſays, *Thou hideſt thy Face, they are roubled; thou takeſt away their Breath, they dye, and re-urn to their Duſt. Thou ſendeſt forth thy Spirit, they re created; and thou reneweſt the Face of the Earth.* everal other Places might be here quoted from the oly Scriptures, in which mention is made of Things being turned to Earth, which we ſhall now aſs by; only adding this brief Remark, that the reat Inſpirer of this Word does not only point at he returning to Earth, but even to Dung alſo. Thus it is ſaid in *Jeremiah* xvj. 4. and xxv. and xxiij. of ſlain Men; and on Chap. viij. ver. 2. even of their Bones too; *that they ſhould be for Dung upon the Face of the Earth.* And again, in *Iſaiah*, Chap. li. ver. 12. *Who art thou, that thou ſhouldeſt be afraid*

afraid of a Man that shall die, and of the Son of Ma which shall be made as Grass.

Sect. XIV. *An Experiment about Distilled Eart*

Now as wonderful as the Matter of Earth h been shewn to be, yet it has been but very sligh ly examined in the preceding Ages; and tho' this last Age the Science of Nature has been mo promoted than in several of the former, yet t knowledge of the true Properties of the fruitf Earth does still remain very obscure. Now, th in so learned an Age the Enquiry into Natu should be wholly neglected, is not to be suppose for which reason, perhaps, the Difficulty of sayi any thing concerning it upon sure Grounds, ma be the Cause that so little is written about it.

To say something of its common Origin: Th the Earth can be produced from Water, has bee shewn before, when we treated of the Latter; an it appears from *Boyle*'s Experiment, how Wat by a continual Distillation, is turned into a ce tain Earth. But to say something particularly abo Fruitful Earth; many Plants (as has been mor largely shewn in the foregoing *Contemplation*, §. IV. grow out of Water, which Plants, being corrupted o rotten, yield a fruitful Earth; in a word, this is con firmed by daily Experience, namely, that all Beast and Plants may be converted into a Fruitful Earth

We shall forbear to deduce any general Hypo thesis from hence; since we have not yet mad sufficient Discoveries upon which to found an certain Opinion; and we are not ashamed t own, with many others, that we do not fully know from whence and how Earth is produced And that the Modern Experiments, tho' they show us many things, are not yet capable of imparting to us the right Knowledge of all that ought to be comprehended upon this Subject. Now,

Now, since the Nature itself of the Fruitful Earth seems to have been but little enquired into as yet, I procured from an accurate Florist, one sort of such an Earth (for that there are several is plain from Experience:) this Earth was composed of Cow and Horse Dung, mingled with Sand, and had been cleared from Stones by sifting: I distilled it in a Glass Retort, and found that it yielded a Liquor, which being mingled with the Acid Spirit of Nitre, boiled up, or effervesced, to use a Chymical Word, the Quantity of this Spirit was in Proportion to that of the Earth; there likewise proceeded from it a dark stinking Oil.

Thus we also find, that rotten Plants and Herbs (among which this Dung must be reckon'd, since it proceeded from Grass, which is the Food of Cows and Horses) yields a *Sal Volatile*, and the like kind of Oil, as is well known to those that deal in Chymistry.

Now how this Property of the Earth can contribute to the Production of all Plants, and to the farther Fertility of the Earth, I shall not enquire here; since these Discoveries are more proper to carry us on to others, than to the concluding any thing that affords the requisite Certainty.

SECT. XV. *The Earth produces Instruments fit to be apply'd for the rendering itself more useful.*

AND that a Sceptical Mind may be more powerfully convinced of the Wisdom and Goodness of Him that formed the Earth; Let him consider with himself, how a Man that must live by the Earth, is born unfit and unable to Cultivate the same without any Instruments. Can he then see no Design of his Creator therein? That this same Earth is not only disposed to produce

Wood,

Wood, but likewise Iron, of which Plows a other Tools proper for Tillage are compos Now it was impossible without Fire to extra this Metal from the Matter with which it is m ed in the Mines, as it is well known to the M neralists: So that tho' a Man were sufficiently p vided with Earth, Wood and unwrought Iron, y he would still want that which was necessary render those things useful to him. But now aga continual Experience has taught all Men, that t same Earth does likewise furnish the necessary M terials of Fire, for making those things that a wanted; and that Wood, Coals, Turf, and t like, are of its Production; by which not or Iron is separated and purified from the forei Matters that cleave to it, and is converted in the Instruments for Plowing and other Uses; b moreover, that the raw Fruits, which are likew produced by the Earth, are ripen'd and digest by the Fire, and so render'd fit for Food.

Sect. XVI. *Of Alchymists, and an Explanation of t Texts in* Exod. xxxii. 20. *and* Deut. ix. 21. *about Gol*

Now, since we have here made mention of Iro so far as it relates to cultivating the Earth; the would have been a large Field to treat more m nutely concerning the same, and other Metals a Minerals, such as Lead, Tin, Copper, Silve Gold, and Precious Stones, which are all t Fruits and Productions of the Earth: But I sha only make these two Remarks *en passant* abo Gold. *First*, How many Alchymists (to be piti for their Folly, if not despised for their mistak Avarice) were found in the last Century, who le nothing unattempted to make Gold from oth and cheaper Matter. Innumerable Things we tried by innumerable Methods, to compass th

End

nd; not only by great and eminent Persons, but
y those of a middling and smaller Understanding;
it all in vain hitherto: And the only Fruit that
to be reaped thereby, has been, that from hence
strong Proof may be fetched to convince those
nceited Philosophers, who imagine they under-
nd every thing, of the defect of their Judgments;
d that something has place in Nature, concern-
g the Production of things, which far surpasses
eir Wisdom. *Secondly*, What I find my self
bliged to insert here, is an Answer to the Objecti-
s which many Unbelievers have brought against
e Authority of the Books of *Moses*. We read in
xodus xxxii. 20. *that Moses took the Calf which they*
he Israelites) *had made, and burnt it in the Fire,*
d ground it to Powder. The same Story is ex-
essed in *Deut.* xi. 21. in these Words; *I took your*
n, the Calf which you had made, and burnt it with Fire,
d stamped it, and ground it very small, even until it
s as small as Dust. And here our Adversaries
ink they have discover'd a great Argument
ainst the Divinity of this Holy Word; forasmuch as all the Experiments that have been made
on Gold, even by keeping it whole Months in
r strong Fires, have always hitherto taught us,
at it can only be Melted, and not Burnt in such
anner as to be beaten to Dust: Wherefore, ac-
rding to them, this burning and afterwards
inding to Dust, seems to be entirely contrary to
e Nature of Gold. Now not to return for An-
ver what has been already said by many very
arned Expositors, in order to remove this Difli-
lty, and whom they, who are curious, may con-
lt; I shall only add,

First, That altho' Gold in itself, and alone, is
combustible, and seems uncapable of being re-
ced by our Fire to such a Condition as to be
ampt to Dust; yet it may be done by the Addi-

tion

tion of some othe Matter, as Chymists know ve ry well; and so do they particularly, that make co lour'd Glass and Counterfeit Jewels, which, b mixing Gold with them, acquire the colour Rubies, and which, together with the said mixe Gold, can be beaten to Powder. Now it is no said in that Text, that *Moses* used no addition Matter to bring the Gold to such a State; so tha for this reason their Argument will not pass.

Secondly, This Argument is not conclusive; *No body knows how Gold can be burnt, therefore Gold can not be burnt*; For if this be good Logick, they mu proceed and say farther; *No body knows how Gold ca be produced, therefore Gold cannot be produced*; whic Experience teaches us to be false.

But, *Thirdly*, to convince these miserable Seeke of Objections beyond a Reply, that it is by n means inconsistent with the Nature of Gold t be thus burnt by Fire, as also that it can be beate to Dust without any Mixture or Addition, w need only refer them to the Experiments performe by great Burning-Glasses, some few Years ago.

Sect. XVII. *Gold may be burnt and reduced to Du*

This, in the *History of the Royal* French *Academ* 1699. *p.* 113. we find this Observation mention among those of Mr. *Tschirnhaus*, the Inventer of th said Burning-Glasses; That all Metals being place in the Focus of the Burning-Glass, will run int Glass; and that Gold in its Vitrification, assume a fine Purple Colour.

But very nice and accurate are the Observatio which Mr. *Hombergh* made upon Gold in the pu Fire of the Sun, in the Year 1702. *p.* 186. an 1707. *p.* 50. as it is largely related in the Memoi of the said Academy; where, after having acknow ledged that Gold is not diminished in our cor

ion Fires, it is shewn, that by such a Collection of he Rays of the Sun in a Focus, or very near it, Gold is evaporated and turned partly into Fumes, nd partly into Glass; which, as the Author himelf expresses it, *p.* 189, 190. *is a real Conversion of his heavy Metal into a lighter Glass.* At the end of he Memoir we find these Expressions; *and thus e see by these Observations, that the Idea we had formed to our selves in Chymistry, of the Fixity or Fastness f Gold, cannot obtain any longer.*

Now I ask those who have hitherto made this Text of Scripture a Foundation of their Infidelity, whether they must not confess, that their Arguments are quite defeated, after the making of this Experiment; and that Gold is really burnt when t is partly evaporated, and partly changed into Glass: At least, it is a Chymical Truth, that Evaporation and Vitrification is the only thing hat can be unsterstood by *Burning*, if we take that word in its utmost Force. Besides, that hereby Gold, which does not otherwise easily appear apable of being made small by any Beating or Grinding (tho' in the last Age a famous Chymist as shewn us, that it may be done by a Mill made n purpose) is brought into such a Condition, that fter its Vitrification it may be ground to Dust. o that we here see all the Circumstances required by the Text, come to pass in the Business of Gold.

I do not say that that Man of God, *Moses*, did n this Case make use of such a Burning-Glass, ince the first mention of those Instruments is made by *Aristophanes* (*see the History of the Royal Academy f Sciences*, 1708;) but they were very imperfect, and ike round Balls. It would have been sufficient, if he had the Knowledge of any such Fires as were o Pure and Strong as these Rays of the Sun thus collected. But that which is properly before us here, is, that from this Experiment it is plainly and

unde-

undeniably shewn, that what has been said abo the Burning of Gold, is possible: And as has be shewn above, *Moses* might have made use of t same or other kind of Mixtures, which the sa Text does not exclude.

Sect. XVIII. *About Precious Stones.*

From Metals it seems as if we ought to pa to the Consideration of Precious Stones; which they be not beholden to the Earth for their Origi at least almost all of 'em are found in and abo the same. Those who acknowledge the Grea ness of an All-creating God, may in this la Instance remark how gracious and bountiful l has been to Mankind, by taking care even for O naments likewise, and by producing out of th Earth, Creatures of so noble a Lustre for th Purpose; by rendring them so far wonderfu that some, and the Chief of 'em, do excell in Firm ness and Incorruptibility, every thing that is y known, whilst in the mean time their particul Structure has remained a Secret to us for so man Ages.

One of the Properties of Diamonds, till the unknown, has been discover'd by Mr. *Boyle*, an since taken notice of in the *French Academy*, 170 *p.* 1. namely, that a polish'd Diamond being rubb' against a Glass, will, in a dark Place, produce Light as clear as that of a Burning Coal whe strongly blown.

Sect. XIX. *Atheistical Objections answer'd.*

I Find my self oblig'd to say something o the other *Stones*, tho' less valuable; not that am able to demonstrate the wonderful Ends of th Creator in them, but only to obviate an Argumen which

which the Atheists raise against the Use of so many Rocks and other kinds of Stones, which seem to them entirely unnecessary.

They think they have here met wth something which does as it were favour their unhappy Notions; to wit, that if there be a God who has made all things with Wisdom and Goodness, to what purpose then has he made so many useless Flints, so many Rocks and Stones that seem to be good for nothing?

But will these miserable Philosophers, some of whom are otherwise Men of good Sense, pretend to offer such an Argument, that because the Use of those Stones is hitherto unknown to them, therefore they have none, nor yield any Service to the Creation?

To be convinc'd of the Vanity of such an Argument, let them only go into the Shop of any Artificer, and view the numerous Tools he uses in his Trade, most of which seem to be useless, because they don't understand the Design and End of the Workman; but when they behold the Works produced thereby, they cannot forbear wondering at the Skill by which the said Tools are adapted to the Service they perform. Now if they observe some things upon this great Theatre of the Earth, the Use of which is unknown to them, can they indolently go on in denying the Wisdom of him who made them, and still maintain that there is no Service in them? Especially, since following Discoveries have frequently shown, that things which were thought to be of no kind of use, have eminently contributed to render Mankind very happy. It was but a little while ago, that such a Philosopher advanced, that Hills and Mountains were not only useless, but prejudicial to our Globe; whereas, if he had receiv'd the Observations and juster Conclusions of wiser Men, he

muſt have been convinc'd, that in many places th Earth would not have been habitable at all but b the help of Mountains, becauſe without them th Country would have been burnt up with Heat, an all the living Creatures ſuffocated with thirſt. An let ſuch a Man tell us, whether there be not mor Wiſdom ſhown in making a hard Stony Bed for rapid River, and Rocks to bafflle the Rage of th Sea, and to ſupply Iſlands for the advantage Navigators, than in the moſt fruitful Gardens Meadows?

Sect. XX. *Concerning the Loadſtone.*

He who had never ſeen a Loadſtone befor would according to the *Philoſophy of Ignorance* (ſc thus we ought to ſtile the Philoſophy of tho Men, who, becauſe they cannot diſcover the U of any thing, do therefore preſently conclude th it is uſeleſs) think that this Stone is one of th moſt uſeleſs things that God has created; to ſa nothing of the contemptible Appearance of it.

But in caſe he were afterwards informed, tha this Stone had not only the Property of attractin Iron itſelf, and of rendring that Iron capable t draw other Iron to it; (and this it does in ſuch manner, as even in the preſent Age, after ſo ma ny Obſervations, with which whole Books ar filled, is confeſſed to be ſtill unknown by all tru and unbyaſſed Philoſophers:) Could he then fo bear to look upon this deſpicable Stone, as wo derful?

But in caſe one ſhould diſcloſe to him afterward thoſe Properties thereof, by which it makes Needle point to the Northern Parts of the World and by that Means chalks out a Path in the mid of the Sea for Ships, inſomuch, that without none durſt venture to launch out into the grea Ocean

Ocean, and all Communication between those Parts of the World, that are so remote from one another, would be entirely interrupted: Would he not then, when he saw the Merchandize and Product of other Countries, which are attainable by the help of this Stone, pronounce it to be one of the most useful things in the World, and own himself, with the utmost Gratitude, obliged to receive it as a most valuable Present from a generous Benefactor?

SECT. XXI. *When the Virtue of the Loadstone was discover'd.*

BUT lastly, when he adds to all this, that the Power of attracting Iron was long ago known to the Ancients, whereas that of finding out the North, and of serving for a Compass to Mariners was concealed from them; and that upon this Occasion not only Christians in general, but among them, likewise great Mathematicians have observ'd that which is noted by *Deschales*, in the Preface of his Mathematical World, namely, that about 500 Years ago, *it pleased the great* GOD *to reveal the use of the Loadstone, when he had decreed, according to his Divine Providence with respect to Mankind, to reveal his Service and his Son to those Nations that were separated from us by the whole space of the Ocean.* Will he judge that the Sentiments of those Persons are so groundless, who acknowledge in this Stone and the Use thereof, the Wisdom of GOD, and his wonderful Direction and Rule over all things, in the time of the Discovery of the Properties thereof.

Sect. XXII. *The Roundness of the Earth.*

If we now pass on from the Matter of th Earth to the Structure of the Globe itself, as i consists of inhabitable Land and Water, could an Body that surveys with his Eyes the appearin Plane and Flatness thereof, have ever admitted into his Thoughts, that the same is Round? An not much rather, by what he might conclude fro the Motion of heavy Bodies downwards, affirn with many of the most Learned of the Ancient that it is impossible to ascribe a Globular Figu thereto? Forasmuch as those things that are und us, if they exerted their Gravity after the sam manner, and according to the same way, wou seem to have no Support, but must fall into t Air, which is below them. Whereas, neverthele modern Experience teaches us, that the great Wisdom cou'd have contriv'd no Figure than th of a Spherical or exactly Round, in order to ma of so small a place, so great and noble a Thea of numberless Wonders. And can any one th satisfie himself with the bare Assertion, that t Globe of the Earth has acquired such a Figure Chance, or at least without any Understanding?

What various Opinions have there been c cerning its Shape in former Ages? With respect Astronomical Observations, by the Roundnes its Shadow upon the eclipsed Moon, and by Remarks, that upon the Sea, the Masts of Ship are seen before the Ships themselves; that the Ships may be seen by standing upon Eminency, beyond the interposing Convexity the Earth, which could not otherwise be s This render'd the Globular Figure of the Ea very probable, till the same was afterwards far pro

proved and confirmed experimentally, by several Voyages round the whole Earth.

If People in those dark Times had not so much relied upon their Understanding and Argumentations as many do at present, and if they would have given Credit to what the Great Creator of the Earth has said himself concerning it, they would have long since been satisfied of the true Form of the Earth: *See Isaiah* xl. 22. *It is he that sitteth upon the Circle of the Earth.* Can any thing more plainly express the Globular Figure of the Earth?

Sect. XXIII. *The Earth is a flattish Bowl.*

Since we are now speaking of the Figure of the Earth, I cannot well pass by that Text of *Jeremiah* vi. 22. *Thus saith the Lord, behold, a People cometh from the North Country, and a great Nation shall be raised out of the side of the Earth:* Which words do likewise occur in the said Prophet, *Ch.* xxxi. 8. and *Ch.* l. 41. according to which the *North* is stiled the *Sides of the Earth.*

Now by the Sides of any thing, for Instance of a Plank, of a Beam, of a Ship, of a Man, or Beast, *&c.* we are wont to understand those Parts of the Circumference thereof, between which the Bodies themselves are Smallest or Thinnest, or otherwise between which the shortest Diameter thereof lyes.

Wherefore, if we suppose that the Earth is not perfectly globular, but that the Axis of it, or a Line drawn from the Northern to the Southern Pole, is shorter than a Diameter at the Equator; and that all the Diameters of the Earth are longer as you approach the Equator, and shorter as you go towards the Poles, the North

and South Parts may be deemed both the *Sides* of *the Earth.*

Now 'tis well enough known to those that have look'd into the latest Observations of the accurate Moderns, that tho' they are wont to term the Earth a Spherical Body, without having any regard to the Inequalities that may be occasion'd therein by Mountains and Vales, yet it is not perfectly globular, but has a greater Protuberancy under the Equator, and grows continually lower or flatter towards the Poles.

Upon the Observation, that the Pendulum of a Clock at *Caienne*, near the Equator, must be $1\frac{1}{4}$ of a Line, or of $\frac{1}{72}$ of an Inch shorter, to strike exactly a Second, than it was necessary to be at *Paris*, Mr. *Huygens*, *in his Treatise of Gravity*, asserts, that the Earth is flatter at the Poles.

In Sir *Isaac Newton's Princip. Philos. Prop.* XIX. *Lib.* 3. we see the same; as likewise in Dr. *Gregory's Astron. p.* 56, and 268. and in Mr. *Whiston's Prælect. Phis. Mathem. Prop.* XCIII. *Corol.* 2. we find these Words, besides what is said in other Places thereof; *Since it is known by Observations and Experiments, that our Globe is actually higher at the Equator than at the Poles.* In the History of the *French* Academy, 1700. *p.* 144. and in the Memoirs, *p.* 227. we find Observations taken at *Lisbon* and *Paraiba* in *America*, which seem expressly to confirm the shortening of the Pendulum in the Approach to the Equator, and consequently to prove the greater Flatness of the Earth at the Poles, tho' the exact Greatness is scarce to be determined by these Observations.

But that we may not be liable to the Difficulties and Objections that shall be made against the Hypotheses used by some for the Proof thereof, it is very remarkable, what is said upon the same Subject, in the History of the said Academy for the

the Year 1701. *p.* 120. and in the Memoirs, *p.* 237. *&c.* where Mr. *Cassini*, carrying on the Meridian of *France* to the *Pyrenæan* Mountains, by order of the King, has nicely measured the length of each Degree of the same, and found in $7\frac{1}{3}$ Degrees between the Parallels of *Amiens* and *Coljure*, which he has compared with each other, that the Quantity of each continually increased as they drew nearer to the Equinoctial, and consequently decreas'd as they approached to the Poles. So that, without contesting too strictly the exact and Geometrical Figure of the Earth, and without admitting any Hypothesis for a Foundation, in case what Mr. *Cassini* has really found in each of these Degrees, obtains in all of 'em from the Equator to the Poles, certainly the Equator or Equinoctial itself is greater than any Meridian or Circle passing thro' both the Poles; And the Earth is really a Globe, but a little flattish at the Poles. The same may be observed by the help of Telescopes in the Planet of *Jupiter* itself, and was so done by Messieurs *Cassini* and *Flamstead*; *See Whiston*'s *Prop.* 93. and others.

Now, whether this be the Experiment of which Mr. *Whiston* makes mention in the place above-quoted, I know not, because I do not find them added to it. This is certain, that this Author, in his *Prælect. Astron.* II. *Prop.* II. *p.* 8. of the Earth, says, that it is *nearly or almost Spherical*; yet with so little Difference, that he reckons them among those Trifles that are not worthy to be taken notice of in Astronomy, because the Difference which the small Flatness thereof may occasion, is in a manner insensible.

Sect. XXIV. *The Gravity of all Earthly Bodies.*

I Have oftentimes consider'd with great Astonishment, that wonderful Motion which the Philosophers call *Gravity* or Heavineſs, and by which every thing that we know upon the Earth is attracted or driven down and towards this Globe.

I shall not here relate nor dispute the various Arguments of Philosophers about the same; whether it is to be consider'd as accidental only, and whether it be occasion'd by the Highness of other Bodies which force the heavier downwards. This is however true, that all Corporeal Things that are known to Mankind upon this Globe, have their Gravity or Weight, not excepting the Air and the Fire, nor even that fine and pure Fire itself which has first passed thro' Glass: All which according to the Discoveries of these Times, have been visibly proved by a nice Balance, to have their Weight. *See Boyle de penetrabilitate vitri & ponderabilibus partibus flammæ.* Yea, that the pure Light itself, being collected by a Burning-Glass may be united to other Bodies, and render them more heavy, will be shewn hereafter in *Contemplation* XXIV. by the Experiments of Monsieur *Hombergh.*

Now how strongly this Gravity operates, does even appear from the Pressure of Bodies, which do otherwise seem to be without Motion. From hence it is we see great Ships sink, and oftentimes very strong Floors of Houses fall in by being over-laden.

Now I ask any reasonable Person, whether he can believe, that stupid and insensible Things, which cannot produce the least Motion in Themselves, are capable of observing such exact Laws,

without the Direction not only of a Powerful, but likewise of a Wise Being? For in case C be the Centre of the Earth (*Tab.* XV. *Fig.* 3.) and the Circle drawn from thence be a great Circle upon its Superficies, and the Lines F G, H I, K L, M N, that touch the said Circle, represent the Horizons of each Place; every one knows, that if a Stone, or other heavy Body, were let fall at A, it would move according to the Line A C; if at B, according to B C; at D, according to D C; and at E, according to E C: and that this is a true Position, is well known to those Pilots that have sailed partly or wholly round the Earth, who must all bear Witness, that such is the Method of their Fathoming in the different Places in which they happen'd to be.

Now let the Cause of this Gravity be such, as every one, according to his own Philosophical System, shall think fit; yet he must nevertheless acknowledge, that without this Property the Earth would be uninhabitable, especially if he comprehends what has been said above, concerning the Weight of the Air and Water.

SECT. XXV, and XXVI. *The Centre of the Earth is a* Nothing.

Now, not to ask, whether any one can imagine that it comes to pass without a wise Direction, that a Body wholly ignorant and insensible, being placed at A, shall move from A to C; and being at E, from E to C, along a streight Line directly opposite to it; and that in all Places where any Body falls down upon the Earth, it shall always chuse the nearest and shortest Way to the Centre thereof: Those who seriously contemplate this great Wonder, that all Bodies, how large and unweildy soever they be, without the least knowledge

knowledge of what they themselves are doin will move with so dreadful a Force towards a M thematical Point, to a mere *Ens Rationis*, whi has no Existence out of the Thoughts of him th conceives it; and (tho' it may be justly called Bodies, a perfect Nothing) will yet remain han ing to it: Can they, without acknowledging t Wisdom of God in his Holy Word, read the E pression made use of by *Job*, ch. xxvi. v. 7. *He han eth the Earth upon Nothing?*

As great a Paradox as this may appear to b the obdurate Atheist, if he understands any thi of the Mathematicks, must own, that it is an u deniable Truth, as the Holy Penman has the expressed it. Is not every thing heavy among Earthly Bodies that have yet fallen under Humar Enquiries? Does not this Heavineſs cause eve thing to descend towards the Centre of the Earth Does not the whole Body of the Earth dispose i self into Circular Figure about the said Centre And therefore in the very Words of *Job*, does n the Earth by such Gravity hang upon nothing o all Sides? Is not then the Centre a perfect *Nothi* in itself, and exists only in the Idea of Men? Wh do we hear *Euclid. Defin.* I. *Lib.* 1. describe th same thus; *A Point is that which has no Parts?* An to shew that the following Mathematicians held to be no Part of Matter, see what *Clavius* says c it in his Annotations, namely, that *no Example ca be given of it in material things.* Thus we see, tha *Whiston*, in his Treatise above-mention'd, *Pro* LXXXVIII. *Corol.* 2. says, that the common Centr of Gravity of things in this World, being only a Ma thematical Point, is plainly a *Nothing*. The lik Testimonies one might produce from more Ma thematicians. Now if it be not material, what i it then, other than *a Nothing* in material Things and a mere Notion only, that we form to ourselve

o

of the Bounds or Limits of something? The Reasons produced by true Mathematicians, to shew that a Point is without Parts and Magnitude, may be found by those that are unexperienced in these Studies, (and who are therefore shock'd at this Assertion,) elsewhere, this not being the proper place for it, it being sufficient for our purpose to have prov'd the Truth of *Job*'s Words, and so far to have consider'd the Nature of *Gravity*, as to shew, that it is impossible for any one to ascribe it to Chance or to Ignorant Laws of Nature; because if any Man can imagine that a Body being successively put into numberless places all round the Earth, can always move itself by numberless different ways to its only Centre by meer Chance, or without the direction of a wise Being, he must be deplorably blind. It ought therefore to be imputed to the Will and Power of GOD only, especially, since no Man hitherto has been able to assign any other satisfactory Cause: insomuch, that after all the Disputes and Cavilling about it, the greatest Modern Mathematicians and Enquirers into Nature have been forced to come to this Conclusion, that Gravity is a general Law, and as old as the World itself; and that GOD was pleased to stamp it upon Matter in the Beginning; and, that therefore we ought no more to ask how it comes to pass, that all Bodies gravitate, that is how it happens, how they are moved. It is well known, that this is the Language of some of the greatest Mathematicians of this Age.

SECT.

Sect. XXVII. *The Globe of the Earth keeps the same Obliquity of its Axis.*

Having made some mention of the Gravit I cannot forbear observing with great Reveren that surprising Wonder which all Natural Phil sophers (whatever some of 'em may pretend conjecture) have acknowledged to be one of t Secrets of the Great Creator; and even to th Day are forced to consider it as such. Now, wh ther we suppose that the Globe of the Earth, *p m f.* (*Tab.* XV. *Fig.* 4.) stands still, and that t Starry Firmament P E M F, together with t Sun O, and the rest of the Constellations, dai move about it; Or whether, with others, w suppose, for greater Conveniency in some Occ sions, that in *Tab.* XV. *Fig.* 5. the said Glob of the Earth is carried round the Sun O, thr A, B, C, D, and is daily moved about its ow Axis *p m*; this is certain, that the said Ax *p m*, does always respect the same Place P an M of the Heavens, in the fourth Figure, or re mains always parallel to itself in the fifth Figure and that so the Earth, without any support, doe thereby always preserve its own Parallelism an Obliquity of the Axis, at least so much, tha the Astronomers have never been able to observ it otherwise; and such as have imagined that the have found it otherwise, have never been able t prove such a Discovery. And, which is still mor wonderful, notwithstanding the Globular Figur of the said Earth, and notwithstanding the Opinio that many have entertained, that the Earth's re maining in its present State and Obliquity, is ow ing to the Equilibrium of its Parts, the same has so frequently undergone such great Revolutions, that it should seem almost impossible to those that judge

udge rightly of things, that it has not thereby been confounded and dissolved, or at least put into different Motions.

SECT. XXVIII. *Without the Obliquity of the Axis of the Earth, there would be reason to apprehend a General Destruction.*

FOR a Proof hereof, let any one consider those dreadful Burning Mountains, which are found in so many Parts of the World, and at such Distances from each other; by which the Earth has been destroyed in so many Places: Especially if those Fire-pits (as one may perhaps conclude from the Relations of them given us by Mr. *Baglivi*, *p.* 510, *&c.*) according to the Sentiments of many of the Learned, do entertain a Communication with each other, by great Rivers of Fire extending themselves from one Part of the Earth to the other, and even under the Bottom of the Sea too: For which reason the Earth seems necessarily to become lighter in those Parts where so much of it has been burnt, and vomited out in Smoak and Ashes.

Add to this those terrible Inundations, among which, according to all Traditions, the whole *Zuider-Sea* is one, and the violent Streams of such great Parts of the Ocean, which by Winds, by Ebbings, and Flowings, and other Causes, do remove such an unconceivable Weight of Water from one Part of the Globe to another; by all which the Gravity thereof must needs be changed into several Places. Not to mention those Earthquakes that are felt over all the World, by which this Globe being moved, may make us all justly apprehend a Change in the State and Condition thereof.

Now in case that by all these Causes acting with such terrible Force, it should once happen, that

that the Earth should totter, and depart from its Place in any manner, what could there else be expected but general Ruin and Destruction, when every thing changed its Air and Climate. For let it be supposed, that those who in *Tab.* XV. *Fig.* 4, 5. dwelt under the Line *e f*, or in the Torrid Zone, near to it, should be carried by such a Shock of the Earth to some of the Countries under the Poles *p* or *m*, or one of the Frigid Zones; by which means those Nations which now dwell under either of the Poles, would be carried into the stifling Air under or near the Equinox. Can it then be doubted, that all Creatures that were accustomed to the violent Heat of the one, even Men, Beasts and Plants, would for the most part perish and be destroyed, by being transplanted to the excessive cold Regions, and so on the contrary. Now all these Evils, which would certainly follow, are hereby obviated; and altho' the Globe of the Earth might undergo so many Revolutions in its Parts, tho' it should become heavier in one place and lighter in another, whereby the Balance of its Structure might be alter'd, yet it would however stedfastly and immoveably preserve the same Obliquity of its Axis.

Sect. XXIX. *Convictions from thence.*

Now that among so many Causes, which seem adapted to produce a contrary Effect, the Globe has unchangeably kept this its State and Condition, can result from nothing else than the miraculous Operation of a mighty Providence. For if any one should ascribe it to a Law of Nature, to its own Gravity, or, as some think, to a magnetical Virtue, let him tell us how it comes to pass, that such a Law of Nature is always unvariable in its Effects, when at the same time the Earth upon

pon which these Laws operate, changes its Com-osition, with respect to Levity and Gravity, to avity and Solidity.

Sect. XXX. *The Earth remains above the Water, notwithstanding its greater Gravity.*

Now in order to lay before an Atheist some-hing that he shall not be able to fathom or con-eive; Let me ask him the reason why, since arth is heavier than Water, the Waters do not nd above the Earth, surrounding the same in the ke manner as the Air, since it seems to be past oubt, that one should follow, as well as t'other, om the Laws of Gravity?

'Tis in vain for any one to alledge, especially ich a one who will not acknowledge herein a Vonder-working God, that the Sea and Waters eing shut up in the Cavities of the Earth, it would e impossible that such a thing could happen. For pposing (as the Experience of Inland Waters, for nstance, those of the *Harlemer Meer*, or *Lake* of *Har-m*, has taught many People to their Damage) that ne continual Beating of the Waves would in time ear away every thing; it seems to be a necessary onsequence, that the Banks and Shores being ereby washed away, this Matter would first ingle itself with the Water, and afterwards sink the Bottom by its greater Weight, and so render ne Seas, and other Waters, more and more shal-ow; by which means the dry Land continually de-reasing, the whole Earth would at last be encom-ass'd and cover'd with Water, tho' not so deep as ne present Cavities of the Sea. Yet we see the con-rary happen, and the dry Land remaining inhabi-able, notwithstanding the Rage of Seas and Rivers.

Sect.

Sect. XXXI. *Concerning the Torrid Zone.*

To pass on to something else: It is well know that all the Geographers do divide the Super cies of this Globe into five Zones. The first th call the *Torrid Zone*; this is that part of the Super cies which extends itself from the *Equator* e (*Tab.* XVI. *Fig.* 1.) on each Side, to the Tropic *c d.*

Now that the old Geographers held it for unquestionable Truth, that this Zone was bar and uninhabitable by the intolerable Heat, appe strongly enough from their Writings; nor w they so much to blame, if we reflect upon t Influence of the Sun in other Parts of the Worl Since this great and burning Luminary movi twice a Year in the Circle A Y D, called t *Ecliptic*, or the Sun's Way, passes directly ov those Lands that lie between the two Tropic *a b x c d.*

And this very rational Notion, as to outwa appearance, had so long obtained every where, Experience teaching the contrary, has therein m nifested the Divinity and unconceiveable Wisd of the Great Creator, who has graciously prevent by other Means this all-consuming Heat, whi with respect to the Scituation of those Countri and the Course of the Sun, seems to be a necessi Consequence, from destroying the same.

Sect. XXXII. *The Torrid Zone inhabitable, b means of Mountains.*

To be assur'd of this Wonder, we need on take the aforemention'd Island of *St. Thomas* for Example: This Island lies under the Line, as he at X, in the middle of the *Torrid Zone*; of whi neve

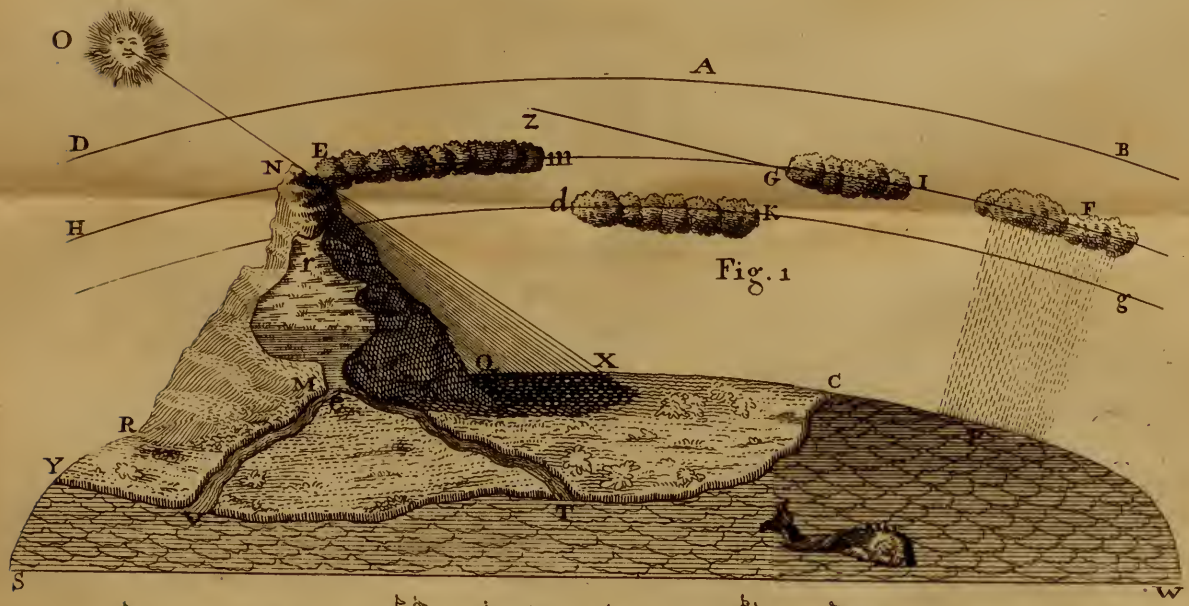

Fig. 1

Fig. 2

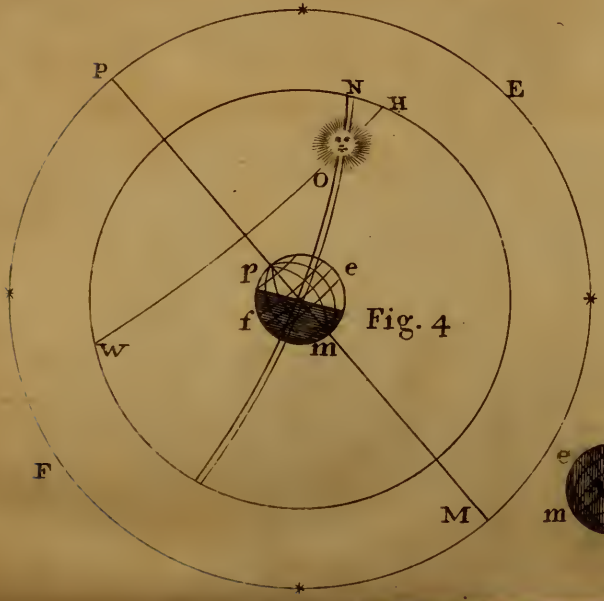

Fig. 4

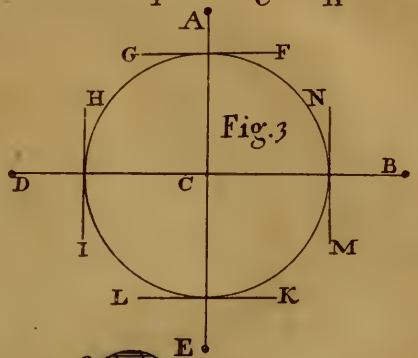

Fig. 3

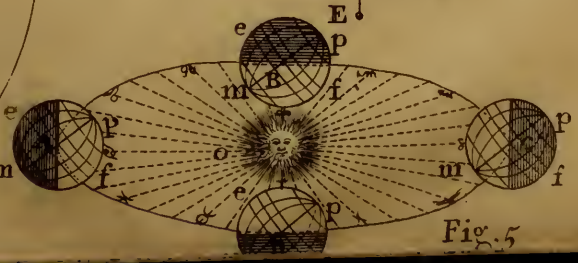

Fig. 5

nevertheless, all that write about it, do unanimously witness the Wholsomeness of the Air for the Inhabitants, and the Fruitfulness of the Country. To which purpose we need only consult the little *Atlas of Mercator*, or any other Books that have treated of the same.

Now I beseech every one that can yet doubt whether the World be made with Wisdom, to reflect with himself, whether it may be deduced from the ignorant Laws of Nature, or from mere Chance, that, to the end the Sun should not render this Island uninhabitable, there is a great Mountain placed in the middle, and overgrown with numbers of Woods; the Tops of which, notwithstanding that the Heat may seem to dry them quite up, are always cover'd with so many Clouds, that the descending Waters, which proceed from thence, are not only sufficient to produce other fruits, but even Sugar-Canes themselves: insomuch, that in the very hottest Days, this Mountain appears cover'd with a continual Cloud; the reason of which is, that a much greater Quantity of Vapours are then attracted by the Sun from the Sea; and the Air being likewise much more rarified by the Heat, carries the Vapours of Water that are mixed with it, more to the Cold and Shadowy Places of this Mountain, whereby they are press'd more closely together, and so the Weight of the Clouds is increased. Now how the Mountains concur in producing these Effects, has already been in some measure shewn before.

Now if any one should refuse to acknowledge a gracious Providence of GOD in this whole Matter, and wou'd pretend, that this is only peculiar to this single Place, and consequently, that it may be the effect of Chance, he may learn from the Description of *Madagascar*, in the Geography of Mr. *Robbe*, and others, that there are likewise

Woods and Mountains in the middle of th Island, from whence Rivers flow on all side which render that Country (tho' lying in the ho test Part of the World) in respect to the Su equal in Fertility to the best Climates of t Earth: And this you will find observed in sev ral other Places.

Sect. XXXIII. *The Inundation of Rivers do li wise render the Torrid Zone habitable.*

But in case any other of these miserable P losophers should again, according to their mann start new Difficulties, and fancy, that since wh has been advanced above, has happen'd in seve Places, it might be the necessary Consequences Natural Laws, they may likewise be convinced the unreasonableness of such Opinions, from otl and different Means, which, besides the foregoi the Wisdom of God has been pleased to ma use of in rendering those Countries fruitful, wh would be otherwise quite scorch'd up by the R of the Sun.

Now, not to speak of *Egypt* again, one part which lies under the Tropick *a b*, and where it thought to be the very hottest, because the S does not only pass twice a Year directly over th Heads, as it happens in all Parts of the Tor Zone; but also, because it remains a much lon time over the Countries lying about the Tropi than it does at the Equator, which it passes more swiftly; and yet this *Egypt* is made one the most Plentiful and Fruitful Countries of World, by the overflowing of the River *Nile*. say, besides *Egypt*, the dry and barren Country th *Blacks*, commonly called *Nigritia*, or *Nigritia Regio*, may serve for a Proof; which likev stretches itself from the 8th to the 23d Deg

of Latitude, and consequently very near to the Tropick of *Cancer*, in the hottest Part of the Torrid Zone, and is overflowed in the like manner by the River *Niger*; which leaving a kind of Mud every Year upon this scorched Country, makes it become the most fertile of all *Africa*. See concerning the same, Mr. *Robbe's* Geography, as also that of *Varenius*, *Lib.* I. *Cap.* XVI. §. 20. about several Rivers besides the above-mention'd, that produce the same Advantages. Many of which there named, and amongst them particularly the River *Zaire*, do overflow their Banks yearly; so that this last renders the Kingdom of *Congo*, where the Air in clear Weather is intollerably Hot, exceeding Fruitful in all sorts of Herbs and Plants that are good for Food. He therefore that is surprised hereat, and has a mind to be farther informed, how in such a Burning Climate the Earth yields so great a Plenty of all things, may learn from the above-mention'd Geography of Mr. *Robbe*, and the so often praised *Varenius*, how the Rivers *Indus* and *Ganges* overflowing always in *June*, *July* and *August*, do Water whole Kingdoms lying about them, and make them Fruitful to a great Degree; as they likewise serve for a sufficient Provision of Water to the Inhabitants during the rest of the Months, in which there hardly falls any Rain.

After how wonderful a manner the Heat of this Torrid Zone is farther qualified in several Places by cool Breezes and Rains, is likewise shewn by *Varenius*, *Lib.* II. *Cap.* XXVI. §. 11. even so far, that by other means, which the Wisdom of the Almighty has been there pleased to use, the Seasons of them frequently to run contrary to the approaching and receding of the Sun. It would be too tedious, and, according to all probability, an unnecessary Work too, to enquire into all the Causes hereof.

Sect. XXXIV. *Convictions from hence.*

Now let me once gain ask these Philosopher
that are really worthy of Compassion, and wh
will have all things come to pass as they are, with
our the Wisdom of the Creator and Preserver
all things, whether, if any Body had found a Me
thod to furnish a little District of Land with
milder Air, and with as much Water as is wante
and which without the same must have perished b
Drought and Barrenness, together with all th
Men, Beasts and Plants that were upon it; wh
ther it could be denyed, that the Wisdom of Hi
that found out and effected the the same (espec
ally if the Knowledge and Power of the greate
Number and most Skilful of Men, would not ha
sufficed for that Purpose) were not worthy of t
highest Praise; and whether they, or any o
else, could imagine, that the Canals and Aqu
ducts whereby in the drained Meers or Lakes
North-Holland the Lands are water'd in dry Se
sons, and the Cattle are provided with Drin
could have been brought about without the Co
trivance of a Skilful Engineer?

Now this is what we see performed, not
drained Meers or Fens, but in vast Kingdom
not a few Cattle water'd, but Millions of Me
Millions of Wild and Tame Beasts, Millions
Trees, Shrubs, Plants, Corn, and other Herb
preserved alive thereby; not some few Acres
Land, but Whole and Great, and otherwise U
less Parts of the World, fertilized thereby, and
into a Condition, from the abundance of th
Productions, to communicate their Agreeablen
to other People. Here are no Sluices or M
made use of, which must be yearly maintaind
the Charge of the Country, but prodigious
d

dies, and vast Mountains discharging those Functions; and which having been once placed there by the Great Director of all things, remain there still without any Expence to those that reap the Benefit of them, being fitted to perform this their great Work, thousands of Years, without any Diminution or Attrition. Here are no Artificial Canals or Sluices of a small Extent necessary for this Purpose, but vast Floods of Water, and the greatest Rivers of the World.

Now, since all this is incomparably more Noble and of greater Benefit than that which every one readily confesses to be brought to pass in the aforesaid *Meers* by humane Contrivance and Wisdom; What Reason can these miserable Philosophers produce, to justifie their persevering in their Opinions, that the same is here done without any Wisdom?

Sect. XXXV. *Concerning the Temperate Zones.*

After this Torrid Zone *a b c d* (*Tab.* XVI. *fig.* 1.) there follows two others, one on the one side *a b h g*, and t'other on the other *c d k i*; which, in respect of the lesser Heat, as in the Torrid Zone *a b c d*, and lesser Cold, as in the two Frigid Zones *g p h*, and *i m k*; and therefore on account of the greater Temperament of the Air, are called the Temperate Zones.

Taking then *p*, for the North Pole, *a b g h* is the North Temperate Zone, and *c d k i* the South; the former of which is inhabited by us, and almost all *Europe*, and the greatest Part of *Asia*, and contains all those Lands and Seas which we may see in the Map of the World, lying between the Tropick of *Cancer a b*, and the Polar Circle *g h*; the South Temperate Zone *c d k i*, which may be likewise seen there, consists chiefly of Seas.

Sect. XXXVI. *The Advantages of the most Northern Parts.*

It is not necessary to expatiate here more particularly upon the Northern Zone: Every thing about us, or that has been represented in all these *Contemplations*, centers in this, namely, to manifest the Power, Wisdom and Goodness of God, which has shined out so brightly in these Parts of the World. This is certain, that in Fruitfulness, in the Temperature of the Seasons, and particularly in the Learning and Understanding of its Inhabitants, it will give place to no other whatever; forasmuch as it is beyond all doubt, that in the Government of its Countries, in Commerce, in Navigations, in the Arts of War, and in an infinite Number of other Sciences, it far exceeds all other People.

But the greatest Benefit of all, and that which incomparably exalts this Zone above all the other Parts of the whole Globe, is, that the Knowledge of the True God, and his right Worship have here their present Seat: Since that this same bright Sun is now set in respect to unhappy *Asia*. God having thought these People worthy (which exceeds all Humane Gratitude) to whom he might reveal Himself and his Holy Word, and by them to propagate and diffuse the Knowledge thereof to other Nations.

A truely upright Soul, such as loves and fears God, will esteem nothing more detestable, nothing more unreasonable, than to imagine, that the Worship of Him also has acquired by Chance, or by a stupid Necessity of Natural Laws, its so just and equitable Principles, worthy of the True God, and surpassing all other Idolatrous Worship.

And

And if an Atheist would but ever have taken the Pains to examine the adorable Wisdom of God in this his Word, and the fundamental Knowledge therein of all Creatures; if he would but compare the exact Accomplishment of so many Prophecies with History; if he would reflect upon the wonderful Preservation of the holy Scriptures, in spight of the Rage and Persecution of great Tyrants and Opposers of the Word, he will be able to produce very few Arguments to make an impartial Person believe, that it is the Effect of mere Chance that God is worshipped in this Part of the World after the manner contained in his Word.

Sect. XXXVII. *The Christian Religion is no Art of Politicians.*

The Atheists and Infidels have never yet been so Foolish and Brutal (if we may use such hard Words) as to ascribe that impression which every one has of a Deity or his Worship (how much soever they are disposed to deduce every thing from thence) to mere Chance or Fatality. Wherefore being now obliged to seek for other Subterfuges and Evasions, they now refer it to the Arts and Stratagems of great Politicians, who thereby endeavour to keep in awe the People under their Government.

That this has Place in some Pagan Religions, as also in the *Mahometan*, is easie to be shewn, they having been established by the Force of Arms. But nothing is more impossible than to prove the same in the Christian Religion: For if it be the Policy of Rulers and Princes to bridle and keep in awe a giddy Multitude, why has not such Policy, with the Addition likewise of all their Power (whereby they have extirpated hundreds of thou-

ſands for the Confeſſion of our Lord JESUS CHRIST been able to ſuppreſs a little, contemptible, inno cent, unlearned and defenceleſs People, nor ge the better of thoſe Principles ſo pernicious to the Atheiſtical Authority? By which Principles, Me were taught indeed to ſubmit themſelves to th Powers that were over them; becauſe there is n Power but of GOD, and becauſe the Powers tha be, are ordained of Him, *Rom.* xiij. 1. But all on the other ſide, (which is by no means to b endured by an Atheiſtical Governour, who woul direct all things according to his own Pleaſure that Subjects are obliged, in caſe the Worſhip an Revealed Will of GOD were oppoſed even by th mightieſt of Monarchs, to deny their Fear an Obedience. Was there ever any Religion bette calculated to oppoſe a Supream Power, that doe not own GOD, like this, tho' in all other Caſes i makes the moſt obedient Subjects? And can an Prince, who accounts his Religion nothing el but a Bridle for the People, in any wiſe endure t hear even the meaneſt of his Subjects ſay, with th Apoſtles, in *Acts* v. 29. *We ought to obey God ra ther than Man?* Or, will he ſuffer a Religion to b exerciſed in any Place under him, where the Foun der of it ſhall give this expreſs Charge to thoſ that exerciſe it, when perſecuted for his Nam ſake; *Be not afraid of them that kill the Body, an after that, have no more that they can do. But I wi forewarn you whom you ſhall fear: Fear him, which af ter he hath killed, hath Power to caſt into Hell; yea, ſay unto you, fear him,* Luke xij. 4, 5. from whenc an Atheiſt himſelf may judge, if all Religions ow their beginning to State-Craft only, whether th Chriſtian would not long before this have bee at an End: And ſince that could not be compaſſe by ſo many bloody Perſecutions, and raging Cru elties of the higheſt Worldly Powers, whether the

ſaid

aid Religion must not have been preserved from he very Rise of it to this Day, against all the Attempts and Designs of those that would extirpate t, by the Intervention of a much higher and more esistless Power?

Sect. XXXVIII. *Atheists differ from the Wisest Men.*

Now to return from this Digression to the Business in hand, it is undeniable, that this Northern Temperate Zone is inhabited by the wisest and most learned Men; most of whom acknowledge a God and supreme Director of all Things; from whence it is plain, that the owning a Deity, which has made and preserved all things, is received and maintained by the wisest of all People. If now a deplorable Sceptick, and who still pretends to doubt of these great Truths, will not continue arrogantly to maintain, that the wisest Men are the greatest Impostors, and that the less knowing are all cheated, and that he himself is the only wise and righteous Man; he will at least, by comparing all these things together, find a just Cause silently to sit down; and whatever his Philosophy might have taught him before, to enquire farther, whether his persevering in this Conceit, that he is the only wise Man, be not the greatest of Follies; and whether the Proofs made use of by others, to shew that there is a God, are not stronger than those to which he hitherto adhered: Lastly, Whether from the Works of Nature, the Wisdom of the Creator may not as justly be inferr'd, as the Skill of the best Workman from those of Art. Which trouble, if he please to take, he will have got a great way already, unless he be entirely abandon'd to his own unhappy Principles.

Sect.

Sect. XXXIX. *Concerning the Frigid Zones.*

The two last Zones (*Tab.* XVI. *Fig.* 1.) are the that are called the *Frigid* or Cold *Zones*, of whi the Southern *k m i*, lies under the Southern Pole and seem as yet to be entirely unknown to Ge graphers, being represented upon their Maps ve doubtfully, either by Seas or by the *Terra Austra Incognita.*

The Northern Frigid Zone *g p h*, especially one approach pretty near to the North Pole discovers nothing else but uninhabited Desar frightful Rocks, and Mountains of Snow and I for the most part; concerning which, the Desc ptions of *Nova Zembla*, *Spitsberg*, and *Greenland*, m be consulted.

Sect. XL. *The Impossibility of approaching the Pol*

One can hardly read without Astonishmen what *Kircher* says in his Subterraneous World, an which he confirms by a Cloud of Witnesses, nam ly, as Men approach the North Pole *p*, the Se is driven towards it with so irresistible a Forc and, as if it fell from a Cataract or Precipice that many, who have had the Misfortune to com within the said Stream, have been hurried away Men, Vessels and all, and never seen again; an on the contrary, those who have endeavour'd t sail towards the South Pole *m*, have found the Se flowing against them with so terrible a Strength that neither Sails nor Oars could bring them neare to it.

I leave this Relation to its own Weight; bu how little Hope there is ever to discover and to learn the exact Geography under the Poles, may be learn'd from all the Voyagers that have bent their

Course that way. Certainly, that in *Kepler*'s time, which is something more than a Century, we were ignorant of every thing concerning them, and did not so much as know whether it was Land or Sea under the Poles, is sufficiently shewn by his *Epitome Astronom.* p. 166, and 150. *De Stair* does likewise represent in his *Physiology*, the invincible Difficulties of ever getting thither; saying, *p.* 487, that when the *Hollanders* endeavour'd to find a Passage to the *East-Indies* by the North, and therefore were obliged to steer their Course towards that Pole, the Compass lost all its Virtue and Direction; by which means all Hopes of advancing farther, seemed to be entirely cut off. Yea, to be convinced, that is still unknown to all Men, what are the Countries lying under the Poles, we need only cast our Eyes upon the *Cosmotheoros* of Mr. *Huygens*, p. 119. who, in plain words affirms the same, adding thereto, that he may express the Difficulty, if not Impossibility thereof, in the following Wish: *O, if one might but once see those Regions!*

But altho' some might think it possible, that in following Ages the same may be discover'd, yet the absolute Impossibility of ever attaining to the first Degree of Latitude, is daily more plain by new Experiments; the vain Attempts of the boldest Sailors are every time so many new Proofs thereof. But that which seems to frustrate all Hopes, even for the future, are the impracticable and always obstructing Mountains of Ice, which are found there early by our *Greenland* Traders, and which, according to all Probability, may date their Age from that of the World; since the Sun seems never to have had so much Strength, as to be capable of dissolving these vast Tracts of Ice, frozen by so many and such long Winters. So that any Access to the Poles will be always defeated thereby, and

as

as long as the Earth continues in the same Po tion with respect to the Sun, the same Difficulti are like to remain.

CONTEMPLATION XXI.

Of FIRE.

SECT. I. *Transition to* FIRE.

NOW, tho' we do not, like some Philoso phers, assert the Earth, Air, Water and Fir to be the only Principles or Foundation of all Things nor pretend to limit the Wisdom of the Almight to a certain Number of Principles, if we may so speak; yet it can be denied by no body, that al of 'em center in the Composition of many natura Bodies: Wherefore we shall proceed to consider this last Element of Fire.

SECT. II. *The Inconveniences that would befall us, if there were no such thing as Fire in the World.*

IF there be any one still so unfortunate, as not to be able to break loose from those deplorable Sentiments, that every thing that exists, and even Fire itself, has been made by mere Chance and ignorant Causes, at least, without any wise and determinate End; Let such a one retire within himself, and contemplate this Globe of the Earth, and every thing belonging to it, in the State

tate in which he might suppose himself and that o be, in case there was no such thing as Fire.

After the setting of the Sun, and all other Heaenly Lights (to take no notice here that the Light hereof does even in a great measure consist of Fire, r brings a great deal of that Element along with) how does the whole Earth, cover'd with Clouly and Nocturnal Vapours, differ from the most ismal Subterraneous Caverns and Dungeons? Since luring such a time no Man would be able to nove one Foot forwards, or to dispatch any kind of Business. Without Fire, which by the Means of Candles, Lamps, Torches, and the like, affords us Light in the greatest Darkness, what difference would there be between our Condition, and that of Men who should be blind half their Life-time? Without Fire, most of the Productions of the Earth, which serve Mankind for Food, for Refreshment, and for Dainties, would not be fit to be used in many Countries to those Purposes, nor could be chewed by the Teeth, nor digested by the Stomach. And every body to whom the way of living, and of preparing our Diet in these Countries is known, must be convinced, that neither Bread nor Flesh, nor most of the Fruits of the Ground, or of Trees, would be of much use without these Means, but would turn to an unwholesome, crude Nourishment, and perhaps to no Nourishment at all.

Would not the dreadful Cold of Winter, if not moderated by Fire, be capable of dispeopling whole Countries, and of freezing to Death numbers of Women and Children, that are not capable of keeping themselves warm by strong and violent Motions?

If there were no Metals for the use of Mankind, (to say nothing of Gold and Silver, which may be the most easily spared) especially if there were no Iron, which furnishes us with so many Instruments for

for numberless Uses; for plowing, building, a in a manner, for all other Arts and Purposes, eve one may easily conclude, under what Inconveni ces all Mankind would labour: Now tho' the Ir and other Mines should be infinitely more in numb than they now are, yet it is sufficiently know that without Fire, no use could be made of the nor could they be smelted or separated from the respective Ores.

Sect. III. *Convictions from thence.*

To reckon no more, let an Atheist represent himself the World in such a Condition, that and all Men should be without Light in Darkne without Warmth in Cold, without any Preparati for raw Food, without all the Conveniences whi Metals, and chiefly Iron would afford them: Nov if any one should come and tell him, that he ha discover'd such a Matter by which all these Defe and Wants might be supplied, and the World b come happier in so many Instances, would not eve the most obstinate Infidel acknowledge the Inve tor to be a very wise Person? Now since the sam is perform'd by a Being infinitely superior to Ma and after a much more sublime and wonderf manner, why will he refuse to own the Wisdom such a Being?

Sect. IV. *It is still uncertain what Fire is.*

There have not been wanting among the En quirers into the Secrets of Nature, those that hav endeavour'd to discover what Fire is in itself, an what are its Properties; and it seems probable tha Mr. *De Stair*, who has in a manner consider'd al Opinions, has fallen upon the best Notion of it i the following words; *Explor.* VI. §. 1. There i nothing

nothing in Nature more obvious to the Senses, and nothing less intelligible than the Nature of Fire.

Sect. V. *The First Notion concerning Fire.*

Two Opinions, which are defended with many Arguments by those who maintain them, are at present in vogue; the first is, that all Particles of Matter, of what Nature soever they be, are capable of being turned into Fire, if they can but be moved swiftly enough, or can be divided small enough.

Now, whether such Motion be occasioned by that Fire-Fluid, which the Followers of the famous *Cartesius* term the *first Principle*, or of something else, we shall not here enquire.

Sect. VI. *The Second Notion. Fire seems to be a Particular Substance.*

The Second Opinion laid down by other Philosophers is, that Fire is a particular Fluid Matter, like Water or Air, which, like those, adheres to many Bodies, and adds something to the Composition thereof.

What sort of Figure the Particles of Fire consist of, we shall not here attempt, as some have done, to investigate; forasmuch as it is not easie to discover the same; nor likewise, whether the Chymists have guessed any better, some of whom will have the Essence of Fire to consist in Sulphur, others in an Acid. We shall content our selves with producing the Reasons why it seems most credible, that Fire both has, and maintains its own Essence and Figure, remaining always Fire, tho' not always burning.

Sect.

Sect. VII. *The first Reason for the aforesai Opinion.*

To prove this, the first Reason seems to l that *all Substances are not combustible.*

How happens it, that Wood and Turf will bur but that the Ashes which they make are incapat of burning? If it be not upon this account, th the Fire-Particles, which were before in the Wo and the Turf, fly away by burning, leaving t Ashes bereft of them, and therefore unfit for bur ing.

I know very well, that those who are of t foregoing Sentiment, will answer to this, that Ash and other Bodies, as the *Amianthus* or *Feather-A lum*, and the like, which cannot be burnt by Fir are of too gross and heavy Parts to be put int Motion by that subtil Matter. But if that we true, it would seem to be a necessary Consequenc that the smallest and lightest Parts would, witho Difference, be the fittest and best disposed to pr duce Fire: But (not to say, that Water migh therefore burn, at least, much better than Oyl Cinnamon, Cloves, and others, which being hea vier than Water, sink down in it) why don't Vo latile Salts burn? which are so easily put int Motion, that the least Warmth is capable of mak ing them evaporate into the Air, and the Part thereof so fine and small, that no Glass can b shut close enough to keep them always in. An to the end that no other Objections may be of fer'd on account of the exceeding Fineness of thei Parts, it is known, that they are so powerful an sharp, that being only dissolved in Water, the will even destroy a Metal as hard as Copper, an turn it into a liquid Matter. They that have a mind to make a Trial thereof, need only put a Copper

Copper Farthing into the Spirit of *Sal-Armoniac*, in which they will find it quickly dissolved.

Sect. VIII. *The Second Reason; and an Experiment.*

Secondly, If a very swift Motion were only necessary to reduce all Bodies to Fire, and that a particular and determinate Matter were not required hereto, how comes it to pass, that hot Water being moved more violently by blowing, is not rendered hotter but colder? And yet, the Air is so absolutely necessary to our Fires, that without it, they would be extinguish'd?

The Truth of this is known even to Women themselves, who for that purpose extinguish their Fire with Covers, or shut it up in Dove Pots.

And to the End, that no body should believe that this way of extinguishing the Fire is not so much owing to the want of Air as to the obstructing the Ascent of the Smoak, whereby it is suffocated; Let a Man make a Tube of Paper (*Tab.* VI. *Fig.* 2. ABCD) the Cavity whereof must be a little larger than the Thickness of the Candle H; and let him suddenly put it over the said Candle burning; now if there remains below at D, any Orifice or Opening between the Candle and the said Paper Tube, so as to admit a free passage to the Air, the Candle will keep its Flame, and remain burning; but if one should compress the Paper at EF, so as to obstruct the Passage of the Air, the Candle will be immediately extinguished; notwithstanding that the Tube remained open all the while at A B, and allowed a free Passage for the Smoak. [*See this Experiment in the Works of Professor* Senguerdius *of* Leyden.]

Sect. IX. *The Third Reason, and an Experiment.*

But *Thirdly*, We see yet farther, that the Air likewise is not proper or adapted in all its Parts in general, for the supplying of Fire or Flame, but that certain determinate Parts of the same are required thereto; from whence it likewise seems to appear, that we must form a more limited Notion of Fire, than to think it merely a Motion of some Parts, provided the same be but swift enough, and that it is very probable, that Fire being maintain'd by some particular Substance, does consist of particular Parts, and has therefore a distinct Nature of its own. For which purpose, let any one make the following Experiment:

We took an eight-corner'd Bottle A D E (*Tab.* XVI. *Fig.* 3.) cutting off the Bottom of it, and then put a Candle, set upon a flat Piece of Board under it; the Ends of which Board D and E stood out beyond the Edge of the Glass, that they might not be driven up into it when the Glass was let down as far as B C in the Water: And we then observed;

I. That the Candle being lighted, remained burning as in a Lantern, while the Air flowed in by several little Holes, that it found between the Board D E, and the Glass.

II. But putting the Bottle into Water as high as B C, whereby all the Passages for the Air were stopp'd, the Candle burnt about 20 Seconds, and then went out; because the Warmth of the Candle driving the Air out of the Mouth A, the Flame lost its Food.

III. A crooked Tin Tube H K F, which was not very large, being put into the Glass, there seemed new Air to be derived to it by the Candle

bu

ut we found however, that after it had burnt be-
ween 21 and 22 Seconds, it went out again

IV. To see therefore if this did not likewise
appen thro' want of Air, which, as it was pro-
uded before the Mouth A, might likewise find
s Passage by the other Mouth of the Tube F K H,
s soon as it was sufficiently rarified by the Warmth
f the Candle, we took a pair of Bellows L H,
lowing continually fresh Air therewith into the
ube, and by the Tube into the Bottle; where-
pon we observed the Candle burning as bright as
ver before, whilst such blowing lasted.

V. But that which is very remarkable, was,
iat when instead of the Bellows we blew into
ie Tube at H, with the Mouth, some Air which
ad been a while in the Lungs, we found the
Candle did not burn above ten Seconds; and con-
equently not near so long as when it had no fresh
ir at all: This is a plain Sign, that the Air in
ur Lungs loses that Property which render'd it
t to feed the Flame, and that Flame and the
Breath of Men seem to require the same kind of
ir.

VI. This is the more confirmed, forasmuch as
hen we suffer'd the Air to go no farther than the
Mouth, and not to descend into the Lungs, and
y quick and frequent Breathings, conveyed the
ame into the Tube, the Candle would continue
urning, tho' not so bright as when we used the
Bellows, which supplied it with more and fresher
ir.

VII. Having put a little Wax-light in the Place
f the Candle, we found that by leaving the crooked
Tube in the Bottle open, the said Light burnt 170
econds.

From all which it may be inferr'd with great
ppearance of Truth, that the Air in general is

not only necessary to Fire, but even, that some particular Parts thereof are only proper for it; and consequently, if it be not easie to prove, yet it is very probable, that Fire is likewise a particular Substance or Matter. For if it had wanted nothing more than that fine Element or Principle; which some Philosophers have supposed, and besides them only some coarser Particles, be they what they will, so that they could by the said Matter only be continued in Motion; it does not seem that either of these were wanting here, even at the time when the Candle was extinguished. For of the latter sort, there was enough remaining in the Candle it self; and according to these Philosophers, the other fine Matter may with less Resistance come at the Flame through the Pores of the Glass, than through the Air it self. Is this likewise by Chance, that whereas Fire does stand in need of a continual Afflux of particular Particles of the Air, the said Particles are always at hand, and are endowed with just such a Property as will feed almost all kinds of Fires? How comes it then, that they dare not likewise maintain, that the Fitness of the Teeth and Pinions of a Wheel, a Clock, or a Mill, or the Wards of the Key for a Lock, which it is to open, are formed without the Contrivance of the Workman? Since the Ends and Pupose for which they are used, fall infinitely short in comparison of those great Benefits which the Aptitude of Air and Fire to each other do derive to Mankind.

Sect. X, and XI. *The Fourth Reason, and Experiments.*

If now, *Fourthly*, we can shew by Experiments, that that which we discover in Contemplating Fire has a great Analogy and Likeness to the Effects of Water and Air, with respect to the Matters that are dissolved therein; we shall learn farther, that those Philosophers seem to come nearest to the Truth, who maintain, that Fire is a particular Matter, or a *Menstruum*, as the Chymists phrase it, capable of unbinding, that is, of dividing or separating very many and almost all Bodies that are known to us; after the same manner, for instance, as Water acts upon Salt, and Aquafortis upon Iron. So that the burning of most Bodies is no otherwise performed, than by the melting of some of the Parts thereof in the Flame. For which reason, if there be many Fire-Particles in such Bodies, as Wood, Turf, or the like, they help to encrease the Flame when they are let loose by burning; and when none of these are to be met with in Bodies, or when they can't be unbound, the Flame is not encreas'd thereby, but those Bodies are only melted and render'd fluid in the same manner as we see Ashes and Metals melted in the Fire, which don't burn, but are turned to Glass. And as other *Menstruums* do either not dissolve some Bodies wholly, or not in a long while; so we find some, but very few, Bodies that are capable of resisting the Power of Fire after it has long operated upon them.

Those that desire to see some Examples of this kind of Effects of Fire, need only consult the Writings of Chymists about them; and to save them trouble, we shall present them with some few.

'Tis known, that if one put Salt of Tartar and pounded Antimony in Water together, that Salt will take hold of the Antimony in a little time, unite itſelf in that *Menſtruum* with the Sulphur thereof, as the Chymiſts delight to call it. After the ſame manner we find, that the ſaid Salt of Tartar unites itſelf with the Sulphur of Antimony when diſſolved in Fire, as before it had partly been in Water. Now the ſaid Chymiſts know, that whether Fire or Water be choſen for a *Menſtruum*, a Mixture of the ſame Properties will reſult from this Salt and Antimony; and every one may ſee the ſame by putting Vinegar to both.

Thus we ſee the ſame Effects reſulting indifferently from Fire and Water in other Chymical Operations; ſuch as Coagulations or Precipitations, as they are called by Chymiſts; the *Regulus Antimonii* being mingled with its Sulphur in Antimony, by the means of Salt of Tartar, that unites itſelf in the ſaid Sulphur, is ſeparated from it by Fire, and ſinks to the Bottom after the ſame manner as Steel united with the Sulphur-Copperas, when this laſt is diſſolved in Water, and ſo in many other Caſes.

Thus we find alſo, that the Flame of a Candle is always blue and tranſparent at Bottom, but much whiter at Top, becauſe more Parts of the Cotton and Tallow are there mingled in the Flame, which is render'd thicker thereby; juſt after the ſame manner as when any thick Matter is mingled with the Water, which will be cleareſt where there is a leſs Quantity of ſuch Matter, and thickeſt or moſt troubled where the Matter moſtly abounds. So likewiſe, when you kindle a Brimſtone Match, the Flame proceeding from the Brimſtone will appear at firſt blue and tranſparent, but ſo ſoon as the Stick or Card, which it cover'd, are diſſolved, the Confuſion of the Parts of both Bodies will render the ſame thicker and whiter preſently.

Infinite

Infinite Examples of the same kind might be produced to shew the like Effects of Fire, and the Flame thereof, as do occur in other *Menstruums*, which may also be observed in the Turf of this Country, and many other combustible Matters. Thus is Flame tinged blue or greenish, like *Menstruums*, by Copper, as it is upon this Principle, that the Engineers understand how to give different Colours to their Fire-Works. This seems yet farther to confirm what we have said above, namely, That Fire is to be accounted a fluid Matter, and like other Fluids, to consist of particular Parts.

Sect. XII. *The Fifth Reason, and several Experiments.*

Fifthly, If it be thought, that it has been justly concluded, that the Air is a particular Fluid, consisting of its own determinate real Parts, only because it had an Elastick Faculty (whereas several, according to a Philosophy embraced at this time, maintained the same to be nothing else but a Collection of all kinds of Particles) why should not the same Arguments be as conclusive to hold the same of Fire too? Seeing that the Parts thereof, when put into Motion, do expand themselves with much greater Force than those of the Air. An Example of such an Expansion of Fire mingled with Water, may be seen above in *Contemplation* XIX. But a more common Proof of the unspeakable Greatness of this expansive and rarifying Power of the Fire, may be fetch'd from the modern Mines, Mortars, Cannons, and other kind of Artillery, which, in the blowing up of such strong Walls and Bulwarks, and in the amazing swiftness of the discharg'd Bullets, do represent to every one the dreadful Force of the rarifying Faculty of Fire; for it is now well.

enough known, that these Effects (scarce to b believed by such as had never seen them) are onl produced thereby.

It was with Amazement that I read the Expe riment of Mr. *De Stair*; having omitted to mak the same my self, because the Glasses belonging t the Air-Pump, and which are wanted for tha purpose, cannot be so easily procured in this Place He says, in his *Physiolog. Expl.* XIX. §. 121. that up on heating Red-Lead in a Glass, from whence th Air was exhausted, by the Rays of the Sun collect ed in a Burning-Glass, the Glased Vessel, i which the said Red-Lead was contained, burst i Pieces with a great Noise. Now he that knows *First*, that this Red-Lead consists only of the Ashe of burnt Lead, upon which a continual Flame ha long acted; and, *Secondly*, that the said Lead Ashes become heavier by the Operation of th Flame, and therefore is impregnated with a grea many Fire-Particles, that join themselves to i (since there comes out a greater quantity of Red Lead than there was of the common Lead put in to the Fire) can he judge otherwise, than tha these Fire-Particles being excited and put into Motion by the Fire of the Burning-Glass, dilated themselves, and thereby burst the Glass? From this Experiment, since the Glass was first emptied of Air; and from the first Experiment of Water, it seems that it may be inferr'd, that it is not always necessary to call to our Assistance the Force of the Air, which is present in Mines or in Guns, in order to understand the rarefying Force of the kindled Gun-Powder, since here the whole seems to be ascribed to the Particles of Fire

The same seems to be confirmed by the addi tional Experiments of Sir *Isaac Newton*'s Treatise of *Optics*, *p.* 354. where it is said, that upon di stilling a Spirit from Oil of Copperas and Salt-Petre,

Petre, and pouring the eighth Part of an Ounce thereof upon half as much Oil of Carraways, in a Place from whence the Air was exhausted, the Mixture presently took Fire, and burst in Pieces a Glass that contained it, of six Inches Breadth, and eight Inches Heighth, just like kindled Gun-Powder: This can by no means be ascribed to the Air, because the Glass was emptied of it; wherefore the rarefying Power of the Fire must be consider'd as the Cause thereof.

Sect. XIII, *and* XIV. *The Sixth Reason, and an Experiment.*

From what has been said above, about Red-Lead, it seems, that one might infer, that as Air and Water are consolidated with Plants and Living Creatures, and help to compose the Bodies thereof, the Particles of Fire are in the same manner to be found in the Structure and Composition of many things, without any actual Burning, as Water may be in hard Horns, Bones and Wood, without rendring the same Soft or Moist. This the Chymists can witness, who have frequently distilled such Bodies, without mixing any Liquid Matter with them.

They who have ever seen how easily many Things burn, and how with a touch of the least Spark of Fire, they are in an instant turned almost all of it into a dreadful and destroying Flame, will perhaps insist upon no other Proofs, to be convinced, that there are lodged in Wood, Turf, Bones, Oil and Gun-Powder, a vast Number of Fire-Particles, which as soon as kindled, do all of them operate; whereas without being kindled, they remain Quiet and without Motion.

But for a plainer Proof, how probable it is, that Fire itself may contribute to the Formation of solid

lid Bodies, the Naturalist know, that there h
been lately in the foregoing Age, a certain Su
stance disclosed to the World, to which they gi
the Name of *Phosphorus*: This appears to be
solid hard Body, that may be handled; but put
into warm Water, and it will assume any For
and retain it after 'tis Cold. So that the Mak
thereof use this Method, to collect a great ma
small Balls, in which Shape it oftentimes con
over first, into one great Piece. Now, that t
Matter, if not wholly, yet for the most part co
sists of a still Fire, is plain from hence: that
you let it lye for Years together in cold Water (
a great Quantity thereof in my Custody has lain
above ten Years) it will not burn; but being t
ken out of the Water, the Warmth of a Ma
Hand will presently produce a Light in it, and
Flame too, tho' not sensible, and if you spread
little of it upon the Skin of your Hand, it w
seem as if a little Flame rose from it, but wit
out burning: But if you encrease the Warmth
this *Phosphorus* a little more, it will presently exc
its Heat, and be changed into a consuming a
unextinguishable Fire, burning till nothing hard
remains of it, excepting, as some say, a litt
Sower Liquor. I never burnt it in a great Qua
tity, but have found by Experience, that t
Warmth of the Sun will kindle it; and that wh
one rubs it hard upon a Cloth, the same will tak
Fire; as likewise, that when some Body ha
smear'd his Face over with it, that he might shi
in the dark, and afterwards moving so much as
get a kind of a Sweat, it burnt all the Hair o
his Head, and had like to have occasion'd muc
greater Mischief. But we shall speak more large
ly hereafter concerning this *Phosphorus*.

But that besides all this, Fire joins and fixes i
self to many Bodies, has been plainly enoug
prov

roved by Mr. *Boyle*'s Experiments; and it is ffirmed by many, that the Beams of the Sun col-ected in a Burning-Glass, and pointed for a time gainst Antimony, have encreased the Weight hereof.

Yea, since Fire as well as Water, Air and Earth, ave been upon Enquiry, found in the Compo-tions of all Animals and Plants, what Reason can ny one alledge, that the three last should be steemed particular and determinate Beings any ore than the first? We shall not reckon the other roperties of Fire, since this seems sufficient to rove, that it is a very particular Matter, at least at it is very probably so.

Sect. XV. *Convictions from the foregoing Observations.*

Now, whatever the Nature of Fire may be, n any one ever fancy, with perfect Tranquility, at so Noble a Creature is found in the World by hance, and without Design? The Beauty where-f is so great, that whereas the Ingenious Painters n imitate the Colours of all things, they are only nable to represent the Glance of Fire; the Be-fit of which is so universal, that without it, the Vorld would be deprived of Warmth, of Light, Fertility, and be nothing but a dismal Solitary abitation for those that dwelt upon it: Even far, that there is hardly any thing to be found in e World, the Preparation of which for the use of Mankind, is not wholly, or for the most part wing to Fire. Not to mention the illustrious se thereof, by which the Enquirers into Nature ave made it, as it were, one of the chiefest Keys, herewith to unlock the most hidden Secrets of Nature. Yea, if Fire has its Existence by Chance, ow can any one who believes it, deliver himself

ſelf from the dreadful Apprehenſions, that eith
by the ſame Chance, or by an unavoidable Co
currence of ignorant, but neceſſary, Cauſes, t
World may to morrow, or ſooner, be deprived
Fire, and he himſelf condemned to perpetual Da
neſs, and to a moſt miſerable Condition?

Sect. XVI. *The great Quantity of Fire in th World.*

Now if one of thoſe Philoſophers, who t
happily doubts of the greateſt Truths, be forc
to acknowledge by what has been ſaid above, th
hardly any Living Creature can ſubſiſt without
uſe of Fire; let him go on and obſerve, what gr
Abundance of it is to be found every where; a
how being at hand in almoſt all Subſtances, it d
as it were, offer itſelf to the Service of all M
and is found ready without their taking hardly a
trouble about it.

To ſhew that this is true, it will not be nec
ſary to ſearch for Demonſtrations, nor a long Ch
of Arguments in the Depths of Philoſophy. W
know well enough, that it is to be met with i
manner every where; as in almoſt all Plants, eſp
cially ſuch as conſiſt of Wood, and which co
poſe whole Foreſts, in the moſt part of Anim
in their Bones, in their Fleſh, in their Blood,
which being dryed, will burn; in ſo many Mi
rals, in Fenny Grounds, in Coals, in Brimſto
in Salt-petre, yea even in Stone itſelf; all whi
Mankind are wont to make uſe of after ſo ma
Ways, when either their Profit or Pleaſure r
quire it.

Sec

Sect. XVII. *The Wisdom of him that restrains the Power of Fire.*

Now if all this cannot induce an obdurate Atheist to acknowledge either Wisdom or Design in the Creator, or Goodness in the gracious Giver of this Fire, let him contemplate the vast Quantity thereof that is found in the World, and the terrible Powers of the same: And then let him tell us, whether he cannot therein discover both the Wisdom and Power of him who preserves the Earth from being destroyed by Fire; since so raging a Matter that is to be met with in such great plenty every where, is after so wonderful a manner bridled and restrained from exerting its Consuming Faculties, and yet so readily offers itself to the Service of every one that wants it.

That this is not a vain Imagination, is as clear as the Day; because there is not only a Quantity of Fire sufficient for all Purposes throughout the World, but even so much of it, that no Body could think thereof without Horror, if he were not assured that there were not an over-ruling Power that holds the same in his Hand.

Sect. XVIII. *An Historical Account of Fire in the Earth.*

Moreover, if we look upon the Earth, how can we avoid being alarmed, when we find so many Parts of it filled with Fire! In our Watry *Holland*, and even in the drained Meers and Fenns, Experience has frequently taught us, that the Vapours exhaling from the Pits and Wells of the Peasants, having been accidentally set on fire by a Candle, have miserably consumed both Men and Houses.

But

But to be yet further convinced of the Dang in which the whole Structure of this Globe according to all Probability, on account of t Quantity and devouring Faculty of the Fire hid the Bowels of it, we need only consult Histo concerning the number of subterraneous Caver of Fire and burning Mountains, in which a nat ral Gun-Powder, if there be not yet somethi more violent, does so often exert itself in all i dreadful Effects. From whence otherwise do pr ceed the terrible Eruptions and Eructations Fire of the famous *Monte Gibello*, or *Ætna*, in *Sicil* By the Force of which, Stones of 300 *lb. wt.* ha been thrown out to the Distance of several Mile and whole Rivers of Fire flowing out of it, ha consumed every thing round about it. In the Ye 1557, it occasion'd an Earthquake throughout th whole Island, with the Destruction of many of th Buildings, whilst Noises, like the Discharges the greatest Guns, were heard, and rent the Earth thro' the Openings of which, the Fire burst out i such great Quantities, as to destroy every thin five Leagues about this Mountain. This grea burning Mountain, according to the account *Borelli*, does contain in Circumference at the Foo or Bottom of it, about a hundred Leagues; an there might be a whole Book writ upon the dis mal Effects of it.

Had this been the only Place of the Worl where such a thing had happen'd, our unhapp Philosopher might still have been easie, flatterin himself, that it was an uncommon Event, and tha there was no Danger from thence to the whol Earth: But he won't be so easily comforted, wher he finds in the Relations of all Geographers, that the like burning Mountains are to be met with in all the Corners of the Earth.

The

The *Monte di Soma*, or *Vesuvius*, lying not far om *Naples*, is both now, and has been for many ges a *Volcano*, or burning Mountain; as is *Hecla* *Iceland*, which rages oftentimes no less than *Etna*, vomiting out prodigious Stones with a ter- ble Noise.

In the Island of *Java*, not far from the Town f *Panacura*, a Mountain broke out in the Year 586, for the first time discharging such Quantities f burning Brimstone, that above 10000 Persons the Country round about were destroyed there- ith, and casting out great Pieces of whole Rocks s far as the said Town, accompanied with so dis- al a Smoak, that the Sun was cover'd with it, d the Day almost turned into Night.

The Mount *Gonnapi*, in one of the Islands of *uada*, that has been burning about seventeen ears, broke from the rest with a terrible Report the Month of *April*, of the said Year 1586; rowing out a most dreadful Quantity of burning latter, and great Red-hot Stones, of the length f a whole Fathom, as they were found in the Sea, esides such a prodigious Number of the smaller rt, that they render'd the Sea in a manner un- ilable, whereby the Fish were suffocated, and the aters boiled as if they were in a Kettle with Fire nder it.

There is likewise another Mountain upon the land *Sumatra*, which smoaks and flames just like *Etna*.

The Earth in the *Molucca* Islands casts out Fire several Places, and frequently with a hideous oise; especially a Mountain in *Ternate*.

In one of the *Moriss* Islands, lying 60 Leagues istant from those of the *Molucca*, there happen ve- y often Earthquakes, with Eruptions of Fire and shes; and those subterraneous Fires have so reat a Strength, that they cast out glowing Stones,

which

which appear like whole Trees; and the Roc themselves are therby burnt and consumed; wh the Mountain which represents a frightful Flam roars with a terrible Noise, as if there were continual Thunder, or Discharge of the great Cannon.

In *Japan*, and the Island about it, there are m ny little, and one great burning Mountain.

In *Tandaja*, one of the *Philippine* Islands, the are found many small Fire-Mountains; and one the Island *Marindica*, not far from them.

The like are found in *North America*, in the Pr vince of *Nicaragua*; as also in *Peru*, among tho Mountains that make the Ridge of the *Cordiller* near the City of *Arequipa*, there flames a Mounta continually, which causes the Inhabitants to live a perpetual fear, least it should burst some time other, and swallow up the Town. There is lik wise one near the Valley *Mullahalo*, which bein open'd by Fire, did cast out great Stones, and t the Cracks and Noise that it made, put even ver distant People into a terrible Fright.

There be also several burning Mountains in th District that lies on the East-side of the River *Je niscea*, in the Country of the *Tongesi*, some Week Journey from the River *Oby*, according to the Re lations of the *Muscovites*; as also near another Wa ter called *Besida*.

They who desire to be farther informed of these and other Places of the World, where Fires hav formerly appeared out of the Earth and Moun tains, may consult the Cosmographers and Geo graphers, such as *Varenius*, &c.

That which is related in the History of the Roy- al *Academy* of Sciences for the Year 1708, is par- ticularly remarkable, namely, that near the Island *Santorini*, in the Year 1707, there sprung up a new Island from the Bottom of the Sea, in which, about

about the End of *August*, the subterraneous Fires, which at first made a terrible rumbling, burst out at last with such violent Noises, as if six or seven Pieces of great Cannon were discharged at the same time, and made continually new Rents and Openings, through which sometimes a great Quantity of Ashes, and sometimes so vast a number of little glowing Stones, were cast up into the Air, that they made a little Island near that of *Santorini*, where they frequently fell down, making it appear as if it were all on Fire: Besides that, there were frequently seen huge burning pieces of Rocks tossed into the Air like Bombs and Carcasses, with such a Force, that they were carried seven Miles before they dropt into the Sea. The rest of these terrible Circumstances may be read in the abovemention'd Place.

Sect. XIX. *Fire in the Air, and an Experiment.*

Now if we pass from the Fire of the Earth to that of the Air; must not even the most obstinate Atheist acknowledge, that this Element is likewise full thereof; in Case he ever saw the same disturbed and put into Combustion by Thunder and Lightning, and the dreadful Effects thereof? But supposing it to be in the midst of fine and calm Weather, and a bright Sun-shine, yet even there would he not reflect, without trembling, upon the great Quantity of Fire wherewith he is surrounded, especially, if ever he had an Opportunity to observe the Effects of great Burning-Glasses, which (by only collecting the Beams of the Sun into a Place not much smaller, as the Focus is smaller than the Superficies of any such Burning-Glass) can kindle a Fire of so terrible a Heat, that in a few Minutes it will do that which our greatest Fires are not able to do in Hours, Days, yea, Months and

Years; of which more largely in another place. But to shew here, that the Air, even warmed with a Kitchen Fire, acquires a sufficient Quantity of the Heat thereof to do harm, one need only take a polished Silver or Pewter Spoon, and put the Cavity of it against the Fingers, and hold it fast with the Thumb, in such a manner that the Handle of it may stick out about half way above the Forefinger. Now if you hold the back of your Hand, and the Concave part of the Spoon against the Fire, so that the Appearance, or Image of the Fire collected therein, throws a bright and enlighten'd Spot upon the Forefinger, you will find, that the Fire which is in the Air, being reflected from the Cavity of the Spoon upon the Finger, will burn the same intolerably, even whilst the Hand suffers no Inconveniency from the Fire itself and the Air about it, and is only sensible of a moderate Heat.

But to be entirely convinced of the great Quantity of Fire in the whole Universe; Let any Body view with Attention the Sun and the Stars, which do not only shew themselves to us thro' Telescopes, but even to our naked Eye; and let him consider, what a vast quantity of Light descends from them to us, which is either plain Fire itself or at least brings along with it the most subtil Fire imaginable: And then ask such a one, whether he be not convinced of the Probability of what we have said, and particularly of this, that the Heavens likewise do contain Fires, the Number of which exceeds all Conception.

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Sect. XX. *Convictions from the foregoing Observations.*

Now to come to a Conclusion of all these Matters, let a Man seriously consider with himself all that has been just now related concerning the Fires in the Bowels of the Earth, or those of the Air and Heavens, and let him tell us, since the Property of Fire is such, that when once put into Motion, it will kindle every thing that is capable of being burnt or inflamed, and wholly destroy the same, whether it does not appear a greater Wonder to every one that argues rightly, that the Earth, with all about it, is still subsisting, than that it has not long since been entirely devoured and consumed by so many Fires as are in and round about it. Certainly, if the Volcanos, or burning Mountains, that are to be found in all Corners of the World, had a Communication with each other by subterraneous Rivers of Fire (as many think may be proved by History and Experiments) it is hard to conceivable, that it could have continued in being to this very Day.

And consequently, that which the Christians confess, and St. *Peter* maintains in his Second Epistle, c. iij. *v.* 7, 10, 12. does not deserve to be so much ridiculed at and derided, as is done by some Atheists, namely, *That the Heavens and the Earth which are now, by the same Word are kept in Store, reserved unto Fire against the Day of Judgment and Perdition of ungodly Men.* ——— *in the which the Heavens shall pass away with a great Noise, and the Elements shall melt with fervent Heat; the Earth also, and the Works that are therein, shall be burnt up.* He repeats the same in the 12th Verse: *Looking for and hasting to the coming of the Day of God, wherein the Heavens being on Fire, shall be dissolved, and the Elements shall*

melt with fervent Heat. Since Nature, and the dreadful number of so many terrible Fires that are found almost every where, in the Heavens, in the Air, in the Body of the Earth, and almost in every thing that it produces (as has been shewn before) ought to make every one believe, that the Destruction of all things by Fire, has long been at the Door; and that it is a certain Miracle, that the World has not sooner felt the Effects thereof.

Sect. XXI. *Convictions from restraining the Power of Fire.*

But after all this, add yet something more, by which a Divine and Over-ruling Power is as sensible, as if it were felt by the Hand: Can any one imagine, that it is by mere Chance, and without Wisdom, that so terrible a Creature, which by one single Spark can be put into Action, and into the most violent Motion, is bridled and curbed from doing Evil, and moreover compelled to be beneficial to Mankind in innumerable Manners and infinite Occasions; and that there is no Direction necessary thereto, to prevent the same from putting the whole Globe into a Conflagration, as it sometimes does several Parts thereof? Can we here discover no Goodness nor Wisdom of a Great Mighty and Gracious Ruler, since by his Power only, this raging Matter is, as it were, imprison'd in Pitch, Oil, Brimstone, and whatever else is a proper Food for it; and that he does not suffer it to break out to the entire Destruction of all Things? That besides this, he does deliver to Mankind the Keys of these Prisons, which can at any time set free this tamed and chained Prisoner, and set it at full Liberty, only by rubbing one piece of Wood against another, by striking Steel upon a little Stone, by putting a very small quantity of Fire

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to other combustible Matters, and in short, after infinite other ways, as often as the Service thereof is necessary? Again, if the bridling all this Fire is brought about by Chance, how can any one remain without a continual and deadly Fear, lest by the same Chance, which is no more determined to one Object than to another, this imprisoned Fire might shake off its Fetters, and so produce a most miserable Destruction, in the most dismal manner, of every thing that stands in its way?

Let now a Philosopher, who will not admit of this, in order to be convinced, step once into a Magazine of Gun-powder, where a great Quantity of that Matter is laid up: Now if Experience had not taught him before-hand, would he have easily believed, that in such a black and unsightly heap of Grains, such an unconceivable and dreadful Quantity of Fire were hid and lock'd up, in which he could neither discover Light, nor Warmth, nor any sort of Motion? and yet, by the fall of a little Spark of Fire into this seeming unapt Matter, it would be in an instant of Time turned into a consuming and destroying Flame, the Violence of which would rend the Earth, and cause even remote Houses and Walls to fly up in the Air, and fall down in Heaps of Rubbish; insomuch, that the strongest Towers, nor even Rocks themselves, how solid soever, would be able to resist the Force thereof.

And to the End that our Philosopher may not flatter himself with this poor evasive Comfort, that there are but few Magazines of such destroying Matter, and that but few People have occasion to come in the way of 'em, let 'em consult the modern Writers of Natural History; or let him only consider with Attention, the Experiments and Relations of the present and past Years; and then

the vast quantity of Thunder and Lightning, and the frightful Eruptions and dreadful Havock made by so many Earthquakes and burning Mountains; and he will undeniably be convinc'd, that it is not only in the Magazines or Mills of Powder, that he is to apprehend the Effects of Brimstone and Salt-petre, which are the Ingredients of Gun-powder; but that likewise the Air and the Earth, if they be not full of a natural Gun-powder (as some Philosophers, and not without Reason, have thought) are at least endowed with so violent and dreadful a Fire, that the Effects of it does not only equal those of Powder itself, but in innumerable Cases, does incomparably exceed it; altho' it so often appears entirely inactive.

Sect. XXII. *After what manner the Fire of the Air and Heavens is preserved.*

Now if that Fire which is imprison'd upon the Earth in so many Places, and in such various Bodies, and hinder'd from breaking out for the Destruction of all things, does discover a great and mighty Preserver; so that even an Atheist cannot or dare not promise himself one Hour's Security, if it were not an all-protecting Providence, but only unknown Laws of Nature, or mere Chance, operating indifferently this or that way that interven'd: How much more then is a Wonder-working and an Adorable Power visible from hence, that such an unconceivable Quantity of Fire can be kept up in the Air round about us, without putting every thing into a Conflagration! And not to speak of Lightning again, is it not demonstrable by the modern Burning-Glasses, that Light itself, as it is derived to us from the Sun, being a little more closely compressed or collected, would be capable of converting the whole Globe (nothing ex-

excepted) into a glowing Ocean, much more dreadful than that which is seen in the Glass-Houses, or in the Metal Smelting-Houses.

Now I first ask those People that cannot discover in all this a Divine Direction, to what Cause 'tis owing, that the Globe of the Earth is placed and still continued at just such a Distance from the Sun; so that the Fire thereof can only warm, enlighten and fertilize the same? And how it happens, that it is not removed to so great a Distance, as to be render'd entirely barren by Cold, or brought so near to the Sun, as to be burnt up and turned into a glowing Heat thereby; since it is plain enough, that nearer to the Sun the Light is more closely compressed in the same Space, and consequently has much greater Force in burning? And whether it be conceivable, that among so many Millions of Places that might have been possess'd either by the Earth or by the Sun, in the vast space of the Universe, there is just one single Point chosen, where only it is most advantageous to this our Globe, without any End or Design?

Secondly, Since, if the Light came down to our Globe so closely compressed, as it is near the Sun, the Earth would undergo a much stronger and more violent Heat than what we observe in the Focus of great Burning-Glasses, wherein, in the Space of a Minute, all kind of Metals fall down in glowing Drops, let these Philosophers tell us, whether any more proper Means could have been imagined by them or others, to secure the Earth from so dreadful a Heat, than to bind the Light to such Laws, by which every thing that proceeds from one Point, is dissipated and scatter'd; insomuch, that the Right Lines, which it describes by its Beams, the farther they flow from their Source, the more distant they become continually from each other. This Dissipation or Scattering of

Light, the Mathematicians expreſs by the Term o *Diverging*, and they prove the ſame by numerou Experiments, by which, beſides that, as we have ſaid above, the Earth is preſerved from the moſ dreadful Conflagration: This great and unvalu able Conveniency is conveyed to Men, that al things, and one and the ſame Point of many, may be ſeen at the ſame time on all Sides. Of al this, thoſe who have no Skill at all in Opticks may for greater Clearneſs conſult what has been ſaid in *Contemplation* XII.

Sect. XXIII. *Convictions from thence.*

And can theſe unhappy Men ſtill fancy that there is neither Wiſdom nor Power in all this; to wit, That all the Rays of Light which is deri ved down to us from ſo immenſe a great and fiery Ball (as we may ſuppoſe the Sun to be in all ap pearance) do ſufficiently *Diverge*, or are ſcatter'd abroad, before they reach this Earth; and that it is without any Deſign, and only by meer Chance, that ſo active and violent Matter as are the Parti cles of Fire, which if preſs'd together, or united in a Point, would, as in a Furnace, turn all things into a glowing Sea; and notwithſtanding its being continually protruded with ſo ſwift and terrible a Motion, is yet ſo ſtrictly bound and confined by theſe Laws of *Divergency*, and continues ſo, that it has never departed from them in ſo many thou ſand Years following; and that all Men whatever, can enjoy nothing but the greateſt benefit there from, altho' its dreadful Motion produces other wiſe nothing but general Deſtruction.

SECT. XXIV. *All the Water in the World not sufficient to extinguish this Fire; shewn by several Experiments.*

THERE remains still to remove one Subterfuge, which seems still of use to those that deny a Divine Providence, namely, that how plentiful and how terrible soever the Fire may be which is found in and about the Earth, there is yet a sufficient Quantity of Water to preserve the same from being burnt; so that upon this occasion, it does not seem necessary to ascribe such a Preservation to a particular Favour and Foresight of GOD.

I shall not object to this, that there are even such Bodies containing such Fire-Particles within them, that can only be put into Action by Water, of which a Lime-Kiln and Mill, not many Years since, has been a sad Example, which by the breaking of a Sea-Dyke, and overflowing of the Water till it reached the Lime, was entirely burnt down: Besides, many other Instances that may be brought from Chymistry, to prove, that a Cold Matter infused in Water, will become intolerably hot, and sometimes break out into a clear Flame: Thus Oil of Vitriol, upon putting cold Water to it, will make the Glass in which they are mingled so hot, that one shall not be able to hold it in ones Hand: the same will likewise happen, by pouring cold Water upon that which remains from the Sublimation of the *Lapis Hæmmatites*, and *Sal Armoniac*, and in many other Cases.

But it is an Experiment known to the greatest Enquirers into Nature of this Age, that Living Sulphur, mixed with Filings of Iron, and kneaded to a Dough, by the Addition of cold Water, will in a few Hours time become warm, and at last be set

set on Fire; touching which, the *Physicks* of M. *Hartsoeker*, the *Opticks* of Sir *Isaac Newton*, as al the Registers of the *Royal Academy* of France, ma be consulted.

Now, whether this be one of the Causes of th Subterraneous Fires, Earthquakes, and the lik Motions, we shall not here nicely enquire into but at least it is unquestionably true, that there a Matters of such a Nature in the Earth, whic far from being secured from burning by Water, a kindled thereby, and compleatly set on Fire.

And to shew farther, that there are also certa Matters which are capable of burning in Wat itself with great violence, without being able t be extinguished any wise thereby, we need on cast our Eyes upon that sort of Fire-Works, whic first performing their Operation under, and th above the Water, do thereby represent an une tinguishable Fire. To this purpose, I find th little Experiment in my Notes, of the *29th* of *Oc* 1695. We took a little Cartouch, or Case, of tha kind which they use in making little Serpents c Squibs in common Fire-Works, and filling th same with Dust of Gun-powder, without addin to it the Cracker or Bounce with Grained-Powde we tied it to a little Stone; then it being kindled and dropt into a Glass filled with Water, we ob served it to burn under the Water, and in the dar of the Evening, to give a great Light.

Now, since there is in the World much Brim stone and Salt-petre (of which Gun-powder doe partly consist) when they have once taken Fire they cannot easily be extinguished by Water, whic does sufficiently appear from what has been jus now said; as it does likewise from the frightfu Eruptions of the Subterraneous Fires, which hav oftentime burst out from the bottom of deep Seas, of which we have given an Instance before, in the

Case

Case that happen'd not long since, of the new-born Island near that of *Santorini*.

Sect. XXV. *Some Experiments about the Phosphorus.*

Besides the foregoing Experiments, the restless Curiosity of Chymists enquiring into the Nature of all things, has some few Years since revealed to the World a sort of Collection of Fire (of which we have already made some mention above) called the *Phosphorus*, which seems to be before scatter'd in the Air, and oftentimes in Water itself, and being prepared by the accession of any Heat, may be reduced into a perfect Flame: Among several Experiments which we have made about this *Phosphorus*, I find the following upon my Notes;

I. That it has been often found, that a certain degree of Warmth was necessary to make the *Phosphorus* yield a Light or Burn:

For in the Winter, or *January 1696*, a little bit of it upon a Paper, lying upon the side of the Glass Receiver of the Air-Pump, in a place that was not warm, was observed to give no Light; but on the contrary, some of it being put upon the Hand, it presently shined and flamed, but without doing any hurt. The same being repeated several times, always produced the like Effect. But being put into a little Bottle, that was made somewhat warm, it did not only burn, but remained burning, tho' the Air was quite pump'd out of the Recipient, into which it was put, and also afterward, when the Air was let in again: So that it appeared from thence, that this Fire, different from many others, would equally burn with or without Air.

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We likewise saw, that the same *Phosphorus* beir put upon the Dust of Gun-powder, and held a Paper at such a Distance from the Fire, as a M may hold his Hand without uneasiness, both of 'e presently took Fire: The same happens wheth you use the Dust of Gun-powder, or the roun Grains of it with the *Phosphorus*. From when the foregoing Assertion, *viz.* that Warmth w necessary, does likewise seem to be proved. likewise from hence, that upon rubbing the *Pho phorus* upon Brown Paper, and warming the sam it will burst out in a perfect Flame.

II. In another Experiment, we took some of th finest Parts of Dust of the *Phosphorus* (which the Distilling are drawn over together with th rounder and larger Pieces) and put it into a litt Vessel, with Water upon the Fire; where after had boiled, we perceived, that in the empt Part of that Vessel, there appeared a great Ligh at the Top of the Water, and some little Piece as if they were burning, floated upon it.

From hence it is plain, that these Fire-Parti cles, with the requisite Degree of Heat, wi likewise burn in Water; and that Fire can als pass thro' Water, and produce a Flame upo it, without being extinguished therewith: can't be objected, that there are not sufficien Pores or Passages in the Water for it, since the foregoing Experiment, *Sect.* XXIII. whe the Gun-powder burnt in the Water, a thic Smoak ascended, as passed thro' the whole dept of the Water.

III. We put the Water, in which the said Dus of the *Phosphorus* was boiled, into the Recipient c the Air-Pump, and observed that some of the sma luminous Particles preserved their Light till th Glas

Glass was almost evacuated of Air; we likewise saw, that every time that the Air was pumped out of the Recipient, a great Light rise out of the Bottle that held the said boiled Matter: From whence, as well as from other Experiments, it seemed to follow, that the Fire of the *Phosphorus* had an Elastick Power, which exerted itself when the Pressure of the Air was lessened.

IV. The said Water being afterwards cold, and having stood about an Hour in the open Air, it was observed, that whilst it was unmoved it yielded no Light at all, nor could any Part of it be seen in the Dark, but being shaken, it fired (as we speak upon this occasion) or flashed after the manner as Sea-Water does in Summer: And we found also about a Week after, that the said Water, upon shaking the Glass in the Dark, did still give Light like the Water of our Ditches in a hot Summer, notwithstanding that the Glass remained always unstop'd and open. Yea, it may be inferr'd from hence, that Fire does likewise cleave to Water. And if the firing of the Sea, and some of our In- and Salt-Waters proceeds from this Cause, that such a Substance cleaves or joins itself to them, one may likewise conclude from thence, that (how strange soever it may appear) Fire does also mingle itself with Water in a great Quantity, without being extinguished by it, if there be but the least degree of Warmth therein.

V. I must add hereto, that this *Phosphorus*, with which all these Experiments were made, had lain at that time four or five Years under Water, and had been kept in the same; so that even Water being cold, seems to be capable of serving for a proper place to keep Fire in, and from whence the same Fire remaining unextinguished, may upon all occasions be produced. VI. Now,

VI. Now whether we may from hence form an Hypothesis, that this ignite Matter owes its birth either to the Air, or to the Rays of the Sun that are therein, since the Urine of Animals can produce no such *Phosphorus*, without having been a long time exposed to the open Air and Light of the Sun, and likewise thoroughly fermented and putrified; as also, whether the Cause why this Fire cleaves to the fermenting Urine, be on account of its Saltness, forasmuch as in other Waters also which are salt or brackish, such Fire or Flame is commonly observed, we are not yet ripe enough in Physical Knowlege to determine any thing about it here: This is certain, that when the Air and Light have acted a long time upon any such Matter many *Phosphorus's* will proceed from thence; and that there is a very great quantity of Fire scatter'd in the Air, which exerts itself in some manner in all Meteors, but in Lightning particularly, after a dreadful manner. Now Lighning, quite contrary to the Nature of other Fires, seems to want nothing but the Heat of the Sun to kindle it; and accordingly it is observed to be most frequent in hot Countries, and with us in warm Weather. This likewise seems to be one of the particular Properties of the Fire which is found in the *Phosphorus*, that an almost common Warmth, yea, such a one as is hardly able to kindle a Fire, or Gun-powder, will yet set the same a burning: And when it burns, we see, that like Lightning it breaks out sometimes with several Repetitions of new Flames as I find in my Notes, that when I held a *Phosphorus* in a little Bottle exactly over a burning Candle.

I don't know whether others can shew such a Fire, even also a Liquid Matter, that can be presently set on burning so easily as this *Phosphorus*, only by the Heat of one of our Summer Days; but

I never

never saw any kind thereof, besides this ignite Matter, that appeared to me in its manner of Inammation so analogous to that of Lightning: For s for all other ways that are made use of by the hilosophers, to shew how Lightning is kindled in he Air, there seems to be either a real burning Fire, r some other Matters supposed, which many will ot allow to have place in the Air.

Sect. XXVI. *A Fluid Phosphorus.*

We find this Phosphorus useful for discovering roperties of Fire in many other Cases; and among thers, it seems to serve for a Proof and Confirmation of what has been said above, §. VI, *&c.* amely, that Fire is a particular fluid Matter: oraſmuch as this compressed Fire in the Phospho- is will suffer itself to be dissolved in Oyl of loves, and some other Oyls, and communicate) the same some ignite Particles; so that if you t a little piece thereof lie any time in the said)yl, it will acquire a Faculty of shining, and re- resent a liquid Phosphorus: At the same time owever, refusing to be dissolved, and to mix itself ith many other Oyls and Liquors. This likewise oes in some manner seem to shew that Fire, at ast that which is in the Phosphorus, does consist f a particular determinate Matter.

Sect. XXVII. *Preparation of the Phosphorus.*

I was not here minded to describe Chymical roceſſes in all their Circumstances; but to the nd, that every one may be assured of the Truth f what we have here said, and have an Opportuity of enquiring farther into the Properties of Fire y the means of this ignite Matter, I shall here dd a Method of making the same more conve-

nient than those which many Chymists have le
behind in their Writings, because it does not stan
in need of the so troublesome way of evaporatin
the Urine. That which I find in my Chymic
Observations about it, is as follows;

I took the Dregs or Settlings of Urine, that ha
stood a long time in a Tub in an Hospital, and ha
thereby acquired the Thickness of Soap; I p
some Rain-Water to it, stirring it about, in ord
to incorporate them together as much as w
possible, and by pouring off the uppermost an
thinnest Parts of it, I separated the other Imp
rities from it. Then I let it stand in the sa
Water so long, till the Matter that was in
did all entirely subside; from which afterward
by the Repetition of fresh Water, all the Sal
were separated. This the Chymists call *Edul
rating*, that is to say, making sweet or fresh. Th
subsided Matter being dryed in a hot Iron Pot, w
put into two little Retorts, and placed after suc
a manner in the smallest reverberating Furnac
that that which we had a mind should come ov
by Distillation, might not rise too high. The
next Morning, at half an hour after Six, I put Fi
under it, but joyned no Recipient to it; and abo
half an hour after Eight, a yellowish Matter beg
to come over, which dropt into two little Glass
set under it, and would make an Ebullition wi
Aquafortis. At One a Clock of the same da
when the Fume and yellow Drops ceased to com
out of the Retorts, there were two little Vessels, th
Mouths of which were prepared before for th
Purpose, fasten'd on with Luting; being first fill
with Water in such a manner, that the Orifice
of the Retorts might be just above the Water
and we presently observed something like Light
ning in the said Vessels. At Three a Clock the Ai
which was in those Vessels over the Water, wa
glowin

TAB. XVI

Fig. 2.

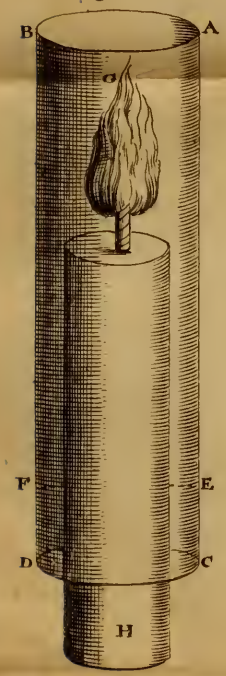


Fig. 1.

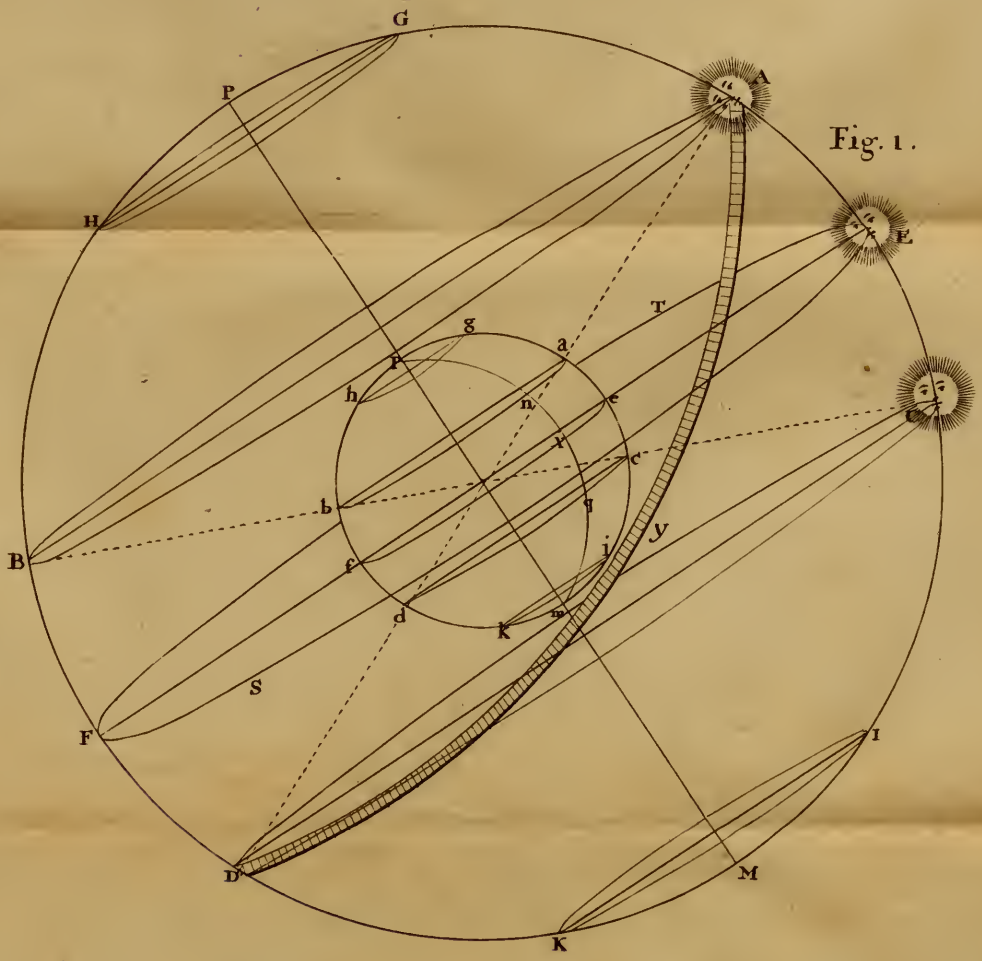


Fig. 4.

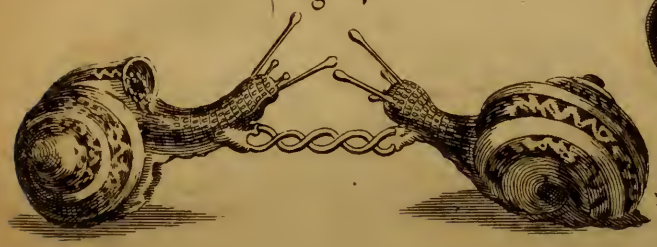
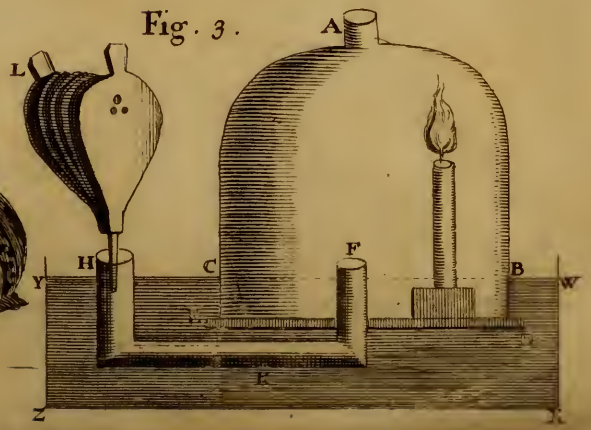


Fig. 3.



glowing and red, and Phosphorus lay at the Bottom of the said Water; the Furnace itself was made narrower than it should be for other occasions, but the Fire-place had its entire Magnitude, to the end, that it might afford as strong a Heat as possible; and to prevent the Diminution of it by the frequent Addition of fresh Turf, it continually was supplied at last with those burnt ones that are used to be kept in the extinguishing Pots.

SECT. XXVII. *Convictions from the foregoing Observations.*

BUT to return to the Business: Since we see in this Phosphorus such a Fire, which upon the accession, of any Warmth cannot only not be extinguished by Water, but may be kindled and burn herein; since likewise we see something of the same Nature to happen in Lightning, which, altho' surrounded by so many thick watry Clouds, yet is not hinder'd from being kindled in the midst of them, and from setting on Fire every thing about it: since we see farther, that this Fire of the Air mingles itself with Salt-Waters, and in the Summer time, causes them to flash and shine; and besides, makes Gun-powder and Salt-petre, when set on fire, to burn in Water just as they would do out of it: To say nothing of the subterraneous Fires, that rage so terribly, tho' they lye under the deepest Sea: I say, if an Atheist would consider all these things, is it possible for him to acquiesce in so poor an Evasion as this, that the Water when once it is put into a general Operation, can secure him either from the Etherial or Subterraneous Fires.

CONTEMPLATION XXII

Of Beasts, Fowls, and Fishes.

Sect. I. *Transition to the Beasts.*

Having already contemplated Mankind under so many Circumstances, namely, with respect to the Air in which we breath; with respect to Water that serves us for Drink; with respect to the Earth that yields us both Food and Dwelling; and lastly, with respect to Fire, whereby such great things are brought about, it hardly seems credible, that any one can reflect upon all the foregoing Particulars with due Attention, without being convinced of the Existence of a wise powerful and gracious God. And in Case all this be not sufficient to disengage him from his deplorable Scepticism, let him proceed farther on with us, and silently and seriously contemplate the Beasts that inhabit the Earth, the Birds of the Air and the Fishes of the Waters, and perhaps the Creator of all those Beings may vouchsafe to bring the Proof of his adorable Perfections, that shine forth therein, powerfully home to his Heart and Understanding.

We have already treated concerning Men, and the wonderful Structure of their Bodies (which otherwise ought to have had the first Rank here), for which reason we shall not enter farther into that Matter now; we shall likewise pass by every thing

thing in Beasts that have any Analogy or Likeness with Men, such as the Structure of their Bowels, Muscles, Circulation of the Blood, *&c.* So that after one or two General Remarks, we shall only here propose some Particulars of Birds, Fishes, and other kinds of Animals; leaving the farther Enquiry, wherewith many large Volumes have been filled, to the Study of those that examine them with a design of Learning, to know GOD from thence.

SECT. II, and III. *Concerning Tame and Wild Beasts; and the Text in* Genesis, *Ch.* ix. *v.* 2. *relating to the same.*

TO come then properly to the Matter; we are wont to distinguish the Beasts into Tame and Wild: Can then any Body imagine, that he is able to prove, that it is owing to Chance, or to any Causes necessarily resulting from the Structure of Animals, that the Tame Beasts, which are so useful and serviceable to Mankind, either for Cloathing or Feeding them, or for other Purposes, such as Kine, Sheep, Horses, and the rest, seem disposed by Nature to be Domestick Animals, and to live among us: Whereas the Wild, such as Lyons, Bears, Tygers, Wolves, Serpents, and the like, delight to dwell in Woods and Solitary Deserts, and of their own accord seem to avoid the Company of Men? Now if this were quite the Reverse, and the devouring and poisonous Creatures should keep together in Flocks, and exert their Violence against Mankind, how much Pains and Trouble would it require in many places to defend ourselves against their Assaults.

We ought therefore to consider with no less Amazement than Attention, that Text in *Genesis Ch.* ix. *v.* 2.; where GOD says to *Noah* and his

Sons, *The fear of you and the dread of you shall be upon every Beast of the Earth, and upon every Fowl of the Air, upon all that moveth upon the Earth, and upon all the Fishes of the Sea; into your hand are they delivered.* And to observe how many Thousands of Years this Word has continued true. Could a Man that had seen an Elephant, a Bull, or a wild Horse provok'd, enraged, and then let out to do what Mischief he would (and who did not know after what manner People used to Tame these furious Animals, and many others, and render them serviceable) ever believe the same without looking upon the above-quoted Text as a wonderful Prophecy? And not to mention Birds and Fishes (without even excepting the greatest Whales) in which the same is very plain and manifest, it is well known, from a multitude of Examples, that this has place in the most devouring and pernicious Creatures: For not to repeat what we have already said, that of their own Nature they chuse to live in Wildernesses and uninhabited Countries we may meet with a very remarkable Evidence thereof in the *Ephemer. German.* 9th and 10th *Year p.* 453; namely, that a Lyon will never assault a Man, unless compell'd thereto by Hunger, Self-defence, or the Discharge of a Gun against him; and in relation to Tygers, we read the following Passage; *they are afraid of white and naked Men, like* (which is very remarkable) *all wild Beasts of Asia and* Africa, *and avoid them as it were a kind of Reverence; and it is without example that they attacked any such.* After having understood all this, let an Infidel himself tell us, whether *Moses*, whom he must account a great Politician, would not have acted against common Prudence, when he pretended that those Words which at that time when they were spoken, were so little probable, proceeded from

from GOD, whom he served, and whom he desired that *Israel* should likewise serve.

SECT. IV. *The Structure of Beasts in general, and Convictions from thence.*

TO come now to some Particulars: If we should contemplate all Beasts, Great and Small, Wild and Tame, and at the same time suppose that there was but one of each Kind in the World; Then, should any one view with a Microscope the Structure of the least, even of the most contemptible Fly, or smallest Mite in a Cheese; could he forbear acknowledging each of them to be a Miracle of Nature; and not be sufficiently convinced, that He who had formed all the Members of them, so useful, with respect to each other, must have been very wise; and that in providing them with a Mouth, Feet, and other Parts, he did it with a Design that they should eat and walk, and discharge other necessary Functions therewith!

It is wonderful again, that these unhappy Philosophers, seeing an artificial Mouse or Fly, by the help of Springs and Wheels, like a Watch, enabled to perform some of the most common and rudest Motions of those Creatures, think they can never sufficiently commend the Skill and Contrivance of the Maker: And yet when we see the Original, the living Creatures themselves, in which they are forced to confess there is infinitely more Skill and Judgment to be found, do yet maintain, that He that formed them, was endowed neither with Wisdom nor Understanding.

Sect. V. *Of Procreation in general.*

But now ſuppoſe one ſhould ſhew them of each Species of Beaſts, not one only, as above, but two, Male and Female, both endowed with Parts of Generation relative to each other, and enabled thereby to propagate their Kind: Let the moſt preſumptuous and conceited Atheiſt, though never ſo well verſed in Mathematics or Mechanics, propoſe to himſelf the following Problem, namely, *To make two Animals of the ſame Species, which beſides all other Faculties of Eating, Drinking, Running, Flying, and the like, have likewiſe that wonderful Property of jointly producing other Creatures of their own Kind, and ſo to continue their Poſterity after their own Kind.* And let him anſwer us, whether he could be able to do this with all his Wiſdom; and if not, whether he muſt not eſteem him that can do it, as much wiſer than himſelf, and all other Men together.

This being done, let him with us contemplate not one, nor two, but thouſands of ſuch Creatures in the World; and then conſider with himſelf, whether a pious Enquirer is ſo much in the wrong, when he acknowledges the adorable Glory of the Great Creator in all theſe things; who, to the end that every reaſonable Being, that ſees theſe his Wonders, even in ſuch ſmall Creatures, may be thereby convinced of his Power, of his Wiſdom, and of his Bountifulneſs, which he extends to the moſt contemptible Animals.

If this be not true, how comes it to paſs that in each of the two Sexes, the reſpective Parts for Procreation are ſo accurately adapted, that among ſo many Millions, there is hardly one only to be found, that is not or will not be rightly form'd for propagating his Kind. And if this were not the De-

ſign

sign and Purpose of the Creator, what Reason can be alledged, that all kind of Creatures living, both upon the Earth, in the Air and Water, (how different soever in Nature, Figure, and Size, they may be) are hurried with so strong an Inclination, yea, even with Rage and Madness, to propagate their Species? Insomuch, that one cannot contemplate the same without Terror many times in those Creatures that are strong enough to do mischief.

Sect. VI. *Generation performed after various Manners.*

The rather (whereby all Evasions are cut off) since the wise Creator of all things living has caused this Propagation of the Species to be performed after so many and various Ways, that whoever is endowed with any Reason or Equity, must be convinced, that all this proves in the cleerest manner, the Work of a free and wise Divine Pleasure, but by no means of a natural Necessity, operating always after the same manner.

Thus we see, that Men, Kine, Sheep, and numberless other Creatures, are received and formed in their Mothers Body.

That most Birds are indeed received in their Mothers Body, but are formed in an Egg out of the same.

That many Fishes (as the Experience of Fishers and other Enquirers inform us) are not only shaped, but likewise received out of their Mothers Body; forasmuch as the Female or Spawn Fishes, discharging their Spawn in convenient Places in the Water, the Males resort thither, and impregnate the same; whereby the little Eggs in the Spawn are fœcundated, and Fishes of the same Kind are produced from thence.

The First is performed entirely in an Animal an Liquid Warmth.

The Second, so far as it relates to the Reception is after the same manner; but the Formation is i a dry and different Warmth: So that in som Countries many Chickens are hatched from Egg in Ovens made expresly for that Purpose; not t take notice that Women likewise have hatche Chickens from Eggs by the Warmth of their Bo soms.

The Third, concerning Fishes, happens both way in Cold Water, without any remarkable Warmth.

And besides this, to shew that the Great Rule of all things will not suffer himself to be bound b any Necessity or Fatality, we may see other Fishe to be conceived likewise in their Mothers Body such as *Carps*, the Spawning-time of which is we known to the Fishers, that testifie the same. Bu besides these, there are other Fishes likewise formed in their Mothers Body, such as *Whales*, in which People have oftentimes found living Young one of the same Species.

Sect. VII. *Animals of both Sexes.*

But farther to prove this last, and the unlimited Will of the Great Creator of all things in the Execution of his own wise Purposes, could it be believed that there is a Species of Creatures, which are at the same time both Male and Female, and which do copulate with each other after both ways? They that desire to be satisfied therein, may consult the *History of the French Academy* for the Year 1699. *p.* 46, 47, *&c.* where Mr. *Poupart* affirms, that he had observed it in Worms that are in the Earth, which would get into a proper Hole for that purpose by two and two, after such Manner, that they can stretch themselves strait out by

by each other, placing the Head of one by the Tail of the other; after which manner they Copulate, and have been so found in Spring in warm and moist Weather. This has caused Mr. *Homberg* to doubt, whether this Kind of Worms might not impregnate themselves, since they can conveniently bend their Bodies, and become Males at one end, and Females at the other, into which we shall not farther enquire. Mr. *Poupart* does likewise give us there a rough Enumeration of the Creatures, in which he says, he is sure, that this Particular has Place; and besides these Earth-Worms, there is mention made of another kind, with round Tails, which are found in the Intestines of Men; so likewise such as are found in Horses; the Snails of the Earth, and of Fresh Waters, together with many other Kinds, and all Leeches and Blood-Suckers.

This Observation is likewise confirmed in the said History, for the Year 1708, with many Circumstances about Snails, by Mr. *du Verney*, as also by Dr. *Lister*, in his *Anotomical Exercitations*, as they are mention'd in the *Act. Lipsi.* 1695, *p.* 318; and Mr. *Blancart*, in the *Theatre of Rupsen*, relates the Observations of *Swammerdam*, concerning the Coition of the Horn-Snails, who have in their Neck both the Parts of Generation by each other, and are wont to brandish the Male *Virga* several times, till it can meet with the Female Part of the other, on both sides the *Tab.* XVI. *Fig.* 4. will shew this without farther Explanation.

SECT. VIII. *Convictions from the foregoing Observations.*

I HOPE there will be no occasion here of using many Arguments to convince a Sceptick, that one who acknowledges a GOD, will not maintain so

abſurdly, when he ſees that one and the ſame E of Generation is performed after ſo many differe ways (each of which is the reſult of wonderf Wiſdom) that this whole Work is to be aſcribed mere Chance, by reaſon of the Skill and Contr vance appearing therein; Nor yet to a blind a ignorant neceſſary Cauſe, on account of the D verſity and Variety whereby the ſame End is wiſely purſued: But much rather attribute it e tirely to GOD, who being neither limited t Laws, by Methods, nor by Inſtruments, in r vealing his Wonders to Mankind, does make eve thing according to his own good Pleaſure, and t Council of his Will.

SECT. IX. *Young ones produced upon the back of Pipal.*

NOW, after how many different Manners, be ſides thoſe already mention'd, the Production Living Creatures into the World is performed may be ſeen in thoſe Treatiſes that have expreſl handled this Matter: And that we may be onc again convinced, that this is only to be aſcribe to a Supreme Will, directing all things accordin to its determinate Purpoſes, and which is boun by no particular Rules, we may contemplate th Production of *Caterpillars*, *Silk-Worms*, and the like, and obſerve how much they differ therein from other Creatures, being not fit for it before that they are entirely and ſpecifically changed, and from creeping become flying Creatures.

Beſides all this, the Belly of the Female Animals ſeems to be the principally deſigned Part for the Procreation of their Young; but again, becauſe none ſhould imagine that this were an abſolute Neceſſity, and to be aſcribed only to the unknown Laws of Nature, let him conſult the Second and

Third

Third Figure in the Fourth Table of the *First Cabinet of Animals*, of Mr. *Ruysch*, where, to his great Astonishment, without doubt, he will find an *American* Animal, called the *Pipal*, like a Toad, which produces its Young ones out of its Back; so that neither those Creatures, nor the Eggs from whence they come, have any Communication with the Cavity of the Belly.

Sect. X. *The Food of Animals.*

And to the end, that it may not be thought that the Generation of Animals is not just the only thing in which the Wisdom of the Maker shines out equally with his Free Will and Pleasure, by which he does all things to his own Glory, and to the Confusion of those who represent his unbounded Power by the Likeness of a Clock, or other Artificial Machine, that Works necessarily and ignorantly; Let the Atheist contemplate those Parts of Animals that are useful to them in Feeding; and let him observe particularly how Kine, and other Beasts that have no Teeth above, and upon that account can't chew their Meat small enough at once, are provided with a Maw, in which the Grass they swallow is thoroughly moisten'd, to the end, that when it is brought up again into the Mouth, being Softer and Mellower, it may be render'd as small as is necessary by a second Mastication, which is called Chewing the Cud; and how, after having been swallowed the second Time, it descends into other Intricles or Bowels, where it is first turned to proper Chyle, in order to nourish them; concerning which those who have expresly written may be consulted. Thus also there are some other Animals fed with Grass, that do not serve for Food to others. In the Dutchy of *Crain* in

Austria,

Austria, there are found black Snails as big ones Fist, and not inferior in tast to Oysters, l ving in the midst of a very hard Rock, whic must be broke in pieces to come at them. L any one guess how, and with what these Cre tures are nourished. But I only ask this Questio *first,* Whether it can be supposed to happen t Chance, or without Wisdom, that these Cu chewing Animals, which are deprived of an u per Row of Teeth, are furnished with such a pa ticular Manner of Digestion, and that Dog Swine, and all kind of Fowl that do not want i are not provided with the same. And, *Secondl* Whether it does not fully appear from thenc that he who has given to all Animals the prop Instruments for Feeding, is not bound by any n cessary Laws of Nature, which tending all to t same Purpose, do always act after the sam Manner.

Sect. XI. *The Motions of Animals in General.*

The same does likewise appear from the D versity of Motions in Animals, whereby the pass from one place to another. Thus mo Birds, both small and great, have Feet for Ru ning and Wings for Flying; Fishes have no Fee but Tails and Finns for Swimming; some Beast have two, some four, others more Feet for Ru ning; others having neither Feet nor Wings, d creep; others, as some Shell-Fish, draw themselv along by Threads, making use of a quite differer manner in moving from one place to another. Se concerning the same; the *Memoirs of the Fren Academy,* 1706, *p.* 69. Now in all this we ma observe different Methods serving the same End and each of 'em executing the wise Purposes c th

he Creator, being adapted thereto after a parti-ular and wonderful Manner.

Sect. XII. *The Structure of Birds.*

And not to stop at those Particulars which eem to have some Analogy with those of the Humane Kind, forasmuch as we have treated of hem in another place; let the unhappy Atheist contemplate the Birds, and let him ask himself, whether (in order to deny, with some appearance of Reason, the Wisdom and Power of an adorable God) he can be contented necessarily to conclude, that all those Instruments which are requisite for Going, Flying, Eating and Procreating, so necessarily and so artfully adapted to all these Purposes, are owing to mere Chance, and to the ignorant and necessary Laws of Nature: And, whether he can conceive, that without an overuling Power and Providence, a Bird so wisely form'd for Flying, not to speak of other Faculties, can have acquired its Existence out of that Matter and Substance with which an Egg is filled, only by a brooding Heat?

Sect. XIII. *The hollow Tubes or Bones of a Bird.*

Let him first contemplate the little Bones of a Bird, and he'll find those of their Legs to be much hollower, as well as the Substance of them much thinner, than those of other Creatures; the reason of which is, that the Bird may be lighter, and so more fit for Flying. But to the end, that the Thinness of the Bone should not render it weaker, it seems necessary that the Substance of it shou'd be harder and stronger than in those of other Animals. Now if we consulr the Observations of those that have inquired into it, we shall find it to be so in Fact.

Fact. Will then our unhappily blind Philosoph maintain, that this also comes to pass witho Wisdom and Design?

Sect. XIV. *The Cartilages in the Joints, and Co victions from thence.*

Moreover, let any one who has, for i stance, a Pullet upon his Table, examine the sam and see how in that, as in other Animals (which something has been said before in *Conte plation* XI. §. VIII.) the ends of these little Le are encompassed with a smooth or polished Cart lage, to move and bend the same conveniently; som are moved by means of a round Cavity, which is like wise clad with a Cartilage, and others by means c two circular Protuberances in two like Cavities ad apted thereto: Let him afterwards attentively vie the little Joints in the Claws of such a Pullet, an he will find, that here likewise, as well as i the great Bones of the largest Ox, the Extreme ties of these so small Bones are encompass'd wit smooth Cartilages, to the end, that in the Moti on of them, one Bone may slide upon the othe more easily, and the proper Motions be performe in every Part without any Obstruction.

Now if there be not a wise Contrivance in thi whole Structure, why are not all the Bone (which would then be too weak) composed o mere Cartilges only? Why do they occur i those Parts alone, where by their Smoothness they render the Motion more Light and Serviceable Why is one end of the Leg spherical, or exactly round, where it is necessary to be moved not only forwards and backwards, but also sidewise? and at the other end, where there is no occa sion for such lateral Motion, there are two such Protuberances formed, as to hinder it from being

inflected

nflected otherwise than backwards or forwards? He who sees all these things, and so many others, which can only serve for their particular Uses, and hall judge, that they have acquired such a Disposition without Wisdom and Design; why may he ot as well, in reading a Book or a News-Paper, ffirm, that all the Letters are ranged in the Form e finds them in, by mere Chance likewise, and ithout any Design of the Printer?

Sect. XV. *How the Wings are moved in Flying.*

But now if we carefully observe, first, after hat manner the Birds fly, and make use of their Vings for that Purpose; and next, how these Vings are made and put together; so that no Man ving could have contrived 'em so artificially, and repared 'em for Service; I am not without Hope, hat this may convince, if not all, yet at least me Sceptical Minds, and oblige 'em to confess, hat Wings are as much given to Birds for the end f Flying, as the Hand of a Watch is made for hewing the Hours.

To be satisfied of it, let us remark, that a Bird oving its Wings, does not strike them from the re Part backwards, nor use them like Oars, after hich manner they would very much obstruct the ction of Flying; since being brought forwards ith so much swiftness, they would strike against he Air, and so either drive the Bird backwards, r at least hinder its proceeding forwards: Forsmuch as their Structure is quite different from hat of the Claws of Geese, Swans and Ducks, *&c.* hich, because it hath pleased the Creator, that hese Kinds of Fowls should make use of the me, as of the Oars of a Boat, their Wings are f an entirely different Structure, of which hereter. And in case any Progress could be made by

by the Birds through the Air after this manner yet the Bird itself by being heavier than so much Air, would fall down, or at least sink leasurely downwards. But not to dwell too long upon Arguments only, we need only observe for a Proof what has been said, that great Birds, such as Ostritches, Storks and Swans (in which, by reason of the slow Motion of their Wings, the same may be clearly seen) in Flying, strike their Wings up and down, (or perpendicularly to the Horizon, as Mathematicians term it) whereby we find, that the Bird is at the same time supported and moves forwards in the Air.

Can we then perceive no Wisdom herein! That these Wings (*Tab.* XVII. *Fig.* 1.) A E and B F, of the flying Fowl B G A, are somewhat hollow below, in order to take hold of the Air with so much more Force and Power in striking them down; and above they are Convex, that in lifting 'em up they may meet with the less Resistance from the Air and so that they mayn't lose in the raising of their Wings that which they gain'd in striking them down, to keep them floating in the Air. But that which is here particularly to be observed, is, that these Wings are not fasten'd to the Body by their whole Breadth, but only at A and B, all the other Parts thereof being entirely loose; whereby it happens, that (as may be seen in the Observations of *Borelli*, *Prop.* CLXXXIII, and CLXXXIV.) the said Wings being raised up, do only cut the Air upwards with the sharp Fore-part A E and B F, that they may meet with less Resistance; but striking the Air downwards with a greater Swiftness, they describe with all their Points, Lines that are almost circular, such as E I P and F V L.

But since the wonderful Manner whereby a Bird cuts the Air with his Wings upwards and downwards, and moves them forwards at the same

described

time with so great a Velocity, cannot so easily be described nor comprehended by Words; let us represent to our selves in *Tab.* XVII. *Fig.* 2. a Bird R S, as he floats in the Air, and extends both his Wings B E A and B C F, we may then suppose, that when these Wings are moved directly downwards, the Arms thereof, B C and B E, which being composed of Bone, and therefore stiff and hard enough, do describe two Circles whose Planes make Right Angles with the Horizon, as in the foregoing *Fig.* 1. *Tab.* XVII. and so cause the whole Wing to follow that Motion, and to exert its Force with this perpendicular Blow upon the Air that lies under it, H G B E A.

Now, forasmuch as this Air when struck by the Concave Superficies of the said Wing, makes a Resistance (as it happens when Women move their Fans through the Air) because it cannot recede quick enough: And moreover, as the Parts of the Air being compressed by the Velocity of the Blow, do sensibly endeavour to expand again, as we have sufficiently proved above in *Contemplation* XVII. about the Elasticity of the Air; and as appears plain enough from the rushing Noise which Birds make by flying or stirring their Wings; it will follow, that the Feathers E A O, by the said Resistance and Elasticity of the Air, will bend upwards, being made of a flexible Matter; and therefore when the Arms B E and B C, composed of an inflexible Bone, pursue their way in striking downwards, the Ends of their Wings, A and E, will, by the bending of the Feathers upwards, be pressed towards each other.

From hence it is easie to see, that the Air being beaten downwards by the Wings, and by its Elasticity resisting upwards, the Bird is supported in it by the repeated Reverberation at every Blow. And forasmuch as by the Flection upwards and

downwards of the Feathers of the Wing, the Air receives the Blow obliquely in the Motion thereof, we may from thence give the reaſon why the Bird is thereby puſhed forwards, and horizontally towards R, and ſo is ſaid to perform the Action of Flying. So that the Beginning of the perpendicular ſtriking upon the Air, does chiefly ſupport the Bird, and the Continuation of the ſaid Blow does chiefly promote the Bird's progreſſive Motion.

Perhaps this may be render'd more intelligible to ſome, by ſuppoſing, as *Borelli* does, the Bird, R S, to be at reſt, and without motion, and that it holds its Wings, B E A and C F, horizontal; and that by a Wind, H G O, blowing directly upwards againſt the ſaid Wings, their Ends A and D being bent towards each other upon the Back of the Bird, the two Wings do thereby repreſent the Figure of a Wedge runnning obliquely into the Points A F. Now if both the Sides of this Wedge are preſſed by the opening Air or Wind every one knows that it muſt follow from thence that it will be protruded towards its broadeſt Part C B E, and ſo carry with it the Bird R S which is faſten'd to it at O. Now thoſe that underſtand Mechanicks, know well enough, that the ſame Effect will be produced, whether the Air be moved upwards as a Wind, or the Wing downwards.

I wiſh I could here ſubſtitute any known Machine proper to ſhew the true manner of the Action of the Wings, and to give a greater light to the Unexperienced, how the exactly circular ſtriking down of the Arms or Bones that are in the Wings joined to the Flection of the Feathers upwards, can at the ſame time ſupport a Bird in the Air, and cauſe him to fly forwards. But I muſt own I know of none my ſelf, nor find any ſuch in others.

Something like it, tho' very imperfect, occurs in the Sails of our Wind-Mills, as also in Ships that sail with a side or half Wind; which however only shews how the Wind blowing from one Point causes the Sails of a Mill or a Ship to move forwards towards one another: This happens in some manner likewise to the Wings of a Bird when it flies, but does however by no means represent the true Manner of Flying.

Yet to suggest something that has a little more Analogy with the Motion of the Wings; let half a Sheet of Paper be fasten'd to a little Stick in the same manner as the Colours are fasten'd to an Ensign-Staff; the said Stick is to represent the Arm or Bone of the Wing, and the flat Paper the Feathers, which must not hang down under the Stick, but be held up in the Air by it. Now if you move this Stick with your Hand in a direct circular Motion from above to below, and the same be done pretty swiftly; you will see, that the Paper is thereby moved, first from beneath, upwards, and next from backwards, forwards; from whence one may form a rough Conception (since the same thing happens in each of the Wings on both sides of the Bird, by the striking down of the Arm) how the Bird moves upwards and forwards at the same time; in which Flying consists.

Sect. XVI. *The Wonderful Structure of the Wings.*

Now whoever has attentively consider'd what has been said, and understands what we have here said about the Action of Flying, will see, that in order to make a Bird fly, the Feathers of his Wings must necessarily be, *First*, Light, that they may not obstruct nor incumber him; *Secondly*, Flexible; and *Thirdly*, Stiff and Elastical; that is, that be-

ing bent, they may resume their natural State, by springing back of themselves.

Now let us Contemplate the same, just as we observe them in Birds, and we shall find;

I. That the Quills to which the Feathers are fasten'd are hollow, that they may be light, and nevertheless stiff and hard, as being composed of a thin and horny Substance.

II. The remaining or lower Part of the Quill must not be inflexible, because in striking down of the Wing, it was necessary that it should be capable of Inflection by the Resistance of the Air, to the end, as we have said before, that the two Wings might approach each other, in order to meet the Air obliquely, and protrude the Bird forwards. Now we find that this part of the Quill is filled with a Matter that is very flexible and light, and which seems to me to be found no where else but there, as indeed it is there only necessary, for it does not seem reducible either to Bone, Flesh, Membrane or Tendon, or indeed to any kind of Parts that occur in these or other Animals. Now can any one pretend, that this is also to be ascribed to Chance, or Ignorant Causes?

III. Now it is not enough that these Quills should be flexible, for so is a Rope too; but it is moreover requisite, that in the perpendicular Motion of the Wings, they should be stiff and hard enough too, to act with some Force upon the Air and that being bent upwards by such Acting, they may in the lifting up of the Wing resume their former and concave Figure.

Now all this concurs in the Structure of the Quill; for in the external Circular Part thereof it is cover'd with a Bark, which is in some measure

hard

hard, and under that, in the Cavity of it, there run two long protuberant Lines of the ſame Matter, parallel with each other (as is viſible in a Writing-Pen) covering and encompaſſing the aforeſaid wonderful Matter, like Marrow in Bones: Now that they become hereby ſtiff, flexible and elaſtical, will be obvious enough, by bending them a little, and then letting 'em go ſuddenly again.

IV. But to the end, that the Air may not ſoak thro' theſe Quills, and ſo render the Force of the Wings vain, there are lateral or croſs Fibres placed in the Feather on the ſides, which do not only exert each of 'em their Elaſtick Faculty, as fine and ſmall as they are, but do likewiſe adhere together, in order to prevent any Paſſage of the Air. Now ſince this can have no Place in the Quills where there ſhould be Pores or Orifices, we find thoſe Interſtices cover'd with little Feathers that grow continually ſmaller, like the Scales of Fiſh, lying upon each other, whereby they do ſufficiently hinder any Paſſages of the Air between the Quills.

Now, notwithſtanding all theſe Functions and Uſes, every Feather is ſo diſpoſed, that it may not obſtruct the Bird in Flying, that nothing can more verifie the Proverb, *as light as a Feather*, than ſuch a Diſpoſition.

Now with how great Art even the ſmalleſt Fibres are formed therein, may appear from hence, that each of 'em has again the ſame Structure as a large Quill or Feather, and does likewiſe conſiſt of a Body paſſing thro' the middle of 'em, and little Fibres on the Sides; to be convinced of this, we need only examine a ſmall Particle of one of theſe little Feathers with a good Microſcope.

Sect. XVII. *Convictions from the foregoing Observations.*

Can any one imagine, after all this, that a single Feather (to go no farther at present) has without any End or Wisdom, acquired its Structure, its Hardness, and at the same time its Elastic Power, its peculiar Substance and Lightness, its Disposition and its Place, just in that Part of the Wing where it can be serviceable, and all other Properties necessary for the Action of Flying!

At least a Christian, who has seriously consider'd the aforesaid Texture of the Feathers and the Wings which they compose, will be thereby convinced, that Jehovah does justly number these things among his Wonders; *Job* xxxix. *v.* 13. And that a Consideration of the Beauty and wonderful Structure of those Wings, is of use to represent the smallness of Man's Wisdom and Power in comparison of the Greatness of God's, appears from this Question; *Gavest thou the goodly Wings unto the Peacocks? or Wings and Feathers unto the Ostrich?*

Sect. XVIII. *Other Reflections upon the Structure of Birds.*

Many more Remarks might be here made concerning the Structure of Birds: He that has ever seen how some little Birds that are wont to make their Nests in Thorny Hedges, are furnished with a particular Membrane, with which they can cover their Eyes, and preserve them from being pricked in their swift Passage through those Thorns; and that such Membranes are therefore transparent, like the Eye-lids of many other Creatures, to the end, that they mayn't be quite de-

priv'd

priv'd of their Sight, will he obstinately affirm that this happens just to those Birds that want the same, without any End or Design?

If one considers the Structure of the Legs of many Birds, especially of such as are used to support themselves upon the Branches and Twigs of Trees; can it be imagined, that it is without Wisdom, *First*, that (*Tab.* XVII. *Fig.* 3) a Muscle HC, runs along the Thigh-bone B C from H, the Tendon of which I K, which contracts the Claws of the Feet of the Bird, extends itself about the Angle B I K, which Angle the Thigh-bone HC makes with the next Bone C D: And to the end that they mayn't be displaced by Motion, they are carried on there thro' a Tube or Sheath, as *Borelli* affirms, §. 149. who has examined into the same in Eagles, Hawks, Swans, and other Birds? *Secondly*, That other Muscles, as K C, which are likewise useful in shutting the Claws E G, are united by their Tendons at K, with the foregoing I K, and encompass the other Angle C D E, and from thence extend themselves along D E G, in smooth Tubes, (that seem to be only made for this Purpose) to the Nails of the Claws at E and G? *Thirdly*, that when these Bones B I, I D, D E, make a right Line, the Tendons are not extended, and therefore the Claws of the Feet remain spread in the Figure of a Star? But, *Fourthly*, the Bones B C D E, forming acute Angles, and being as it were forced to lie upon each other, that then this Tendon being stretched, the Claws of the Bird are shut close thereby, and drawn together as it were like a Fist; insomuch, that *Borelli* vouches, that he could not without a great deal of Pains, thrust a sharp Stick between the closed and contracted Claws of an Eagle or a Hawk, tho' it was already dead.

A common Experiment is usually made, by laying a dead Pullet on its back upon a Table, and stretching the Feet streight out; at which time one shall see that the Claws will be extended, and again contracted by pressing the Thighs and Legs against the Body; and then putting the Finger between the Claws, one shall easily perceive, that by such Inflection they are strongly enough closed together, to keep so fast a hold upon the Twig or Branch upon which they sleep, without the Assistance of any other Muscles, that they can abide there without any Danger of falling. And from hence likewise the Reason is plain, why this sort of Fowl, as often as they advance their Legs streight forwards, extend their Claws like Rays of a Circle, in order by the greater Breadth of them, to tread more firmly, which, without using any particular Muscles thereto, results only from the Structure of the Foot, and yet is of very great use for this Creature to walk conveniently. One may make the same Trial upon dead Sparrows and other little Birds, if one would take the trouble of examining them.

Lastly, To draw a Conclusion from the whole; Can any body think that all this Disposition in the Tendons, whereby the Claws are moved, is without any particular Design? the rather, since even the Flying Bird R S, resting itself upon the slender Branch F G, can, according to this Supposition, sleep safely, without fear of falling, tho' their Muscles should not act in Sleep as the same is proper to all Beasts; for when the Bird R S, having thrust its Head backwards upon its Body O, and thereby brought the same to an Equilibrium over its Feet, rests with the sharp Part of its Breast-Bone upon the Twig; if the Motion of the Wind, or any other Accident should put him in danger of falling, the strong Contraction of his

his Claws upon the same Twig, comes to his Assistance, just as if the Twig were held fast by two stiff compressed Knippers; for that such Contraction is perform'd with much Strength, only by the Bird's sitting down, and by bending with its Weight the Bones B C, D E, upon each other, is already demonstrated by *Borelli*, and by the aforesaid Experiments. And to any one that has but Eyes to observe the Care and Providence of God over all his Creatures, and even for the Birds themselves, this seems to be a particular and palpable Demonstration of his great Goodness and Wisdom, who has bestow'd upon these Animals such a Structure with respect to their Bones, Muscles and Tendons, as that without any Pains on their Part, or once waking from their Sleep, their own Weight and Figure preserves them from falling, in such Circumstances, that no body could imagine that they could remain one Minute upon the Twig at the least Motion thereof.

Sect. XIX. *The Feet of Water-Fowl.*

Let no Body think, that forasmuch as this Pinching or Contraction of the Claws, is likewise found in some Birds that live both upon Land and Water, as Swans, the same happens by Chance or by other necessary Laws, because these Birds are seldom observ'd to sit upon Trees, and therefore have little or no occasion for such a Structure of their Feet; for if it be considered that Ducks, Geese, and Swans, make use of their Feet in Swimming, as Men do of Oars; and that their Feet are of such a Figure, that being thrust out backwards, they are expanded likewise by the Resistance of the Water, and so exert a greater Force in the Progression of the Bird; we may likewise see at the same time, that if these Feet, in

their whole Breadth were to have been draw forwards, it would have driven the Bird as muc backwards; for which reason then, the Contractio of their Feet (as may be observed in Womer Fans, but after another Manner) is necessary t them, to the End, that they might strike out thei Feet, without giving the Water too great a hol of them: Now this happens in them likewise b those Tendons which, when they bend their Leg upwards (and so cause the Bones thereof to ap proach more to the others) draw their Claws to gether, and only by this Structure, without bein obliged to make any particular Motion thereto This Experiment may, like the former, be trie upon a dead Duck or a Teal.

Sect. XX. *The Tails of Birds.*

But after having said thus much concernin the Structure and Use of the Wings, let us add a Word or two more about the Action of Flying, of which we have already said something, so far as may relate to the horizontal Motion thereof. The Structure of a Bird, if there had been nothing more in it than what they have already considered, would have been a wonderful and irrefragable Proof of the Wisdom of God; but how much more surprising is it still, when we contemplate another Part that he has bestowed upon these Creatures, to enable them to fly perpendicularly, that is to say, directly upwards or downwards, I mean the Tail, which is to them as the Rudder to a Ship; this the Bird raises at B H, when it moves upwards from the Line B F to the Line K L; and when downwards, in the Line N O, it lowers it to B I; for that it does not serve, or at least not commonly, in a lateral Motion to the Right or Left, is plain, from the Structure thereof. The farther

Reasons

Reasons may be seen in *Borelli*, Prop. CXCVIII, and CXCIX; who teaches us (as does also Observation and Experience) that when Birds which fly horizontally, without rising or falling, have a mind to turn themselves nimbly to the Right or Left, they move the Wing of the opposite Side more strongly, and after an uncommon Manner, as a Man uses his Arm and Hand, when he would turn himself in Swimming; tho' such Birds as thrust out backwards long and slender Legs in Flying, do seem likewise to use the same as a Rudder, when they turn to the one side or the other.

There still remains something which does as it were appear wonderful to those that consider it; namely, how it is possible that swift flying Birds, that descend perpendicularly from any great heighth, do not fall flat upon the Ground at once, the rather, since the Swiftness of their Fall seems to be then increased by the Weight of their Bodies: Now they that have ever seen how artfully they use their Wings, to moderate and stop their progressive Motion, and how they spread their Tails, must at least acknowledge that they are admirably provided with every thing necessary for Flying, and for the various Uses of their Wings and Tails.

Sect. XXI. *The Center of Gravity and Force of the Muscles of the Wings.*

Now, after all that has been said, I shall not dwell upon that wonderful Structure which Mathematicians observe in Birds with Astonishment; whereby their Center of Gravity always remains in their Breast, below the Rise of their Wings, and which alone enables them, whilst floating in the Air, without any manner of trouble, to dispose their Wings, Legs, and other Joints for the most convenient Uses. Thus we see that the strong-

ſtrong Muſcles with which they move their Wings are inſerted in their Breaſt; inſomuch, that eve that Muſcle which raiſes the Wings, and whic one ſhould otherwiſe have expected to have foun in the Back, is likewiſe ſeated in the Breaſt, an is carried through a Hole expreſly made for it af ter a wonderful manner, to the Legs, in order t perform its Function: Concerning which, ſee th foremention'd *Borelli*, Prop. CLXXXIV. where beſides what has been already ſaid, thoſe tha pleaſe to conſult that learned Work, will find a great deal more, to convince them of the odora ble Wiſdom of him that has created all kinds o Animals.

To inſtance in one Thing that ſeems almoſt in credible; Could any one imagine that the Force o the Muſcles whereby the Wings are moved, is ten thouſand times greater than the Weight of the Bird that flies with thoſe Wings; and if one de ſires to be more fully ſatisfy'd thereof, with an intent to admire the Greatneſs of the Creator, he need but conſult the aforeſaid Author, *Prop.* CLXXXIII, and CLXXXIV. We have already given a brief Demonſtration of the amazing Strength of the Muſcles of Men, ſo that this will not ſeem incredible to ſuch as underſtand what has been there repreſented.

Sect. XXII. *Convictions from the foregoing Obſervations.*

I now ask again, whether any one (that reflects upon all that has been here ſaid about Birds, and comprehends how many things concur to the ſame End, and to the moſt proper Purpoſes within ſo ſmall a compaſs, as that of a contemptible Bird) can imagine, that this Creature is formed without Wiſdom, and diſpoſed as he finds

finds, in all its Circumstances? Let him view with this Knowledge, a Sparrow, a Finch, a Canary-bird, or any other of those little Creatures, and then ask himself, whether it be conceivable, that in the little quantity of Matter of so small an Animal, such numberless Instruments were found by chance; of which some of them serve for Eating, for Digesting their Food, in a word, for Nourishment; others for Generation; some for Walking; others for Flying, and all of them so exactly adapted to their particular Ends, that the most learned Mathematicians and Naturalists of this Age, that have taken the trouble to enquire into the same, have very often expressed themselves thereupon with Wonder and Astonishment.

Sect. XXIII. *The Preservation of Birds.*

Now, as the Wisdom of the Creator shines forth in the Structure of the Birds, so likewise his Providence and Goodness in preserving many of them, is not less clearly manifested. The great Saviour of the World, endeavouring to dissuade his Disciples from taking too great care for Food and Raiment, mentions these Creatures for a Proof of what he would have them understand thereby: These are his Words: *Matth.* vi. 25, 26. *Take no thought for your life, what ye shall eat, or what ye shall drink;* ——— *Behold the fowls of the air; for they sow not, neither do they reap, nor gather into barns; yet your heavenly Father feedeth them: Are ye not much better than they?* Could the greatest Logicians have used any stronger Arguments in the world, to shew so palpably the Care and Providence of a God? In case he had spoke of Tame Creatures, one might presently have answered, that Men who make use of them, provide them with Food, as in the Case of Horses, Kine,

Kine, Sheep, and the like. And as for the Wild ones, it might likewise be said, that they are able to fall upon what they meet with, and convert it to Food, such as Lions, Bears, Tygers, and the rest. If he should speak of Fishes, no body can shew that they ever suffer Want in the Waters: If of Ants or Bees, these gather their Food against the proper Season: If of Caterpillars, Silk-worms and such other Insects, it may be answer'd, that in order to continue their Species, tho' their Lives are mostly limited to one Summer, their Eggs rest in the Winter, in order to produce their little Ones with the approaching Warmth, against the time that their Food is ready for them. But that for Ravens, and other Birds that live in desart places, and that would otherwise perish for Hunger in a few Days, their Food should always be so seasonably provided; and that for other defenceless, fearful little Animals, that run away from every thing, such as Sparrows and the like, their Food should be provided even at such times when they seem to be deprived of all Means of meeting with the same in the midst of a hard Winter, and when no Man himself, tho' never so ingenious and laborious, could instruct them how to find it (and much less meer Chance.) All this, I say, is a most manifest Proof of a great and adorable Preserver, as it is likewise of the Truth of the following Text; *Matth.* x. *v.* 29. *Are not two Sparrows sold for a farthing? and one of them shall not fall on the ground without your Father.* Or, as it is expressed in *Luke* xii. *v.* 6. *not one of them is forgotten before God.* I leave it then to an Atheist himself, to judge, whether he can ascribe the Manner after which these little Birds, contrary to all Appearance, are kept alive every Year, with a safe Conscience, to Chance only.

Sect. XXIV. *Transition to the Fishes.*

ASK now the Beasts, and they shall teach thee; and the Fowls of the Air, and they shall tell thee; or speak to the Earth, and it shall teach thee; and the Fishes of the Sea shall declare unto thee: Who knoweth not in all these, that the hand of the Lord hath wrought this? In whose hand is the Soul of every living thing, and the breath of all Mankind. These were formerly the Emphatical Words which *Job, ch.* xii. *v.* 7, 8, 9, 10. made use of against those that doubt, whether there be a Wise and Powerful God. I do not produce 'em here to convince an Atheist whilst he has no respect for this Holy Word, but only, that these miserable Men may once again silently examine themselves, whether what has been said before about the Birds, cannot move 'em to observe the Truth and Wisdom of those Expressions; and if that will not entirely satisfie them, let them pass on with us to the *Contemplation* of the Fishes.

Sect. XXV. *The Miracle of Fishes living under Water; and Convictions from thence.*

We shall not here repeat what has been said concerning the Fishes in the *Contemplation* of Water, nor prove more fully from thence the Goodness of the Creator, who has filled those mighty Caverns of Seas and Rivers with all Kinds of Fishes, to the end, that those vast Spaces should not remain useless; which Fishes in some Countries serve for Bread, in others for Dainties; and by their variety, are fitted to gratify the different Palates of Mankind. Now let one of these most Conceited Philosophers, that thinks every thing is made without Wisdom, tell us, whether he could

ever

ever have believed, if he had not known it, that there were ſuch things as Fiſhes, and that any one ſpoke Truth to him that ſhou'd give him an account, that in Water, in which other Creatures can remain alive but a very ſhort time, there was found a particular Kind of Animals that could live, move, procreate, and perform other Animal Functions: And upon ſeeing a Fiſh perform all this in the Water, whether he could help taking it for a Miracle. And, which is more, whether he could, tho' his Life were at Stake, and tho' he had conſulted all the wiſeſt Men in the World, tell how a Fiſh muſt be formed, to be able to preſerve itſelf in Water, and what would be the Difference between its Blood and other Humours, and thoſe of Animals that live in the Air.

Sect. XXVI, XXVII, *and* XXVIII. *How Fiſhes balance themſelves in and againſt the Water, illuſtrated by ſeveral Experiments.*

But not to dwell upon ſuch general and well-known Reflections; let us paſs on to ſome Particulars; to enumerate all would be impoſſible: How a Bird, only by the great Force and Motion of his Wings, does at the ſame time ſupport itſelf, and fly forwards in the Air, has been lately ſhewn; but can any one obſerve, without Amazement, how a Fiſh raiſes its Body up to the Superficies, and again ſubſides to the Bottom of the Water, with hardly any viſible Motion, or floats in any Part of it, without either riſing or falling.

If there were in Fiſhes a ſettled and unchangeable Gravity, not much differing from that of Water, when they paſs from Lighter to Heavier, that is to ſay, from freſh to ſalt Water, they would emerge, even in ſpight of themſelves; and on the contrary, paſſing from Salt to Freſh, they would ſubſide

ſubſide in the ſame manner, juſt as we ſee that an Egg will ſink in freſh Water, and ſwim or float in ſalt Water or a ſtrong Pickle, as is known even to the Women. So that to render the riſing and ſinking, and continuing in the ſame place in the Water, practicable to Fiſhes, without uſing the Force of any External Motion, it ſeems neceſſary, that according to particular Circumſtances, their Gravity, with reſpect to an equal Bulk of Water, ſhould be augmented and diminiſhed; the rather, becauſe the ſeveral Waters in which they are found, are oftentimes render'd lighter or heavier, not only by more or leſs Salt, but alſo by the mixture of other foreign Bodies.

Now let a Sceptical Philoſopher ask himſelf, whether he can imagine, that it is without Deſign, that the Structure of moſt Fiſhes do compoſe the moſt wonderful and proper Hydroſtatical Machines; whereby, according as they have a mind to emerge or ſubſide, or according as the Water is lighter or heavier, they may diminiſh or increaſe their relative Gravity?

To be ſatisfied herein, we need only open the Bellies of a Carp, a Bream, a Roach, an Eel, and many other ſorts of Fiſhes, and we ſhall find therein a little Bladder, like B D (*Tab.* XVII. *Fig.* 5.) which is ſerviceable to them in all the aforeſaid Purpoſes.

To give any one a Notion thereof, who reads this only for the firſt time; let him ſuppoſe a Fiſh M C (*Tab.* XVII. *Fig.* 6.) lying in the Water; the Bladder whereof D B appears in its Belly at *q*; and is ſo far expanded by the Air within it, that the Fiſh and it together, are juſt as heavy as an equal Bulk of Water E F; by which he will know, if he underſtands any thing of the Principles of Hydroſtaticks, that this Fiſh will ſtand ſtill in whatever Part of the Water it is plac'd,

without riſing or falling, ſo long as it hinders, either by the Muſcles of its Belly, or perhaps by thoſe of the Bladder itſelf, the Air within it from expanding itſelf farther, and rendring the Cavity of the Bladder larger.

But foraſmuch as the Air that is in it, continually endeavours to expand itſelf, the Bladder B D will be more dilated, and become greater, when the Muſcles ceaſe to contract it ſo ſtrongly as in *b d* at *p*; and the Fiſh having ſo much more Emptineſs in itſelf, will become lighter than an equal Quantity of Water; and therefore ſo long as that laſts, continually emerge or aſcend, as in the Figure from *q* to *p*.

Finally, ſince the Air may likewiſe be compreſſed and ſqueezed together; and being ſo on every ſide, will lye in a narrower Compaſs than before, if the Fiſh M C, by the contraction of the ſaid Muſcles, preſſes the Air inwards, and renders the Bladder B D ſmaller; it is plain from the Laws of Hydroſtaticks, that the Fiſh will thereby become heavier than a like Quantity of Water, and conſequently ſubſide from *q* to *d*.

To preſent the Reader with a groſſer Idea thereof, we need only ſuppoſe a Lad ſwimming, and ſupported by two Ox-Bladders blown up; in which caſe it will be eaſie to conceive, that if he could dilate and contract the Bladders at pleaſure when they were very ſmall, he would ſink, and on the contrary he would float when they were large; and if he could readily find upon a meaſure between both, whereby he could render the Bladders too large for ſinking, and too ſmall for floating, he would be able to ſtand ſtill in any part of the Water.

A remarkable Proof that theſe Bladders are of the ſame uſe to Fiſhes, may be found in the XXIX *Prop.* of *Borelli*, where he relates, that after having

kept a Fish in a place exhausted of Air, so long, till that the Air which was its Bladder finding no Passage to go out fast enough, nor any Resistance of the external Air, did so far dilate itself, that the Bladder was burst thereby; after which they threw the said Fish into a Pond, where, during the space of a Month that it lived, it could never raise itself up with Swimming, but was always found creeping like a Snake at the bottom of the Pond.

Among my Experiments, I find one that seems to give some Light to this Matter, which was as follows; we took two Gudgeons, and put 'em into a Glass Receiver in Water, and thereupon exhausting the Air, we observed them to emerge, without being able to get downwards; after which they swelled in such a manner, that their Eyes stood out of their Heads, and afterwards suffer'd several Convulsions; but by letting in a little Air again, their Eyes sunk as suddenly; both which Appearances happen'd every time that the Air was drawn out or admitted, without their contributing any thing thereto by their own Motion.

The reason thereof was, because the Air dilated itself in the Bladder at the same time that the external Air was exhausted from the Receiver: So that the Bladder becoming larger, the Fish was lighter than so much Water, and emerged; but the Air being let in again, and the Bladder being pressed by it, and becoming smaller, the Fish was heavier again than an equal Bulk of Water, and so sunk down.

To make the thing appear yet more visible, we took a little Hog's Bladder, in which there was very little Air, tied a little Stone to it, to make it sink in the Water under the Receiver, and we let the Bladder that was taken out of one of the Fishes, float upon the Water; whereupon we per-

ceived, that by one draught only of the Pump, the Fish's Bladder presently dilated itself, and the Hog's Bladder, to which the Stone was tied, ascended and floated upon the Water; but on the contrary, by letting in the Air again, both the Bladders shrank and became smaller, and the last sunk down, which shew'd the Action of the Air in the Bladders of Fishes, as is above represented with great clearness.

Another Experiment proved the same no less agreeably: We fill'd a little Bottle A (*Tab.* XVII *Fig.* 7.) so far with Water, that being inverted there remained a little Air upon the Water at A; but being put loose into a great Vessel of Water it sunk down. But after having put this great Vessel M N Q P, under the Receiver of the Air Pump, and drawn off the Air that pressed upon the Superficies of the Water M N, the Air that was in the little Bottle at A, missing its Resistance did remarkably and visibly dilate itself; upon which forcing the Water out of the said Bottle, it made the Bottle rise up to B; but upon restoring the Pressure of the Air upon the Water at M N, the Bottle sunk again, because the Air at B was there by compressed into a smaller Space, and the Water returned into the Bottle, and made it heavier again. This, if the Bottle be not too full of Water at first, may be repeated as often as you please by every lifting up and letting down of the Sucker of the Pump.

Sect. XXIX. *The Effect of Cold and Heat, and of a greater or lesser Column of Water pressing upon Fishes, shewn Experimentally.*

But now in case the Air contained in the Fishes Bladders should be always the same, and the Quantity thereof unalterable, we know that by

the Gravity of the Water, and according as the Pressure thereof is greater or smaller, the said Air would be more or less compressed, as it happens likewise by Cold or Heat; the Consequence of which would be, that the Fishes would be driven upwards or downwards oftentimes against their Will and Convenience.

To give an Instance hereof, in Case of Heat or Cold, and to shew the Proof of this Supposition, we need only let so much Water run into the aforesaid little Bottle (*Tab.* XVII. *Fig.*7.) that it may sink very slowly and gradually, without much over-balancing the external Water, and remain lying at A. Then set the Vessel M N Q P, either by the Fire, or in the Sunshine, whereupon the Air at A dilating itself by the Warmth of the Water, will drive out a little Quantity of the Water that is in the Bottle; and the Bottle becoming lighter thereby, wil rise up to D; but if you let the external Water cool again, the Air will be compressed and reduced to a smaller Space in the said little Bottle, and the Water flowing into it, will sink it again down to A.

But to shew likewise, that the same Effect may be produced by a greater Depth or Column of Water; and that the Air in the Bottle may be more compressed without a greater degree of Cold, than when the Bottle is nearer to the Superficies of the Water, take the Bottle E, and by puting more or less Water into it, you may bring it to such a Weight, that when you let it go, it will float upon the Superficies of the Water M N; but by a thrust, or with the addition of never so little Water, it will sink down: Now if you take a Stick and thrust the little Bottle E down to O, you will see it continually sinking there, tho' you should raise it a little up; and again, when it is raised up to about M N, you will see it continually float-

ing upwards, tho' you ſhould thruſt it a little down. And it may likewiſe be often moved in the middle this way and that way, between N and P, horizontally, without either riſing or ſinking, if you can find the exact Middle D; and holding the Bottle with the Stick againſt the Side of the Veſſel till it be quite ſtill, it will remain in the very place you leave it.

Thoſe that underſtand Hydroſtaticks, know the Reaſon thereof; and thoſe that do not, may learn them in *Contemplation* XXVI. Thoſe Reaſons are; That the Bottle being at O, is driven down with a Force, as F R, and upwards with another, as F S; but being at D, the Force F H, preſſes it downwards, and F I upwards. From hence we ſee, that this Bottle is every where between two Powers, preſſing againſt each other, which are greater when at O, and both of 'em gradually leſs when it is at D, or yet higher: Wherefore the Air at O, ſuffering a greater Preſſure than at D, and being likewiſe more contracted or preſſed together, the Bottle is fuller of Water, and conſequently heavier at O than at D or E; it muſt therefore ſink at O, riſe at E, and at D remain in an Equilibrium, that being ſuppoſed the place where the Bottle, with the Water and the Air it contains, taken all together, is equal in Weight to a like Bulk of Water out of it.

Now, if inſtead of this Bottle we ſuppoſe a Fiſh with its Bladder, in which ſo much Air is included, that in Winter the Fiſh, by the Expanſion thereof, may emerge; and when arrived to the Superficies of the Water, may with little trouble contract its Bladder, and the Air within it, after ſuch a manner, as to remain where he is, or to be able to ſink down again: In ſuch a Caſe it is plain, that a hot Summer following, this Air, the Expanſion whereof was ſufficient in Winter, being ſtill the ſame in

Quantity,

Quantity, will dilate itself much more strongly by the Heat, and hinder the Fish, unless he constantly exerts all his Strength, from being able to descend again.

The same Inconvenience would happen if there were less Air in the Bladder, and only so much, that the Fish might easily support itself at Top of the Water in Summer; for upon the return of Winter, or upon a Fish's descending lower, and meeting with more Cold and a greater Pressure of the Column of Water upon it, and by both these Means, the Bladder being contracted without any Concurrence on the part of the Fish, much Strength must be used to raise it up again; insomuch, that with the change of the Seasons, the Fish would oftentimes have too much Air in the Summer, and too little in Winter: So likewise the Fishes passing into Water of different Gravities, would be many times furnished with too much or too little Air in their Bladders; and in order to avoid all these troublesome Alterations, and to pass conveniently from one place to another, they would be obliged to remain always in a Water of about the same Weight, and as much as possible in the like Depth and Temper, as to Heat and Cold.

To prevent all these Inconveniences, the readiest manner seems to be, that the Fishes should be endowed with the Faculty of encreasing or lessening the quantity of Air in their Bladder, according as occasion required, which likewise we see happen by the Wisdom of the Creator; forasmuch as their Bladders have a Communication with their Stomach by the Means of a very small and narrow Tube; so that they can diminish the Air by discharging from the Bladder thro' the Mouth, and increase it, by drawing it in again; about which *Borelli, Prop.* CXI. *Part* I. has this Observation;

That the Bladder is empty when the Fish being *in Vacuo*, discharges a great many Air-bubbles by its Mouth; and the swallowing in of Air may perhaps be the reason, why we often see the Fishes moving their Mouths in the upper Part of the Water near the Air.

Sect. XXX. *Convictions from the foregoing Observations.*

Now if a deplorable Atheist has taken the Pains to read this, and understands it, let him tell us, whether it can any ways seem probable to him, that so many Laws of the Water, of the Air, and of the Motion of the Muscles in Fishes, are so accurately observed by meer Chance? or could blind Nature, ignorant in itself of all its Effects, produce such a Difference, as on the one hand to furnish the Fishes with such a Bladder, and Birds on the other hand, tho' they likewise move in a fluid Matter, or in the Air, with quite a different Method of Progression; since such a Bladder by which a Bird were to be raised up, must be lighter than the Air, and for that reason empty of it. Now they who ever proposed to raise a heavy Body in the Air, with a Globe out of which the Air is exhausted, know first, That the Shell of it must be made pretty thick, least, being thin, it should be unable to resist the Pressure of the external Air upon any Accident; and besides, tho' all this were not observed, yet it must be of so disproportionate a Magnitude, that no Bird, being incumber'd with it, could be able to fly: Not to take Notice, that the Greatness of a hollow Brass Globe (that being empty of Air without lifting up any heavy Body, it might ascend alone, and of itself) is computed by Mr. *Leibnitz*, in the Philosophical Transactions of *Berlin*, published in the Year

1710,

1710, *p.* 127. to be such, that the half Diameter thereof would require to be above twenty thousand times longer than the Thickness of the Metal of which the Crust of the said Globe must be composed; so that the said Globe being an Inch thick (tho' that perhaps would not be sufficient to resist the Pressure of the external Air) the whole Magnitude of this hollow Globe would take up some thousands of Feet. I have expatiated here something the more, to convince Sceptical Philosophers, that are any ways versed in Modern Experiments, that the Structure of Fishes is entirely opposite to what is proper for the flying of Birds; and that it is undeniable, that in order to make Fish and Birds move upwards and downwards, (each of 'em in their different Fluids) different Means must necessarily be applyed; which being performed in both, in a manner so suitable to all these Circumstances, I leave it again to their own Judgment, whether this does not plainly shew the Wisdom and the good Pleasure of a Great Creator.

Sect. XXXI. *Fish Swim with their Tails.*

Now, if we observe farther in so many Fishes, that in order to their Progressive Motion in Water by Swimming, they do not make use of their Fins as Oars to row with, nor after the same manner as the Birds do their Wings in the Air, but by the help of their Tails, much after the same manner as a Boat moves when they put an Oar out at the Stern, and Paddle with it backwards and forwards.

Is there no Wisdom to be discover'd in this (since Fishes stand in need of no external Motions for raising and sinking their Bodies, as we have shewn before) that their Instruments are so formed, that no time should be lost in their advancing forwards;

wards? And that having made a Motion with their Tail, by which they are protruded, they have no occasion to draw it back again, in order to dispose the same, to repeat the said Protrusive Motion: This the Birds are forced to do with their Wings, that they may strike upon the Air every time perpendicularly, in order to support themselves therein; but the Fishes by putting their Tail in its former Place and Disposition exert the same Force on the other side, which contributes as much to their Progression, as the first Stroke had done? Is it now by Chance, that these Tails, like the paddling Oars, are broad at Bottom, that they may act with greater Force upon the Water; and that they are composed of a strong Membranous Matter, which is however flexible; that the Muscles of the Back are of such a Structure, as to move the Tail with a sufficient Strength, even so far, that the Violence which the larger kind of Fishes, such as Whales, exert therewith, is so terrible, that one can hardly read the Accounts thereof without being amaz'd?

Sect. XXXII. *The Use of the Fins.*

But forasmuch as in all Bodies that float in Water, the heaviest Part always tends downwards, according to the Laws of Hydrostaticks, would it not likewise follow from hence, that since the Backs of Fishes, quite contrary to those of Birds, are the heaviest Part of their Body, they must always turn their Bellies upwards in the Water, as it is commonly observed to happen in dead and floating Fish, since their Bladder cannot be then compressed, but the Air being dilated therein, makes the Fish float and turn its Belly upwards, the Back being not only heavier, but the Belly also

so lighter by such Expansion of the Bladder than when the Fishes were alive.

Can it then be imagined that the Wisdom of the Creator did not foresee this in the Forming of Fishes, to which he has given two Fins under their Belly, by which they support themselves upon the Water, and by giving them the Faculty of Swimming whilst alive with their Bellies downwards!! of which we may find an accurate Examination in *Prop.* CXIII. of *Borelli*, who having cut off all the Fins under the Belly of a Fish, and in that Condition thrown it into the Water again, found it continually staggering on one side or t'other, without being able to support itself in the natural and common Position of Fishes.

But besides this, to the end that the Fishes might be provided of every thing that is necessary for them towards Swimming, it seemed to be still wanting, that they should be able conveniently to stop that Progress which they had acquired by their Tails, and to be able to turn to the Right or to the Left in their Course, neither of which could be done by the Tail but with great Trouble. For this Purpose we find the Fishes provided with two Fins on the Sides, by which, when they extend 'em both together against the Water, their Motion may be stopt; and if they stretch out one and keep the other close, they may turn to that side whence the Fin is displayed; just as we see happen in a Boat which turns to that side where one Oar is thrust out in the Water to stop its Progress.

Sect. XXXIII. *Creatures that live in the Air see confusedly in the Water.*

In Case this does not yet suffice to convince a Sceptick that there is a God proposing to himself a wise

a wise End in all his Designs; let him reflect upon what follows, which seems to be capable of removing all farther Uncertainty.

It is known to every one that ever div'd under Water with his Eyes open, that one may indeed see the Light and many Colours of Objects, but that all will appear Confused and without Distinction. Now we have shewn before in *Tab.* XI. *Fig.* 2. that the Rays of Light B C and B C coming from a Point B into the Air, continually diverging or spreading wider and wider from each other, meet in the Eye with a watry Humour, thro' which they do not then proceed directly from C, according to *g g*, but are refracted towards each other at C D; which refraction or bending being repeated again the second and third time at D and E, they both of 'em unite again at the Bottom of the Eye at *b*; in which manner of collecting all the Rays proceeding from B into this one Point *b*, all the Exactness of a good Sight consists.

Let us now suppose this Eye, as also the Point B, in the Water; then the Rays B C and B C, will come out of the Water upon the Aqueous Humour C C. And since, in order to be bent or refracted, they must likewise change the Medium thro' which they pass, these Rays therefore remaining in the said Medium or Water, and passing to C, will not be broken or bent to D D; but proceed directly to *g g*, till they meet the Crystaline Humour S T. So that altho' they be refracted after the usual Manner, thro' the same at D and E, yet failing of the first Refraction at C, they will not be able to approach near enough to each other, in order to be collected just at one and the same Point *b*, which is at the Bottom of the Eye: But this Point of their Collection will fall farther behind the Eye, for Instance, at *k*; for which reason every Point, as B, with its Rays, will fill the whole Space

m n at the Bottom of the Eye; which happening in like manner from the other Points of the Object near B, the Rays of these several Points will be mingled together at the Bottom of the Eye, even in the same Space between *m* and *n*, and so occasion an entirely distracted or confused Sight, because each Point B is not seen in a particular Point *b*; after the same manner as in a dark Chamber, when you hold the Paper a little too near to the Glass, the Objects painted upon it are all confused, whereas by holding it at a due Distance, it represents the most accurate Painting that Eye ever beheld.

Sect. XXXIV. *To prevent this confused Sight, Fishes are endowed with rounder Eyes.*

Now this is the Inconveniency that would happen, and be peculiar to all Fishes, if their Eyes were of the same Figure with those of such Creatures as live in the Air. Now in Case any one that should doubt of the Wisdom of God in the Formation of Fishes, does understand the Laws of Opticks; and if he were to tell us how this Inconvenience in Fishes might be prevented, and how they could be furnished with a distinct Sight; such his Skill in Opticks might indeed teach him some of the Methods whereby the same might be brought about; as for Instance, by holding a round Glass before the Fishes Eyes, as old People do, who find the same Defect in their Eyes, because they become less round and more flat by Age: but it is plain, that such a thing can't be done for the Fishes. The making their Eyes longer, so that they might be extended not to *b* but to *k*, would indeed render their Sight more distinct; but then it would bring along with it this Inconvenience, that their Eyes, by losing so much of their Roundness, could not easily be turned

to

to all Sides. And, to pass over others, let him tell us, whether he could have thought of a shorter Way, than by making the Crystaline Humour of the Fishes S T rounder, and of a smaller Circumference than the Eyes of those Creatures that live in the Air; and he will know, that according to the Rules of Opticks, this will be sufficient to make good the Defect, and cause the Focus of the Rays to fall so much nearer upon the Crystaline Humour.

Now this is what we really find in Fishes; in which the said Humours are sufficiently Convex, and like little Globules, as may be daily observ'd in the Eyes of boiled little Fishes; and as appears even in the Eyes of great Whales, which are very small and round, and which if they were larger, and consequently of a flatter Circumference, would take up a great Part of their Heads for the use of their Sight, which now is contain'd in less Room.

Now let those self-conceited, but unhappy Philosophers, who deduce every thing from meer Chance, or from ignorant or necessary Laws of Nature, retire within themselves, and reflect, whether it can seem probable to them, that it is perfectly accidental, that besides the wonderful and uniform Structure above-mention'd of the Eyes of all Animals, those that belong to the Water have their Eyes so form'd, as to see and distinguish Objects in that Element; and those that live in the Air, have theirs likewise adapted to this Element. Or let them with all their fancy'd Wisdom, prove to us the Necessity, according to which they can infer from the nature of the Water, that (unless the Creator had had this End in view) the Eyes of Fishes would have been always rounder than those of the Creatures which belong to the Earth or the Air. But as this is not possible for them to do, let

them

them confess with us, and besides with so many Men famed for Learning, that a God of Wisdom and Goodness extending his Care even to Fishes, does visibly appear in this matter. Or if they still perseverе in their Opinion, they must pardon us, if we say, we are compell'd to think that they are to be pity'd, as lying under a secret Judgment of God, as well as a natural Blindness, especially if they go on to affirm, that after having duly weigh'd all things, they still remain unconvinced.

I have dwelt a little the longer upon this Subject, because one of my Acquaintance, who being involved in Doubts, and having entertain'd some Scruples about the most important Truths, by much (but wrong) Philosophizing, happen'd to read these Observations in *Rohault's Physicks*; whereupon he felt great prickings and trouble in his Mind, and presently own'd that he was now fully and irrefragably convinc'd that the Eyes of all Animals, and especially the diversity in the Form of those of Fish, could not be produced without a manifest view and design of him who made them: and consequently, that there must be a God, who by causing his Wisdom to appear to all Men by his Works, deserv'd to be fear'd by all his Creatures. May He grant, that all those who shall read this, and seriously reflect upon it, may likewise be convinced!

Sect. XXXV, *and* XXXVI. *The Fruitfulness and Numbers of Fishes.*

That we may be more confirmed in the Acknowledgment of a God, we need only contemplate the Multiplication and Fœcundity of Fishes, which happens in many Kinds of them after so wonderful a Manner, as has been shewn already upon

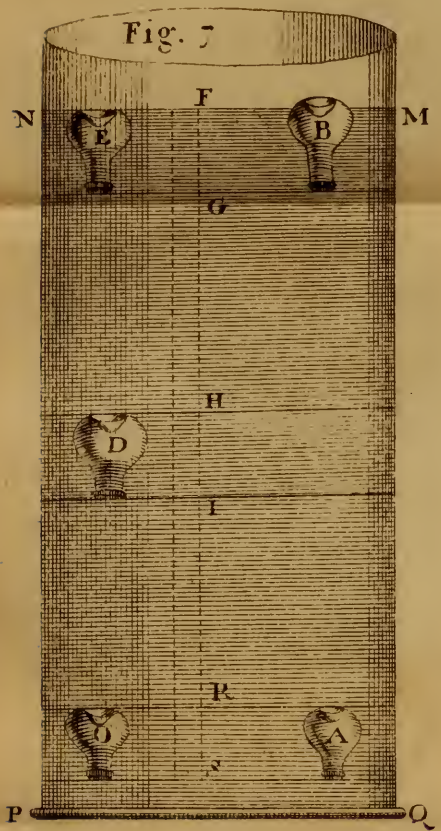
upon another occasion; some of the Females discharge their Spawn, and the Males their Melt or Seed in the Water near each other, and without any farther Acting of the Fishes on either side, both these Seminal Matters being intrusted to the Water, do produce Young Fishes of the same Kind.

Now can any Body imagine, that this Spawn and Melt of the Males and Females, together with the Water, have the Property of Engendering Fishes after such a manner by meer Chance, and without a wise Design! The rather, since we see that herein is a Direction or Disposition of propagating the Species of Fishes above all other Creatures in an infinite Number; for if there were not some other extrinsical Impediment, every single Grain or little Egg that we find in the Spawn would become a Fish. So that it is no wonder what some Travellers relate concerning their Fruitfulness; as for Instance, that in the Island called *John Fernandez*, in the *South-Sea*, there is such a vast Quantity of Fishes, that one Man can in one Day catch enough to feed 200 Persons.

I have often thought of the Text in *Genesis* i. 20. *And God said, let the Waters bring forth ABUNDANTLY the moving Creature that hath Life* whereby the two aforesaid particular Properties concerning the great Encrease of Fishes, are as one may say, pointed out with the Finger; the rather, because in the 21 Verse it is repeated with the same strong Ephasis, *which the Waters brought forth ABUNDANTLY after their Kind.*

Now that this has respect to Water, which as a second Cause, produces these Fishes out of their Spawn, seems to be deducible from hence, That the Procreation of Birds being mention'd in the said Verses, is not ascribed to the Air, tho' they live and are produced therein, as Fishes in the Water.

TAB. XVII.



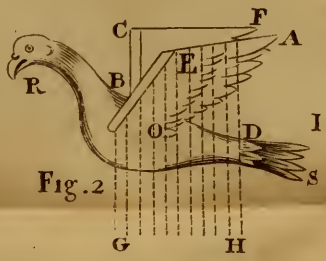


Fig. 2

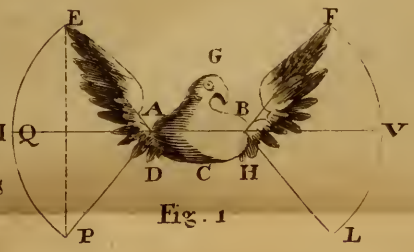


Fig. 1

Fig. 3

Fig. 5

Fig. 6

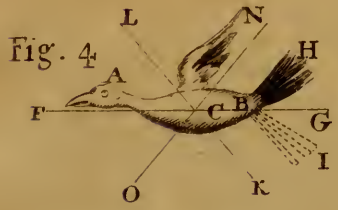
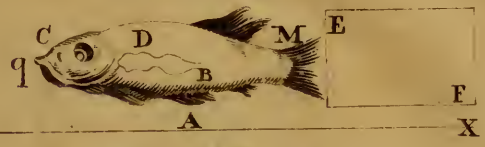


Fig. 4



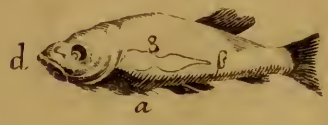
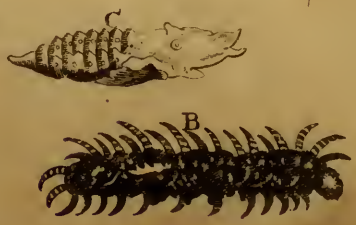
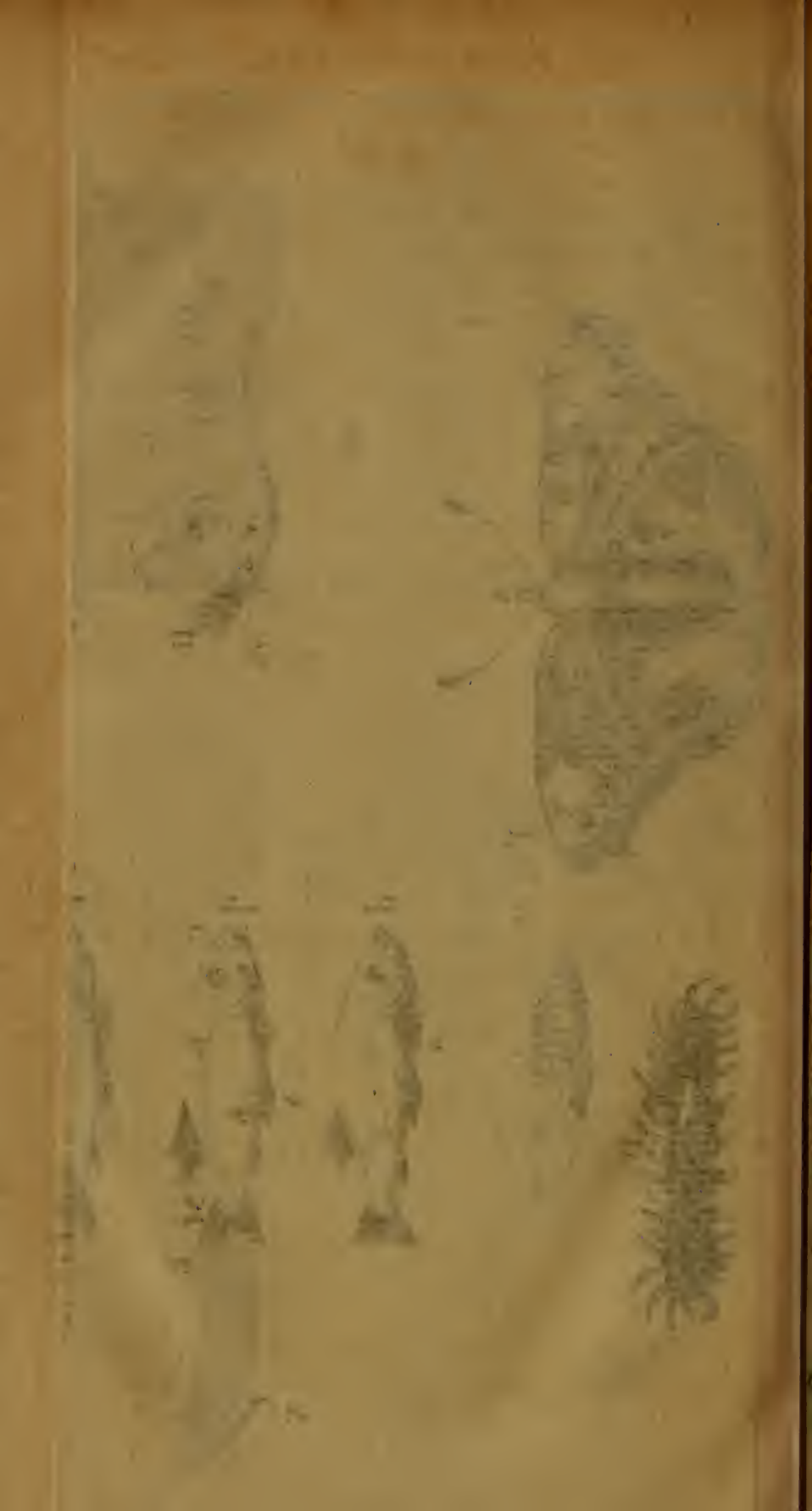


Fig. 8





ter; as also, forasmuch as afterwards mention is made in the 24*th* Verse, of the Earth (of which all Creatures do at present consist, since all of 'em receive their Food from thence) after a different Manner: And moreover, how much this first Command of the Creator does continue firm, and prevail even to this very time, appears especially from hence, that in both the quoted Places the Expression of *bringing forth abundantly*, is only found in relation to Fishes, but not at all mention'd concerning Birds and Beasts, tho' they are compared with one another in this same Chapter. Now that the Fishes do multiply in much greater abundance beyond other Creatures, even to this day (tho' an abundant Production is likewise ascribed to other Places where there is no Comparison; and in *Genesis* the viii. and 17. and the ix. and 7. the same radical Word is used) at least that they can be more multiplied, is obvious enough, from the prodigious Quantity of Eggs in their Spawn, and from other Relations that have been hinted at above. Thus in *Ps.* civ. they are said to be *innumerable*; and upon the same Foundation *Jacob* wishes that *Ephraim* and *Manasses* may *grow into a Multitude* (or, as it is in the Margin of that Text, *as Fishes do encrease*, Gen. xlviii. *v.* 16.) At least, it is plain from hence, that those Words were not spoken without a Fundamental Knowledge of the Properties of Fishes, as two great Circumstances in which they differ from other Creatures, namely, the Effect of Water in their Production, and their great Fœcundity.

Sect. XXXVII. *The Curse appears from the Production of Fishes.*

There may still one Remark be made about the foregoing Matters; namely, that this so great

Multiplication of the Fishes, which seems to be the necessary Consequence of the Quantity of their Eggs, is not however observed to be so at this time. Now such as allow the above-mention'd Text to be the Word of GOD, may discover herein the Force of the Curse, which after the Fall of Man is extended to all things; for the sake of which not only the Trees are less Fruitful than from their Contexture one might have expected them to be (of which hereafter more largely) but Men likewise live a smaller Space of Time than their Structure seems to promise (of which something has been said above in *Contemplation* XII.) Now if this be seriously consider'd by a Sceptical Atheist, it will not be easy for him to assign any other Cause besides this Curse for the same, nor to remove the Difficulty which offers itself, that so many Things, and among them the Fishes, do not answer the Expectation which we might justly entertain from their Structure; and which is more, have not in so many Ages answer'd the same, tho' every thing be compleatly disposed thereto.

SECT. XXXVIII. *Creeping Creatures not yet thoroughly known.*

NOW how the Creeping Creatures, such as Worms, Snails, *&c.* do move from one place to another without Legs, and other external Instruments, has not (that I know of) been yet examined into with so much Accuracy, as to enable any one to say any thing satisfactory about it; he that desires any account thereof, and how, according to the Opinion of the great Mathematicians, such Motion may be perform'd, let him consult *Borelli* in his Book about the Motion of Animals, *Part* II. *Prop.* XIII. Mr. *de la Hire*, in his Treatise of Me-

Mechanicks, §. CXII. *p.* 358. seems to have carried his Observations upon this Matter somewhat farther, affirming, that in great Worms, such as are found in the Sea, the Muscles can be discover'd, some of which encompass the Worms like so many Rings, others are extended lengthwise in the said Worms. Now if this latter sort be so form'd as Mr. *Borelli* describes them, the Serpentine Motion of Worms seems to be performed by those Muscles; since when the long Muscles are contracted, the Worms becomes shorter, and when the round ones, it is stretched out in length. But forasmuch as the Structure itself of these Creatures does not seem to have been sufficiently enquired into, we shall be silent about it, that we may (as much as possible) avoid substituting Conjectures, tho' of very learned Men, and proposing them to any one, instead of the true Works of the Creator. This only would I ask of any one that does not own a God, whether it can appear reasonable to him, to suppose that a Worm is made without Wisdom, when so many learned Gentlemen, tho' urged to give an account thereof, must acknowledge it to be a very difficult Question.

Sect. XXXIX. *Insects, Silk-worms, Caterpillers, &c.*

Now if we pass on to the Examination of the surprising Structure of so many different Kinds of Shell-Fish, both great and small, and yet farther of Caterpillers and Worms, and of the Aurelias proceeding from them, and of Flies, Grashoppers, Beetles and the like; with which at present the Closet of Persons of Distinction (that delight themselves in contemplating the surprising Works of the great Creator) do with laudable Charge and Pains abound; and wherewith a great many Books

besides are filled, without near comprising all the kinds thereof; to produce many Instances thereof will not be necessary here, since they are to be found in so great a number elsewhere.

But to instance in two or three of 'em; ask any Body, be it who it will, whether he can think, that it is by meer Chance, that a Silk-worm comes out of an Egg furnished with all the Instruments for Moving, Eating and Digesting its Food as other Animals are; that afterwards Spinning itself up with the Silk that comes out of its own Bowels, it is turned into an Aurelia, from whence at last proceeds a Butterfly, which after Copulation with a Male of the like kind, lays Eggs again, which in the following Year become Silk-worms; this is known even to our Children that are wont to breed the same.

They that in Summer meet with so beautiful a Butterfly as is represented *Tab.* XVII. *Fig.* 8. flying with Wings, running with Legs, and furnished with all the necessary Parts for Nourishment and Generation; when they read in the Observations of the accurate Mr. *Goedart*, that the said Creature was a Caterpiller B before, and that it was first turned into the Aurelia C, and afterwards became a Butterfly; could they, seeing such Metamorphoses, and change of Figures in so many kinds of Animals as are briefly named above, and of which the said Author faithfully reckons up a great number; could they look upon 'em, I say, otherwise than as so many Wonders of a great and wise Creator? Or can they perswade themselves, that all this is brought about by Causes divested of Understanding and Knowledge? And the rather, forasmuch as the little Eggs of those that we know are found by Experience not sooner to disclose their young Ones, than till the Herbs and Leaves that are to serve them for Nourishment, do spring

out of the Ground or Trees. Now if this be true, as several Naturalists pretend they have observ'd, let an Atheist see whether he can calmly persist in that Opinion, that here is no room for an End and Design of a great Preserver. And if the same has place here, and that there is undoubtedly so great, so adoreably Wise and Powerful GOD that governs all Things, woe be to them, yea, double woe to all that deny him.

SECT. XL. *The Consideration of small* Animals *in general.*

TO return to the Matter again; Since these Insects, together with Shell-fish, have been consider'd with great Diligence by many learned Men, every one may find Matter of Astonishment in what has been transmitted to the learned World concerning the same; and I hope that this happy Beginning, which Men of Note and Judgment have made, may in process of time be an inducement to great Minds, to contemplate these small *Animals* in certain other Views, and to enquire farther into the Wisdom and Art that do so manifestly appear in the Instruments which they use for Motion, Nourishment, and all external Sensation; by which particularly the Glory of their great Creator (which does not appear less in the Structure of a Fly, a Flea, or a Mite, than in the making of the biggest Elephant) may be demonstrated by yet stronger Arguments against those that refuse to acknowledge the same.

He that doubts hereof, let him consult those great Enquirers, who by the help of their Microscopes have discover'd as it were a new World, and thousands of otherwise invisible Creatures; in the unconceiveable smallness of which, not only the Desires of a curious Eye will meet with intire

Satisfaction; but likewiſe the manifeſt Deſigns of the Creator and his Wiſdom and Goodneſs, (even with reſpect to theſe *Animalcula*, that by reaſon of their Smallneſs are almoſt inviſible) will ſhine forth as clear as the Sun.

SECT. XLI. *The Eyes of a Beetle, and Convictions from thence.*

FORASMUCH as whole Books have been writ upon this Subject, I ſhall only give an Inſtance in the ſurpriſing Structure of the Eyes of a *Beetle*, the like of which we alſo find in Flies. The great Creator, in the Formation of this Inſect, thought fit to make the Eyes thereof immoveable, which in bigger Creatures can be turned to all Sides; ſhewing thereby, that he does every thing according to his good Pleaſure, and will be bound to no Laws. Now it is certain, that theſe Beetles and Flies, not being able to turn their Eyes, can only ſee that Way towards which the opening of their Eye is directed; but becauſe the bountiful Preſerver of all things does likewiſe extend his Goodneſs even to theſe moſt contemptible Creatures, and that they may be aware both of the Birds, and other Perſecutors that prey upon 'em, and uſe them for Food; and that they may ſpy them not only before, but ſidewiſe, and likewiſe behind, in order to their Preſervation, he has been pleaſed to cauſe their Eyes to ſtand out of their Heads, with a Protuberance or Convexity, and beſtowed upon 'em ſuch a Figure in a manner as we find in Glaſſes, which being ground with many and different Faces, do multiply the Object as many times as there are Superficies upon the Glaſs; So that each of theſe little Planes or Superficies of the Eye do appear thro' a good Microſcope to be an exact Hexangular Figure, as we may ſee in a Bee-

a Beetle's Eye (*Tab.* XVIII. *Fig.* 2.) A B C D, and in that of a Fly (*Fig.* 3.) G E F. They that look upon it in this Table, must be pleased to take notice, that it is represented here much greater than it really is, and so as it appear'd through a good Microscope; whereas otherwise each of 'em are so small, that the Observer, Mr. *Leuwenhoek*, having counted those that are in the Diameter of the Eye, justly concludes, that the number contained in the Superficies thereof does amount at least to 8000.

From this Structure every one may infer, that these Insects by the means of so many different and convex Superficies, are able to see upwards, downwards, sidewise, before and behind, as if they had so many Eyes, with as much Ease, and perhaps more, than any other Creature that can turn one and the same Eye every way.

One that is well versed in Dioptricks, and understands the Nature of Vision, might perhaps find this Defect in such a Structure; that in case these Insects must see like others, it would not be possible if the Superficies were flat (as in the polished Glass or Diamonds, to which they were compared) that the Rays passing thro' them from a Point, could be collected in a Point at the Bottom of the Eye, which, as we have shewn above, is required to a distinct Sight, and which is besides, the reason why the Eyes of Fishes must be rounder than those of other Creatures living in the Air. So that these Insects, according to the Laws of Vision, might indeed have a confused Sensation of Objects without them, but yet see nothing distinctly thereof, unless each of the said little Superficies were in themselves Convex. But can any one who justly objects this Difficulty, observe again upon farther Enquiry, without being amazed at the Wisdom of the great Creator,

that each of these exceeding small Superficies are of a Convex and Globular Figure, to the end, that they may serve for a distinct Sight to each of these little *Animals*, according to the exact Rules of Opticks, as those that examine them more nicely and attentively will find. But forasmuch as the globular Figure cannot be compleatly shewn by the said Microscopes, let any one take the Eye of one of these little Creatures, and observe them nicely against the Light of a Candle, holding them at a little Distance from the Glass, and he will then discover as many Images of the Flame of a Candle inverted, as there are Superficies in the Eye of a Fly, all incompassing the middle Superficies upon which he looks as in a Right Line: Which burning Candles are so exactly delineated, tho' all exceeding small, that as the Flame of the Candle itself moves upwards, the Picture of it will appear to do the same every time, but inverted; just after that manner, as one may see thro' a round polished Glass, the Picture of a remote Candle inverted upon a white Paper; or otherwise looking thro' a double Microscope; as likewise by keeping ones Eye behind the Focus of a round Glass; in all which Cases one sees the Object turned upside down.

Now every Mathematician that is never so little versed in Opticks, knows that this cannot be done by a concave or flat Figure; and that, in order to shew the exact Image of a luminous Object inverted (which is here beyond Expectation every way distinct) a convex or a more protuberant Figure is only required; which cannot be doubted by any one that understands the Refractions of Light.

I must confess, that for my own Part, I could not oftentimes see and observe without Emotion, a Providence operating with the wisest Views

even

even in the very smallest Things, and appearing not only so visibly, but so adoreably too in these small *Animals*. And since such a Figure would create trouble enough to the most skilful Glass-grinder, if he were to form a great and manageable Glass like it, how impossible would it be for any humane Art to extend itself so far, as to communicate such a Shape, and all the Properties belonging to Sight, to an almost invisible *Animalculum*. Now if these little Particles or Eyes were not transparent, there would be no Sight; if each of 'em were not round, there would be a Sight but confused; if they were not disposed in a convex Superficies, these Insects would not be able to see round about 'em, because of the Immobility of their Eyes; if the Membranes thereof were not supplyed with Humours proper for them, and such as must be conveyed thither by unconceivably little Vessels, the Sight would be ruined by Dryness, as Experience teaches us when Eyes continue too long dry: Now all this is required, and all this is found in each of these Insects, and every one of these Circumstances is wonderful: Can we then see them all concurring in so small a Compass, and coolly affirm, that it is all by Chance?

Now every one that has seen the curious Structure of the Eyes of these so small *Animals*, in the Observations of Mr. *Leuwenhoek*, or other Naturalists, or made the Experiment himself, may imagine, how overflowing the Wisdom of the Great Creator thereof is, who has vouchsafed to display so much Skill and Contrivance to render Happy so many thousand Millions of such contemptible Insects (how much more then a rational Man) and to cause them to see distinctly.

Sect. XLII. *Something concerning the beginning of Action in Beasts.*

My Reader must not be surprised, that in this *Contemplation* of Animals, I have said nothing of the Principle of the Actions in Beasts; concerning which, Philosophers differ so much among themselves, some of whom look upon Beasts to be no more then Clock-work, without either Sense or Understanding; but others think that another Principle of their Actions must be allowed, to enable Beasts to act as we see 'em.

The chief Reasons that have induced me to pass over this Matter in silence are, that both these Parties agree in owning a God, how much soever they differ in other Sentiments; wherefore, since we only write here for the Conviction of Atheists, we thought it unnecessary to engage ourselves in this Subject.

However, to say one Word about it to unhappy Infidels, how much soever we see perform'd by Beasts, that may appear surprising to us, and how much soever they may seem to mimick the Actions of Men; this is certain, that we could never yet discover any thing in them that was like any Sign or Character of the Knowledge of a God, or of his Service. Let then an Atheist learn from hence, that far from deserving the Title of a *Strong Mind*, upon account of his deplorable Philosophy, the only Reward that he is like to receive for the Pains he takes therein (I say it with Compassion for his Blindness, and without Design of the least sarcastical Reflection) is, that it serves to distinguish him from a rational Creature, and in this Case, sinks him down into the Condition of a Beast, and yet without giving him this comfortable Assurance, that he is to expect nothing else after his

his Death, but to be reduced to the State and Condition of Irrational Beings. And I leave him to judge for himself, (since there appears in Men the Knowledge of a GOD, but by no means in Beasts) whether the Opinion of Christians are so absurd, when they maintain, that Death does entirely annihilate Beasts, but that the Souls of Men do still remain; forasmuch as the Knowledge of an eternal GOD does exert itself so much more adoreably in a Being that is framed for Eternity, and so adapted to glorifie that GOD for ever.

CONTEMPLATION XXIII.

Of PLANTS.

SECTION I. *Transition to* PLANTS *in general.*

NOW for the farther Confirmation of what we aim at in all these things, let us pass on to the Plants, and tho' a great many of them be still unknown, yet, what the Experiments of Enquirers have discover'd thereof of late Years, is sufficient to prove, that a wonderful Power and Wisdom does appear, in adapting them all to their respective Uses.

Now if we should take notice of nothing more, than what is already sufficiently known both to the Learned and Unlearned, namely, that we see a little Seed first taking Root downwards in the Earth, and then shooting up a Trunk or Body in the Air, and in some producing Branches, and in others

others Leaves, Flowers, and Fruit, in which again there is Seed, by this means multiplying the Plant, which when dead, revives again in the Posterity of the same Species; let every one consider with himself, whether he could expect such a constant Circulation and Series of Plants in Seeds, and again of Seeds in Plants, that has lasted so many Ages without any Variation; and all the Instruments necessary thereto, from mere Chance, and a confused concourse of Atoms.

Sect. II. *Without Earth and Water no Plants will spring from their Seeds.*

Let an Infidel or Sceptick examine farther the Earth and the Rain-Water (of which when we treated about Water itself, we shewed that all Plants do mostly consist) after as many different Ways as he can possibly; and then let him see, whether he can with any reason prove from thence how it comes to pass, that when we sow the Seed of a fine and sweet smelling Flower, or of nourishing Corn, and another of a poisonous Plant in the same sort of Earth, each of 'em will produce a Plant according to its own Nature, differing so much in Figure, in Strength, and other Properties; and let him say, whether it does appear to him with any kind of probability, that all this is done without Wisdom; and the rather, forasmuch as Earth and Water being excepted, Experience has shewn in so many Cases, as the Learned *Malpighi* observes, *de Sem. Veget. p.* 12. that neither Urine nor Lye, nor Spirit of Copperas, nor Chalk, nor Salt-petre, if in too great abundance, nor Atimony, nor burnt Hartshorn, nor many other things when mingled with Water, and the Seed soaked in such Water, or when water'd with the same after they spring up, can produce any encrease or growth thereof,

thereof. Nor, according to the Observations of the said Author, can Seeds produce their usual Plants in simple Water only: They that would be fuller informed of this Matter, may consult that accurate Writer in the Place above quoted.

Now when so Understanding and Learned an Enquirer has made so many Experiments about Plants in vain; and consequently, since 'tis not so easy for any one to discover wherein consist those Properties that are requisite for producing Plants out of their Seeds, and yet we see, that they are in a manner found alone in Matters so contemptible to the Vulgar, and trampled under foot as Water and Earth; let any one that does still doubt of the gracious Direction of the great Preserver of the World, ask himself, whether he could bestow upon a simple Seed, or upon Water and Earth, a Figure or Form, by which the whole World may be preserv'd from Death: And in case he can't (as hitherto no Body ever had such a Faculty) whether he has not just cause, from all these things, to acknowledge a Wisdom far superior to his own, and to that of all Mankind; and at the same time too, a Goodness and Bountifulness that has bestowed upon all Creatures their Food and Support.

Sect. III. *Every Seed has its Seed-Plant.*

Now they that would see how far the Knowledge of Men has attained, in respect to the Parts of which Plants consist, and the Use thereof in their Encrease and farther Oeconomy, may consult thereupon the Learned Writings of *Grew*, *Malphigi*, and in some Cases of *Leuwenhoek* also, and others; and one would think that towards the Conviction of an Atheist, there would be nothing more required, than

than to refer him to the Obſervations of thoſe Perſons: At leaſt, that which can't occur to him without great Aſtoniſhment is, that he will find in the Accounts they have given about Seeds, that having enquired into a vaſt Number thereof, they have diſcover'd and ſeen in every ſingle Seed an involved Stamen of the future Plant, which by *Malphigi* is named *Planta Seminalis*, or the Seed-Plant.

Sect. IV. *The Seed-Root and Pluma in a Bean.*

To ſay ſomething thereof, which every one may eaſily try; take ſome great dry Beans, and ſteep 'em 24 Hours in Water, then take them out and lay them in a place that is dry, but not cold, ſo long till, as the Gardeners term it, they begin to ſhoot out; Strip the Skin off of one of 'em, and you will find the Body of the Bean conſiſt of two Parts, lying with their Planes againſt each other, and having a little white Stalk or Sprig by which they are joined together; for Inſtance *Tab.* XVIII. *Fig.* 4. *a a a*, and *a a a*, are the two Parts of the ſlit Bean; *d c* is the white Root-Sprig faſten'd to both the ſides, and which afterwards in the Earth becomes the Root of the Plant. Now let an unhappy Sceptick ſay, ſince this Root *d o*, muſt firſt grow and ſpring out before it can be nouriſhed by the Earth, and be turned to a Root for the whole Plant, whether he can imagine that it comes to paſs without any propoſed Deſign, that in the Body of the Bean, and in both the Parts thereof, there is another Root placed, repreſented here by *b b b b*; which is carried on to the white tittle Point *c*, on each ſide with a Branch *d d*, and thereby furniſhes this little Root-Sprig *d c*, *d c*, with nutricious Juices, in order to communicate thereto

to the beginning of its Encreaſe, and the Power of becoming a Root, before it be able to draw any Nouriſhment out of the Earth.

From this little ſprouting Root *d c*, there proceeds to the other ſide another little Body *e*, which being the Trunk or Stalk in Miniature, does conſiſt of a very little Stalk and Leaves; upon which account it is called by Dr. *Grew*, the little *Pluma*, or Feather; and the ſaid Sprout of the Root *d c*, and this little Feather *e*, do make together the Stamen of the following Plant.

Sect. V. *Each Plant has two Roots.*

So that almoſt every Plant (as Experience teaches us, that the ſame thing happens in almoſt all the known Seeds after the ſame manner) is thus furniſh'd with two Roots; the firſt of which is that deſcrib'd here by *b b* and *b b*, and which ſpreads itſelf thro' the Body of the Seed, being therefore call'd the *Seed-Root* feeding the little Root-Sprout *d c*, and the Pluma *e*, ſo long till the firſt of thoſe is big enough to draw Nouriſhment to itſelf out of the Earth, and then it becomes the ſecond and laſt Root, cauſing the Pluma, now become a larger Trunk, to grow up to a compleat Plant. From whence it is farther apparent, that the Matter of the Seed itſelf, or of the Bean by which the firſt Seed-Root *b b*, *b b*, is extended, performs almoſt the ſame therein (by making the Root-Sprout *d c*, put forth at firſt) as the Earth does afterwards when it becomes a larger Earth-Root; that is, does feed and increaſe the whole Plant.

This Seed-Root *b b*, *b b*, appears more plainly in large Beans, and in the Seeds of Lupins, than in many others, according to the Obſervation of the ſaid Dr. *Grew*. And in caſe one cuts a freſh

cropt

cropt Bean into thin Slices crosswise, one may see in every such Slice the Course of the little Seed-Roots (represented here by little Points or Dots) quite to the end; (see *Tab.* XVIII. *Fig.* 5.) where *b b* shew the Dots through which the Seed-Root is cut across; and if you should cut off thin Skins lengthwise from the said Bean, you may see the little Branches of the said Root that were just before cut across. *Tab.* XVIII. *Fig.* 6. shews the said white Lupin, as it appeared to Dr. *Grew*, of which *c* is the *Pluma*, *b* the Root, *d d* the Pith, and *a a* the Branches of the Seed-Root. *Fig.* 7. is the Seed of a *Gourd*, where the said Gentleman says, that one need only split it in two, in order to see within it the said Seed-Roots clearly and accurately in all their Branches. In other Seeds, where these Roots are not quite so visible, either because they are of the same Colour with the rest of the Body, or for other Reasons, yet the Root-Sprout, or the Feathers, may be always seen plain enough. [*Vide Grew, Cap.* I. of his Anatomy of Plants.]

Sect. VI. *The Cavity in the Bean for the* Pluma.

One might here add other Particulars; as for Instance, that in *Fig.* 4. the little *Pluma e*, is the Origin of the future Trunk, or rather the Trunk itself in miniature; for which reason those that know how very necessary it is to the Existence of the Plant, and who likewise observe the Tenderness thereof, must they not be convinced, that it was with some View, and Design, that in each Part of the Bean there was form'd a small Cavity to place the said *Pluma*, and to preserve it from all Inconveniences, in such a manner, that the Beans may be handled, thrown together in Heaps, and tossed

tossed into Sacks, without the least prejudice to the said tender Trunk?

Sect. VII. *The Hole in the Skin of the Root-Sprout.*

Besides all this, we see in the great Seeds, such as Beans, even with the naked Eye (and in those that are smaller, with the Microscope) that the external Coat or surrounding Membrane is always pierced or bored through with a very little Hole, directly opposite to the Point of the Root-sprout *e*; to the end, that when the Seed is sown, and begins to shoot forth, this Root-sprout may not be hinder'd by the Thickness of the closed Bark or Skin, from growing out and spreading itself in the Earth; in order, as we have said before, to serve afterwards for an Earth-Root to the Plant. Insomuch, that even Nuts, and hard Peach-stones, have the like Orifice or Hole to make room for the putting forth of the said Root-sprout.

Sect. VIII. *The Nutricious Juice or Sap changes its way in the Seed.*

Those that desire to be informed of other Particulars, in which the Wisdom of the Creator does appear, may consult the aforesaid laudable Authors, concerning the Structure of the Seed itself, and learn thereby to acknowledge a higher Direction of Him that has adapted the Instruments of the Seed thereto; among which there is one that cannot be contemplated without Wonder, namely, that the Nutricious Juice, which proceeding first from the Matter of the Body of the Seed *a a a a*, *Fig.* 4. through the Seed-root *b d*, causes the Root-sprout *d c*, to fix itself below in the Ground; after which it changes its Course

as ſoon as ever this Root becomes ſtrong enoug to draw its Nouriſhment from the Earth; an then on the contrary, taking its way upwards, causes the *Pluma e* to ſhoot forth, in order to bc come a Trunk.

Sect. IX. *The Seed-leaves, and their Uſe.*

It is remarkable, beſides all this, that in mc Seeds, when the Root is big enough to feed tl Plant, theſe Seeds-particles *a a*, *a a*, are carri upwards with the Trunk out of the Earth, aft which they compoſe the *Seed-leaves*, ſo called, b cauſe theſe firſt Leaves, in almoſt all Plants, ha a different Figure from the ſubſequent Leaves the ſaid Plants. This is very viſible in ſome Seec as for Inſtance, in Cucumbers, in which the Se itſelf, with its white Colour, does firſt appe above Ground; and afterwards by little a little, becomes viſibly yellow, and then is turn into green Seed-leaves; the ſame are as ma in Number, as the Parts of which each Se conſiſts.

We do not here diſpute, whether the uſe theſe Leaves is to communicate a more prop Food to the *Pluma*, or tender Trunk of the Pla than the Root is capable to do at that time frc the Earth, and to moiſten the ſaid Trunk wi the Dew and Water of Rain, which they recei by conveying it along their little Stalks, and hinder it from being too ſuddenly dried up the warm Air; or, whether theſe Seed-leaves h to defend the tender Plant from other Inconveni ces, after the ſame manner as we ſee where in th Grains that have no Seed-leaves, the *Pluma* e compaſs'd with a Membrane like a Sheath, pr bably for the ſame purpoſe; and of which alſo, may obſerve two little Membranes in the gre

Bea

Bean, that have likewiſe no Seed-bladders. At leaſt Dr. *Grew* obſerves, that in Seeds, the Parts of which ſpringing out of the Earth, are turned into Seed-leaves, none of theſe Membranous Sheaths are to be found. We ſhall not determine any thing particularly in all theſe Matters; but that theſe Seed-leaves are abſolutely neceſſary in preſerving and nouriſhing of the Trunk, and for the encreaſe of the Plant, is plain enough from the Experiments that the learned *Malphigi* has made concerning them, from whence he finally draws this Concluſion; *The Effects and Uſes of theſe Seed-leaves are ſo neceſſary, that if they be pulled off and ſeparated from the Plant, it won't grow; and if it ſhould any way increaſe, it won't be compleat, but remain always defective.* [See his Treatiſe *de Sem. Veget. p.* 16. of the *London* Edition.] Every one may likewiſe make the ſame Obſervation.

Sect. X. *Convictions from the foregoing Obſervations.*

Deplorable Atheiſts, who in order to quiet in ſome Meaſure their uneaſy Conſciences, (which is terrify'd always, and in all Places where it expects to find a God,) and to harden it againſt its perpetual Pangs, are forced to aſcribe all theſe admirable Properties that diſplay themſelves ſo multifariouſly in the Body, and in the Operations of a little Seed, to Cauſes that have no Knowledge, and which when they produced ſuch Seeds, were Strangers to what they did, and even to their own ſelves too. Now if any of thoſe Atheiſts had been able to have produced any thing of the like Nature, tho' incomparably leſs Perfect, and could have form'd a Seed from whence the very ſmalleſt Leaf of Graſs might ſpring, would he not think that every one who ſhould maintain that

there was no Skill nor Judgment necessary thereto, would do him great Injustice? And in case a Seed or an Acron were shown to any Man who had never seen a Tree, and who having set the same in the Earth, should observe a whole Oak growing out of it, would he not, tho' never so much conceited of his own Wisdom; I say, would he not look upon it as a most amazing Phenomenon, especially when he found that so many hundred Acorns were yearly brought forth thereby? But an unhappy Atheist must judge quite otherwise in this Matter, and maintain a Notion contrary to that of all Men: With what Satisfaction to his own Conscience, will be best known to himself when he rightly considers the Matter with himself, and discovers how little Reason or Ground there is to conclude, that each Seed contains the Stamen of the future Plant, and even of the greatest Trees (as far as can be observ'd) in all their Parts folded, or rolled up like a Clew of Thread and that all this is purely accidental. Let him once more examine himself, and consider whether if there were nothing but Chance and ignorant Causes in the World to produce such Effects, he could satisfie himself in believing, that all these Wonders could ever happen, not to say constantly and regularly, in the vegetable Kingdom, and that one Tree could ever have been produced.

SECT. XI. *Considerations on the Texts in* John xii. 24. 1 Cor. xv. 36. 7, 8. *and* Gen. ii. 4, 5, 6. *with Observations on the last of 'em.*

NOW since it is an experienced Truth with all Inquirers, that the Seeds of almost all Plants do not remain nor perish in the Earth, but that their Parts spring out of the Earth under the Figure of Seed-leaves, the Grains of Corn and Beans being

TAB. XVIII.

Fig. 2.

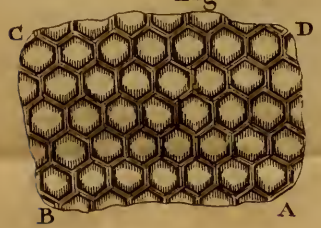
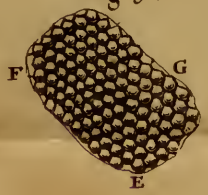


Fig. 3.



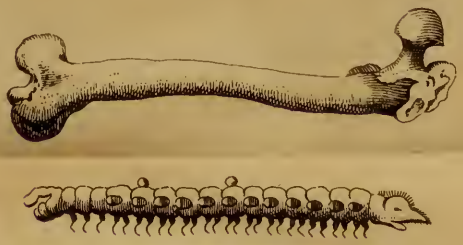


Fig. 6.

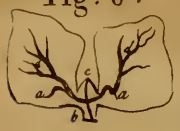


Fig. 5.

Fig. 4

Fig. 1.

Fig. 7

Fig. 10.

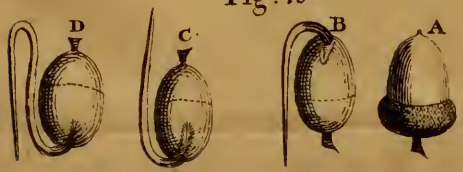


Fig. 9.

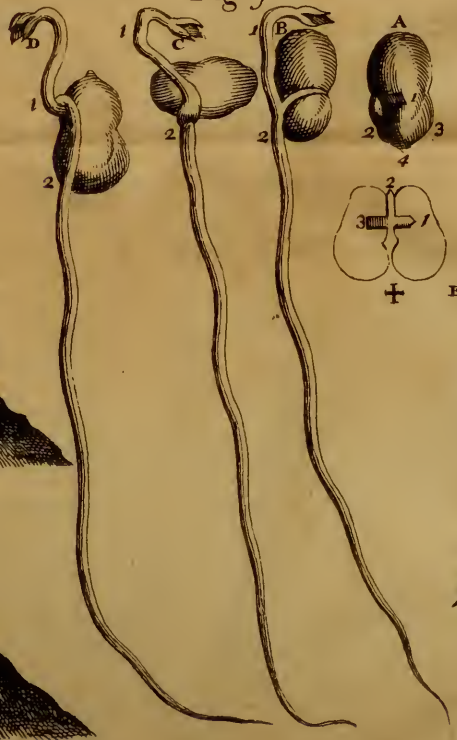


Fig. 8

Fig. 11.

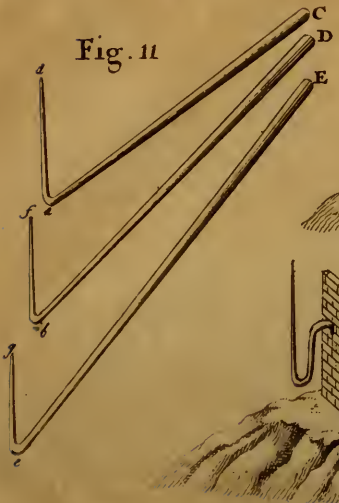
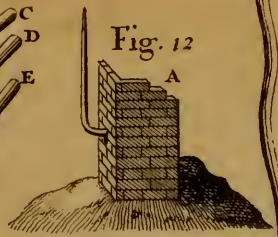
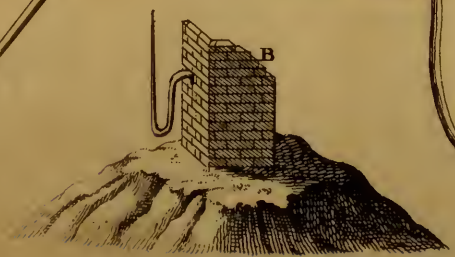


Fig. 12.





the only ones obſerv'd by Dr. *Grew*, that continue in the Ground, and produce no Seed-leaves; the words which we find ſpoken by the Son of GOD in *John* xii. 24. ought to have a particular Emphaſis; *Verily, verily, I ſay unto you, except a Corn of Wheat fall into the Ground, and die, it abideth alone; but if it die, it bringeth forth much Fruit.* In which, agreeably to his infinite Knowledge, he is pleas'd to ſingle out from among ſo many thouſands of Seeds in which the contrary obtains, the only one almoſt which dies in the Earth; and which therefore was the only proper Similitude, and could only be accommodated to that Purpoſe, for which he intended to uſe it.

I know very well, that the Expreſſions here uſed, of conſuming and dying, will ſhock ſome Naturaliſts, becauſe there likewiſe proceeds from the ſame Grain of Wheat, both a Root and Stalk. But that however, there is nothing ſpoken herein, beſides that which we can thus diſcover, will ſufficiently appear by what has been writ by thoſe who have carefully conſider'd the ſame. Let us hear what Dr. *Grew* ſays of it in his *Anatomy of Plants*, Ch. I. where treating of Seed, and how it ſhoots up out of the Earth, he uſes the following Words: *This does not come to paſs in all kind of Seeds; for there are ſome which rot in the Earth, as Corn for Inſtance, which is different from moſt Seeds*, &c. And leaſt we ſhould think that the ſame thing happens in many Seeds, he adds a little lower: *But all Seeds, excepting theſe two* (meaning Corn, and great Beans) *grow moſtly after the ſame manner, ſo far as I could obſerve; they do not rot in the Ground* (as he had ſaid juſt before of Corn and Beans) *on the contrary, they come out at the ſame time as the* Pluma; *and the Seed-leaves are in moſt Plants the two parts of the Seed*, &c. And to the end, that none ſhould imagine that this Poſition is not ſufficiently

verify'd by Experience, let them conſult *Malpighius*, ſo famed for his Accuracy, *de Sem. Veget.* p. 9. *Edit. Lovel.* where in his Enquiry into the Changes which a Grain of Wheat undergoes as it ſprings up, we find theſe words: *After the Eleventh Day, the Seed-leaf which ſtill hangs to the Plant, is ſhrivel'd, and in a manner corrupted.* Now that by this Term of *Seed leaf*, is meant the Grain it ſelf in theſe Circumſtances, appears by what follows a few Lines after: *In the mean while* (that is, whilſt it continues to grow) *the Seed leaf, or the Grain it-ſelf, pines and conſumes away, and being become empty within, if one preſſes it, he will find nothing but a watry Matter in it*, which confirms what was ſaid before: as alſo by what has been ſince obſerved in another kind of Grain, namely, *Millet-Millium, the Seed-leaf*, which as we have ſhewn, is the Grain, *is ſhrivel'd or wither'd on the ſeventh Day, and being preſt, yields a putrid and naſty Liquor.*

Thus we find the Holy Ghoſt expreſſing himſelf by the Pen of St. *Paul*, 1 Cor. xv. 36. *That which thou ſoweſt, is not quickned, except it die.* And to the end, that the Modern Philoſophers ſhould not have it in their Power to object againſt this, from their Experiments; that no Seeds (excepting a few, and as far as is yet known, only the two above-mentioned ſorts of Grain, and ſome Beans) do die in the Earth; the ſame Inſpirer of that Sacred Writer, is pleas'd to go on thus, Ver. 37, and 38. *And that which thou ſoweſt, thou ſoweſt not that Body that ſhall be, but bare Grain, it may chance of Wheat, or of ſome other Grain: But God giveth it a Body as it hath pleaſed him, and to every Seed his own Body.*

SECT. XII. *Concerning the Expansion of the Seed-Plant, with an Experiment of Mr.* Dodart *thereupon.*

THEY that will be pleased to consider what we have said before relating to Beans, and particularly, concerning the little *Pluma*, with its Root, or otherwise the Seed-Plant, before it shoots out in the Earth; and they that will farther take the Pains to read what those great Philosophers of later Ages, such as *Malpighi*, *Grew* and *Leuwenhoek*, have writ about it; or rather those, who after their Example, have consider'd it all with a good Microscope, will know, that not only in all Beans, but also in all other Seeds that have been yet examined, there is such a little Seed-Plant to to be found, in which all the Parts of the Plant that are to proceed from it, are involved or rolled up as it were like a Clew of Thread; which being afterwards filled and expanded by Nutricious Juices, becomes an entire and compleat Plant, whether it be a Tree, a Shrub, or a Flower.

To give some farther light into the Structure of such a rolled up Seed-Plant, and upon the Account of the Wonderfulness thereof, I have transferr'd one of 'em from the *Memoirs of the French Academy* for the Year 1700. *p.* 187, and 188. to *Tab.* XVIII. *Fig.* 8.

In the said Memoirs Mr. *Dodart* says, that above 20 Years ago, he had communicated to the Academy such a Seed-Plant, as it appeared in the above-mentioned Figure, when it was scarce come out of the Earth, and was only one *Line*, or the 12th part of an Inch long. He adds, that having viewed this little Ear of Corn with a Convex-Glass, the Focus of which was half an Inch, they could discover all the Seeds in it, and the

Stalk or Trunk itself among those little Seeds, of the heighth of a Line and a half; they could likewise distinguish therein the Knots of the Straw; but all had a very different Proportion from what we see in a full grown Wheaten Plant. The Leaves, which do scarce otherwise make the sixth Part of the heighth of the Plant when compleat, were now above 18 times longer than it; the little Ear made about a third Part of the entire heighth, whereas, when the Plant is perfect, it hardly comes up to the 48th Part; the little Body of it was about 3 times as long as thick, tho' when full grown, the heighth is incomparably greater, with respect to the Thickness; the little Tubes that compose the Straw or Stalk with their different Knots, appear to be thrust within each other, like the Pieces or Parts of a Telescope when a Man puts it into his Pocket. The Seeds were round, like perfect little Pearls, and half transparent: To form a more compleat Notion of them, you must suppose in the said *Fig.* 8. that A is a part of the Root from which this little Plant is separated; B C D E is the Tube of the Straw; of which B is the first Joynt between two Knots, C the second, D the third, E the fourth. Each of these Tubes, of which the whole Straw was composed, bore a Leaf, which is stripp'd off, to the end, that the Ear that would have been hid by those Leaves, might more plainly appear. F is the last Leaf, which leaves the Ear sufficiently naked. Finally, G is the little Ear, having already attained its compleat Figure in the middle of the little Sprout.

Now can any one observe this whole Contexture of the future Plant, in so small a Body, without amazement; and pretend to ascribe the same to Chance or Ignorant Causes?

The

The Gentlemen of the *French Academy*, having made use of some Microscopes that magnified the Object much more than the above-mention'd, have observ'd in much smaller Seed Plants than the aforesaid Ear of Corn, how the Parts of the future Plant were adjusted together, which in shooting forth, extricated themselves from each other.

Sect. XIII. *Whether the Seed-Plants contain all the following ones.*

Several famous Men have gone so far in this Matter, that by seeing in each Seed its future Plant, some of 'em have maintained, and others, to use a softer Word, have conjectured [See Mr. *Dodart*'s Memoire in the Transactions of the *French Academy*, 1701. *p.* 315.] that it was not improbable, that this Seed contained in its little Seed-Plant another Seed with another Seed-Plant, and so continually forwards; from whence then this Consequence must be deduced, that every Seed, how small soever it is, does actually contain the Seed Plants, and their following Seeds, of as many Trees, for Instance, as might be produced from this one Seed to the end of the World; and consequently, that all Kinds of Plants whatever, of the same Sort that were to be produced in all the following Ages, were already actually formed in the first Seed that was created; by which they understand, that tho' the Imagination of Men cannot possibly represent to itself such an unconceivable Smallness and Number, yet the Incomprehensibleness of the Works of an infinite Creator, may be thereby set in a clearer Light, to the reproach of them that deny him; *since* (as Mr. *Dodart* says in the aforemention'd place, and which is also the plain Truth) *those that are accustomed to exercise themselves*

selves in Natural and Mathematical Sciences, know, that they can seldom go far without meeting something infinite; just as if the Author of Nature, and of all Truth, had been pleased to fix the Seal of his chief Property upon all things.

I leave these Opinions, which do not seem strange to several Great Men, to their own Weight: But forasmuch as the said Mr. *Dodart* is pleased to bestow upon them the Title of *Conjectures*, as they really are; and since we endeavour as much as is possible to abstain from all Uncertainties, tho' never so probable, because there are Experimental Truths in abundance, which prove a GOD, and a Divinity of his Word, we shall not lay any farther stress upon this Hypothesis.

SECT. XIV. *Transition to the Roots and Trunks of Plants.*

WHAT we have now said about Seeds, seems to be abundantly sufficient to bring any one that has hitherto denied a Divine and Omnipresent Power, by which the Operations of all things are directed to more reasonable Thoughts: But to shew how this Providence proceeds in all things, we should add something concerning the Roots within the Earth, and the Bodies or Trunks of Plants as they grow out of it. Now, how the Nutricious Juices are drawn or insinuated into the first from the Earth, and how by rising or circulating therein, they cause the Trunk to grow out of the same, we shall not here relate; forasmuch as that which has been said of it, is not founded upon sufficient Certainty, and all the Experiments that have occur'd to me in order to prove the same, are still but too defective. They that desire to see any farther Account thereof, may consult

sult the learned Opinions of *Grew*, *Malpighi*, and others; they that will only take the Pains to follow the Methods of those and other Enquirers, and view the things with their own Eyes thro' a Microscope, when they see a Tree or a Plant grow, and after that, consider the Structure of the Roots and Trunks, will never be able to perswade themselves that these Bodies have acquired their Form by meer Chance.

Sect. XV. *The Structure of the Root and its Parts.*

Notwithstanding the many different Conjunctions and Dispositions that these Parts which compose the Root have among themselves, yet in almost all those that have been examined, we find the following Analogy and Agreements, according as Dr. *Grew* has described them; namely:

I. The external Part of the Root is a Membranous Matter or Bark, consisting partly of a great Number of little Bladders like a Spunge, or rather like those Bladders which we see lying upon one another when we blow with a Pipe in Soapy Water; and partly of a Ligneous Matter or Fibres, that are so many little Tubes. The first Kind are visible through a Microscope; and the last are seen in some Roots, such as *Scorsonera*, and others from the Experiments quoted by the said Dr. *Grew*, in the 2d Chapter of his *Compar. Anatom. Radic.*

II. The second Part, which composes the Root, and lies under the outmost Skin of all, is the Bark (*Liber.*) and this likewise consists of two Kinds of Bodies, the first of which is also a Collection of roundish Bladders, which, being dryed, shrink in like a Spunge, but when steep'd in Water, swell

out again. Among theſe little Bladders there are mingled ſeveral Veſſels that convey the Sap, of which ſome contain in themſelves a watry Humour, ſome a milky, and others of other Kinds; and they repreſent very different Forms, as they are diſpoſe among each other.

III. The third Body that we meet with in the Bark, in the Roots, does likewiſe conſiſt partly of the ſame Bladders, that are interwoven with thoſe of the Bark and thoſe of the Skin; and partly of Tubes or Veſſels that compoſe the Woody Part of the Root, and ſome of 'em contain Sap, and others only mere Air. Theſe are likewiſe diſpoſed after various manners, in different Roots.

IV. The inmoſt Part of the Root is the *Marrow* or Pith, which is found in ſome, but not in others. This likewiſe conſiſts of little Bladders, and of the ſame kind of Body as we have deſcribed before in the Bark, and in the Woody Part of the Root: 'Tis often only a Veſſical Matter, and ſometimes 'tis mingled with Woody Fibres, or with the little Tubes that convey the Sap and Air.

Sect. XVI. *Theſe Diſpoſitions repreſented in the Pepper-Root.*

The Diſpoſitions of theſe Parts do ſufficiently appear in many Roots to the naked Eye, if they be cut acroſs; but much plainer thro' a good Microſcope; and we find 'em very accurately delineated both ways, by the ſaid Dr. *Grew*.

I ſhall produce one here (*Tab.* XIX *Fig.* 1.) in which, thro' a Microſcope, part of a little Slice of the Pepper Root appears, after the following manner: The outmoſt little Bladders A A, repreſent

presents the Skin and its external Membrane; from thence to B B is the Bark, in which the Vessels that carry the Sap may be seen between B and L, representing inwardly a broader, and outwardly a narrower and more acute Composition: Between B and G we may observe several Kinds of Orifices of the Air-Tubes; and between G and E, another little Circle of other Vessels that carry Sap, in which from E to K is the Pith; the little Bladders in the Skin in the Bark, between the Sap-tubes thereof, and between the Air-Vessels too, and lastly in the Pith, are all of 'em, according to their different Sizes, visible enough.

Sect. XVII. *The Structure of the Trunk in an Ash-Tree.*

The Trunks of Trees and Plants do consist of much the same Parts as the Roots, namely, of vessical Globules, and various Tubes for conveying Sap and Air. Thus it has been observed by *Malpighi* and *Grew*; but however in a different Disposition and Proportion in respect to each other, than in the Roots, and in several Plants with a very great Diversity, as to Size, Number, Place, *&c.* as may be seen in the said *Grew's Comparative Anatomy of the Trunks*, in many Instances, but not without Astonishment.

One Example we have produced from him here in *Tab.* XIX. *Fig.* 2. in an *Ash-Tree*, the fourth Part of the Trunk whereof is represented as cut across: A B C D is the Bark; of which A B is the outmost Skin, and A H B the Sap or ligneous Tubes ranged by one another in circular Dispositions next to the extreamest Skin; I I is the vessical Matter of the Bark, which below at D and C, has another kind of Sap-vessels, disposed in an arched or curved Order; D C F E is the Wood; D Q L K,

K L

K L M N, and M N F E, are the fourth part of three circular Superficies, each composing a great Tube from Top to Bottom, in such manner, that one of 'em grows every Year about the Tree; the real Wood is S S S; between S and T are the round Orifices of the Air-vessels, which are dispersed thro' the whole Wood, being larger in the inmost Part of the Circles K L, M N, E F, and lesser in the outmost; E F G is the Pith; *e e* the Bladders thereof; and O *o* O *o* are the *Insertions*, in which the vessical Textures of the Pith and Bark have a Communication with each other.

Hitherto these abovemention'd Naturalists have only discover'd a vessical Structure, and ascending Sap and Air Tubes; but *Leuwenhoek* has likewise discover'd Vessels therein that run horizontally; and whereas the Figures of *Malpighi* and *Grew* do represent in general the Trunk and Root, and the Parts and Vessels of which, according to their Remarks, the same are composed; we may yet farther understand the Kinds of those Vessels as they have been observed with great Accuracy by the said *Leuwenhoek*, and drawn by him from the Life.

Sect. XVIII. *The Trunks grow upwards, and the Roots downwards.*

Now if ever there occur'd in Nature a surprising Phænomenon capable of obliging the most obdurate Atheist to acknowledge, that in the growth of Plants, a wonderful Wisdom, Power and Goodness, has had its own Ends in view, and has carried 'em on even contrary to the Imagination and Opinion of Men, 'tis certain the same is here displayed most evidently, and after such a manner as has hitherto been inscrutable even to the greatest Philosophers: The Wonder which we are ushering in with so much Pomp, and upon which such

such famous Naturalists as the Gentlemen of the *Royal Academy of* France, do likewise bestow the name of *Wonder*, in their *Histories for the Years* 1700, and 1702, is that Law to which we see so many Trees and Plants incessantly subservient: According to which the Roots of all Seeds are for ever found to grow downwards, and the Trunks thereof to grow upwards.

Sect. XIX, XX, XXI. *Three Experiments made upon Beans, Acorns, and other Trees.*

To give an Idea of what we have just now said very briefly; It is known, that in all Seeds there is not only a little beginning of a future Plant and Root, as may appear from the Beans, *&c.* but we likewise find, that the *Pluma* and Root-sprout of which we have treated above, have a determinate Place in all Seeds, out of which they shoot at first according to a determinate Course; but when they proceed, we always see that the Trunk ascends, and the Root descends into the Earth. They that desire to make a Tryal of it, may imitate that of Mr. *Dodart*, a Member of the *French Academy*, with very little Pains and Trouble; I my self have done it with several Beans, and to my great surprize, found it not to fail in any: 'Tis thus, if you split a Bean (*Tab.* XVIII. *Fig.* 9.) and separate two Lobes or Pieces of which it is composed, from each other, having first steep'd the said Bean 24 Hours in Water, and then dryed it as long after, till it begins to shoot out as at 2, which will be the Root, you will see at 1 the *Pluma*, which is to be the Trunk lying in a hollow Place on one side; and in the other at 3, another little Cavity, in which the *Pluma* is likewise preserved: If then you take another of these Sprouting Beans, and Plant it as at A, so that the Root 2 extends

extends itſelf downwards, it won't ſeem ſtrange to any one that the Root-Stalk 2 (*vide* B) ſhoots downwards, and the little Trunk 1 upwards, forasmuch as the Situation of both of 'em do naturally tend thereto. But it will be very ſurpriſing, when one takes the Bean C, and lays it upon its ſide flat in the Earth, that the Root 2, and the Trunk 1, do not grow horizontally, which muſt have come to paſs, if they had continued the preceeding Courſe, as the Bean ſeemed to determine it; inſtead of which we diſcover, that both the Root 2, and the Trunk 1, make a Bow or a crookee Line, in order to proceed downwards and upwards: But to come to the utmoſt; can a Man ſee without Aſtoniſhment, that when he plants the Bean inverted, that is to ſay, with the Root upwards, and the Trunk downwards, yet the Trunk 1 winds itſelf about the Root upwards; and in like manner the Root 2 making a Semicircle about the Trunk or Plume, takes its Courſe downwards. Now that theſe Figures may not appear ſomewhat improper, it is to be obſerved, that the little Trunks 1, 1, 1, at B, C, D, are drawn here before they were ſo old, that they could properly make their Appearance in the Air. See the *Memoirs of the French Academy* 1700. *p.* 18. Now that this does not only happen in Beans, is ſhewn by the ſaid Mr. *Dodart*, in the *Hiſtory of the* French *Academy*, 1702. *p.* 62. That Gentleman found in the Month of *December*, ſome Acorns lying in a heap upon a moiſt Place where the Ground was firm and compact, as in a beaten Path: Many of theſe Acorns had ſhot out their Root in the Air without being in the Earth, and their little Roots came all of 'em out of the Point or Top of each Acorn, having the length of from 4 to 18 Lines, or 12 Parts of an Inch; and that which was wonderful was, that every one of theſe Roots bent themſelves

ſelves the ſhorteſt way towards the Earth, as if they all ſought for it. This was therefore the more ſtrange, becauſe he did not obſerve any of the Acorns, whoſe Points tended downwards, ſo as that if they had grown ſtreight out, they could have reach'd the Earth; but on the contrary, he found one Acorn among 'em, the Point of which grew upwards, and in that he ſaw that the Root ſhot ſtreight up about an Inch in length, but that it afterwards changed its Courſe, and as it grew, turned downwards to the Earth.

This then gave him a handle to make the following Experiment: He took ſix of thoſe Acorns, and ſet 'em in a Flower-pot, after the manner as you may ſee in *Tab.* XVIII. *Fig.* 10. at A, that is with the Point ſtreight upwards, ſo that the Roots that were to ſpring from 'em, ſeemed not capable of growing any other way than upwards; he cover'd them with Earth of about two Fingers thick, and let 'em remain in the Pot the ſpace of two Months, in which time they had ſhot out; and the Root having now acquired ſome length, made cloſe to the Acorn an Inflection and Turn; and ſo in the reſt of the Acorns, they grew down again, ſeeking as 'twere a depth of Earth, juſt in the ſame manner as at B: And now the Conſequence certainly ſeems to be, that all theſe Roots having once taken this Courſe of growing backwards from the Point to the Tail, they would perſiſt in it, and purſue their Courſe again right forwards; for which reaſon he took theſe Acorns and inverted 'em again, preſſing the Earth down quite round 'em, to the end that it might touch every Part; ſo that they ſtood as at C, with their Root now turned upwards, which before at B tended downwards. In this Condition he left 'em two Months more, and the Event was, that having uncover'd them, he found that there was nothing

less than their growing upwards, but that each of 'em had made a second and new Inflection or Elbow, as at D; in order to make their Roots, as it were in spight of all these Obstacles, sink down deeper into the Earth, where they must be if they would perform any Service.

The said Mr. *Dodart* relates a great many of the like Accidents with respect to Trunks, as he had done before concerning the Roots of Acorns; *viz.* That finding some Trunks of young Pine-Trees, thrown down to the Ground by a Storm, at a place call'd *Chauville*, some lying upon a greater Steep or Slope, others upon a lesser, as in *Tab.* XVIII. *Fig.* 11. of which all the extream Parts *a d*, *b f*, *c g*, grew streight and perpendicularly upwards; insomuch, that those that fell upon a greater Obliquity, as here at E *c g*, in order to ascend directly, were forced to make a much more acute Angle than the uppermost D *b f*, and C *a d*; which lay in Places, the Declivity of which was not so great: The like we may observe in many Branches of Trees, when they are hinder'd by any Violence from growing upwards; so that likewise Weeds, that spring out of the Sides of perpendicular Walls, after running a little horizontally, extend their Trunks upwards again; and even when some of 'em are not stiff enough to bear their own Weight horizontally, insomuch that they are thereby pressed downwards, we see, that when the Trunk becomes stronger, they will make a little Inflection, and then grow upwards. The first Instance thereof appears in *Tab.* XVIII. *Fig.* 12. at A, and the second at B; of this I observed not long since a wonderful Example in an Elder-Tree, growing out of the little Crack of a Wall.

Sect. XXI. *Convictions from the foregoing Observations.*

After having consider'd this whole Matter, and particularly what has been said about *Beans* and *Acorns*, who can conceive the Reasons thereof! And if we do not ascribe it to an adorable Providence, which executes its great and wise Ends by means as yet unknown to Men, to the Confusion of its Enemies; then let any Body furnish us experimentally with a true Cause that may be sufficient for this Purpose; and shew us what Mechanical Operations and Laws are known to him in Nature, from whence we may plainly deduce this Phænomenon in all its Circumstances.

The Gentleman who made these Experiments, and so carefully observed all these things, was not ashamed to record the Weakness of his Understanding, and the Insufficiency of his Argumentations, immediately after the Relation thereof, even in the *Memoirs of the Royal* French *Academy*. I shall not here relate all the Reasons that are there collected, to shew the Nothingness of all the Hypotheses hitherto laid down; any Body that has a mind may see them there himself. But I cannot here forbear to take notice of the noble Acknowledgment of an Adorable God, which the worthy Author subjoyns upon this Occasion; and which such great Philosophers, as are the Members of that Academy, have permitted to be so emphatically expressed: For Mr. *Dodart* having in the said Memoirs for the Year 1700. *p.* 72. suggested all that is yet unknown, and that seemed requisite in order to trace in some manner the true Cause of this Effect, concludes his Discourse in these Words: *I know nothing of all this, and chuse rather to wonder*

at a certain continual and amazing Phænomenon, than to flatter my self with imagining that I know something of that, of which I know nothing at all. I confess I would very willingly discover the Cause thereof, but my Ignorance will not suffer me to enjoy a Pleasure which would overpay the loss I suffer by not understanding the Natural Cause of so wonderful an Appearance; for this Darkness and Ignorance in which I find my self, makes me see, and even makes me palpably sensible of a Supream Cause, whose Wisdom and Power infinitely surpasses not only my Thoughts and Conjectures, but also those of all Men of the quickest Apprehension and Judgment that ever were or ever shall be.

Now let the Atheist tell us, whether he ever durst maintain, upon seeing a ploughed Land full of Corn, by which his own Life, and the Lives of so many more must be maintain'd, that the Plowing, Sowing, and Preparation of that Ground, and the Production of the Corn from thence, was all performed by mere Chance, without any Concurrence of the wise Husbandman; and yet can he imagine that he argues rightly, when he asserts, that what we see happening to these Seeds in their Growth (and without which all the Pains and Charges that have been bestowed upon the Land would be fruitless) can be ascribed to a Cause that neither knows itself nor any of its Operations? For unless Providence had been pleased to take so much Care, that the Roots of all Seeds should tend downwards to the Earth, and the Trunks or Bodies upwards, tho' the Seeds themselves were thrown into the Earth, either horizontally or inverted, it won't be necessary to prove, that every thing that lives by Sowing being deprived of its Nourishment, would soon perish: Since, by far the most Kinds of Grain, and all other Seeds that are strewed and sown either by

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the Hand, or by Wind, as moſt are, it is hardly credible, that one of them ſhould fall in ſuch a Poſture, as to ſhoot forth its Root directly downward, and its Trunk upward, and yet this is requiſite, if they grow as they ſhould.

Sect. XXII. *The Knots and Buds of Plants, and Convictions from thence.*

We don't think it neceſſary to transfer hither all the Obſervations which the Naturaliſts have made upon the Texture of Plants by the help of their Microſcopes, ſince we don't pretend to give an entire Hiſtory of *Botany*; wherefore thoſe that deſire to contemplate the numberleſs Wonders that occur therein, and which do unconteſtably demonſtrate the Power of God to ſuch as are any way reaſonable, may be pleaſed to conſult what Meſſieurs *Malpighi*, *Grew*, *Leuwenhoek*, and others, have writ concerning the ſame; we ſhall only ſay a word or two briefly about them: Now they that have ſeen before, the Texture of the Roots and Trunks of Plants, if they ſhould take a yearly Sprig of a Tree into their Hand, can they think it happens by Chance, that it is furniſhed round about with Knots or Buds ſo exactly placed at a due Diſtance from each other, which Knots are the Source or Beginning of Fruits or other Branches! But particularly, can any Body ſee without Aſtoniſhment, that each of theſe little Knots does regularly ſpring from the inmoſt Part of the Branch, and that the Structure of the ligneous Fibres and little Bladders of the Branch, are ranged ſo nicely in this Form, that upon the putting out of the Branch, the Knot or Bud that is compoſed of the ſame Matter with it, may likewiſe ſhoot out?

Besides all this, one of these little Buds only may seem sufficient to make any one who seeks for a GOD, to find him therein; let him but contemplate in the 74th Figure of *Malpighi*, *Cap. de Gemmis* (and which is transferr'd hither in *Tab.* XIX. *Fig.* 3.) the Structure of an Oak-Knot, where are represented at A some of the little Bladders of the Pith of the Twig, which you may observe to be surrounded with ligneous Fibres at B; C is the Bark, the Fibres of which do further compose the Leaves D of the Knot. So that all Knots consist of the little small Sprig A, with its Bark, ligneous Fibres and Bladders; and the said Sprig is preserved by little Leaves lying upon one another like Scales, and encompassing it round about.

In the Bladders of some of these Knots (for almost all of 'em differ from each other) are little Nipples or Globules, containing in them a terebinthinous or glutinous Matter.

These Knot-Leaves, if we trace their growth, do appear in many Plants gradually longer, and in time are changed, shooting out into Stalks of the following Leaves, which cloath the Branch proceeding from thence. How wonderfully this happens in several Plants, may be seen in *Malpighi*'s *Anatomy of Plants*, *p.* 26, *&c.*

Wherefore the said Gentleman having observed all this with an unwearied Diligence, justly concludes, that the Sprout of the Knot does already comprehend the future Branch in Miniature. This will appear so much the more plain, if one reads the fifth Continuation of Mr. *Leuwenhoek*, who says, that in the Bud of a Currant-tree, even in Winter, he could discover not only the Ligneous Part, but likewise the Berries themselves, appearing like small Grapes, and that the said Ligneous Part

or

or Stalk shot out exactly at that place where the Bunches of Currants first appear. B C D, *Tab.* XIX. *Fig.* 4. are the two Bunches of Currants, and E F G the young Sprig or Branch, according as the said Mr. *Leuwenhoek* has describ'd them.

Now if any one can believe, that this Stamen or Principle of a Plant, which discloses itself in these Buds roll'd up in a Space so unspeakably small, and with so much Regularity, is to be ascribed to mere Chance, why does he not maintain the same of the finest Watch that was ever made?

Sect. XXIII. *The Structure of the Leaves, and their Usefulness.*

How the Leaves of the Branches proceed from those of the Knots, we have in some manner shewn above: They consist of the same Parts with the Trunk and Branches, and have Wood and Sap-Vessels of several Kinds: Thus the Sap, in the *Tithymallus* and others, is white; in the *Chelidonia*, yellow; in others, of other Colours; and each of 'em have their Air-Vessels.

The Wood, or Air and Sap-Vessels being collected in the Stalks, spread themselves out in the Leaves like so many Branches of little Trees, and these compose the Ribs of the Leaves, which in some Plants are knit together Reticularly or Net-wise: Between them are the little Bladders which make the Thickness of the Leaves; in the upper Superficies of some Leaves we find little Orifices, which proceed from internal hollow globular Bodies, and through which perhaps there exhales either a Vapour or liquid Matter; to which Matter proceeding from the Leaves of Trees, may perhaps be referr'd that which is said in the *Memoirs*

of the French *Academy*, 1707. p. 62. at least, *Malpighi* affirms, that these Cavities may be plainly seen in Chestnut, Popler and Mulberry-Trees, when the Bladders that are in the Leaves are dried up. The XIXth *Table* represents in *Fig.* 5. how the large Rib A sends out little Branches B through the Leaf, which, with other Branches C, that proceed from them, make up those Reticular Interstices, which here in the Figure appear Blank, in which may be seen the hollow globular Bodies D, opening externally. In these white Interstices there are likewise little Bladders E, dispos'd orbicularly, and which often make such a Cavity as F, out of which there filtrates a kind of a glutinous Liquor. Now, whether all this happens by Chance and without any Wisdom in such a Number of Leaves in each Tree, together with the Changes in all of 'em so necessary to the well-being of each in particular, one may safely submit to the Judgment of any reasonable Person; the rather since we see that these Leaves are so exceeding necessary to the Trees, that when they are robb'd of the same too early by Caterpillers, or others Causes, they can bring no Fruit that Year to Perfection. Now, whether these Leaves do render the Sap and Juices of Trees and Plants more proper to fructify, or whether they contribute any otherwise to the well-being of the Plant, since they seem to extend their open Arms, as it were, towards Heaven, to receive the Dews and Rains thereof; and to derive them farther for other uses, we cannot yet determine; this at least is probable, that in many Leaves the little Stalks are contrived more or less gutterwise, so that the Dew and Rain falling upon the Leaves, may run along them, and be conveyed to the little Knots (which are often found in Trees, in those Parts where

the

the Leaves spring out) in order to moisten the same, other Stalks are round, along which the Water can creep well enough from the Leaves to the Knot, but not in so great a Quantity: So that these Leaves seem at least to serve to supply each little Knot with Water. Will any Body pretend, that this likewise is to be ascribed to Chance?

We likewise see that the Juicy Fruits that are in danger of being dried up too soon by the heat of the Sun, such as Mulberries, Strawberries and Currants, are furnished with Leaves larger than themselves, to the end, that they may be cover'd thereby; and that Apples and Pears, that are more solid, and require a stronger influence of the Sun, have smaller Leaves, tho' their Trees are often bigger.

Besides all this, since the Leaves do shadow the Tree, and since we have shewn above in *Contemplation* XIX. that this is the Cause that the Air with its watry Parts, is continually driven towards it; we may likewise observe from hence, that the great and adorable Preserver of all things, has, by the means of Leaves, imparted to Trees such an Advantage, that tho' no Wind should move the Dew and moist Vapours of the Air, yet through the greater Coolness of the Shadow, the external warmer Air being condens'd and driven thitherwards, carries its watry Parts with it to the Trees, and continually moistens the same.

Sect. XXIV, XXV, and XXVI. *Several Experiments to shew the Perspiration of Leaves.*

I Shall not here enquire, whether with all this, the Orifices likewise which *Malpighi* observed to be in the Leaves, may not perform the same Functi-

Functions in Trees as the Pores of the Body do in Men, that is to say, to cause an invisible Perspiration: This the Perfumes and Scents which we find in the Air under many Trees, seems to render very probable: And the same is likewise coroborated by the Experiment of Mr. *de la Hire* in the *Memoirs of the Royal* French *Academy*, 1703. *p.* 73. This Gentleman, in order to try whether Fountains could be produced by Rain only (according to the Opinion of Mr. *Marriote*) had a mind to try how much Water was necessary to the growth of a Plant; for which reason upon the 30th of *June*, about five in the Morning, he took two fresh-pluck'd and solid Fig-leaves, and thrust their Stalks in a Bottle that had a narrow Neck, and which was filled with Water, so that the end of the Stalks might touch it; then he closed the Mouth of the Bottle so carefully, that no Water could evaporate from thence, but thro' the Stalks; having weighed the whole, he set it in a place where the Sun shined, and where the Wind did blow a little. The Fig-Leaves alone weighed 5 Drahms and 48 Grains; at eleven a Clock, he found that the whole was lighter by two Drahms, on account of the Particles that were drawn out of these Leaves by the Air and the Sun; having likewise found in other Plants, of which he had made tryal, always a great Evaporation of Moisture. But he has not taken notice, whether the Water which at first weighed a Pound, was so much diminished, or whether the Leaves were so much dried up, or, whether the loss happen'd partly to both; however, he proves from thence, that there was a sensible Perspiration thro' the Leaves: Which may likewise be concluded from the Experiments of Dr. *Woodward*, mention'd in the *Philos. Transf. Num.* 253. So that it appears from hence (at least it seems so) that the Leaves, besides

sides other Uses, do likewise serve for the Perspiration of Plants.

I should now have passed on to something else, did I not think that (in order to give some Light to the so obscure Structure and Oeconomy of Plants, and thereby render the adorable Wisdom of the Creator, the clearer in so many of 'em, and to understand the Nature of 'em with greater Certainty) the following Experiments might perhaps be of some use.

I find among my Notes for the Year *1696*, that upon the 21st of *January*, we cut a little piece of a *Radish*, and another from the middle Rib of a *Colwort-Leaf*, and a third of a sower *Oak-Apple*, and put each of 'em into a particular Glass, fastning 'em at the Bottom with a Brass Wire, and then fill'd the same with a strong Lye made with Water and Pot-ashes, filtrated thro' a Paper: then setting them all under the Receiver of the Air-Pump, we observed, that upon taking away the Pressure of the Ambient Air, a great Quantity of Air ascended from each of them, particularly from the sower *Oak-Apple*, which produced a perfect Froth upon the Superficies of the Lye (we shall not here inquire, whether this last might not be increased by the fermentation of the Acids of the Apple with the Salts of the Lye) and every time we exhausted the Air, the same Effect followed. The reason why we made use of Lye rather than Water, was, that it might not be objected, that the Air which is oftentimes found in Water, might contribute something thereto; tho' even in Water also, and before that the Air is boiled out of it, the thing appears so plain, that no Body, who is not too scrupulous, need make use of Lye.

On the 2d of *June*, *1696*, we took two little pieces of the Branch of an Elm, and put 'em both into

into the Lye and under the Receiver, one of which was placed with that End upwards that grew next the Trunk of the Tree, and t'other in a contrary Position; then exhausting the Air, we observ'd that a great many Air bubbles ascended equally out of the Bark of each of 'em; but that out of the middle of the Wood, the Air flowed as it were in an entire Stream, both at the under and upper End; and when we cut away a little of the Bark from the Ends, we observed the same, as also when we put in Wood without Bark, and Bark without Wood, the Air came out very strongly from both. About a Week afterwards we took a single *Asparagus* that had been two Days out of the Earth, cut it to pieces, and observed a great deal of Air to come out of it, but nothing near so much as what came out of the Elm-Twig; most of the Air came likewise out of that End that stood upwards in the Earth: There appeared some little Bubbles at the other end, and some came also, but not many, out of the sides of the *Asparagus*.

On the 7th of *June* 1709, we tied a little piece of a Branch of a Morello-Tree to two Nails, and fasten'd 'em with a Thread to the Hook of the Receiver of the Air-Pump; so that being put into a Glass full of Water, it hung about three Fingers breadth under the Surface of it.

After that, we took a little piece of the Stalk of the Flower, called the *Imperial Crown*, and tied two Nails to it likewise, to make it subside in the Water; then drawing off the Air, we observ'd a whole stream of Air rising upwards out of both; from whence it appears, that the Stalks or Trunks of Plants do contain a great deal of Air in them, and what was before discover'd by the Microscope, is hereby confirmed.

To

To examine into this Matter a little more strictly in Leaves, we tied five Morello-Leaves together by the Stalks, and then cut off about half of 'em, to the end, that the Tubes or Canals in their little Ribs being open'd, the Air might more easily be drawn out of them; then putting them into a Glass of Water, after the same manner as before, we could observe scarce any Air to come out of the Sides of the Leaves that had been open'd by cutting, but the Superficies or flat Parts of the Leaves were cover'd with clear Air-bubbles, insomuch that those Bubbles swelling bigger by our continuing to pump, the Leaves and the Nails to which they were fasten'd, rose up to the Top of the Water; but upon letting in some Air again, the little Bubbles disappeared as usual, and the Leaves subsided.

From hence likewise it seems to follow, that Leaves perspire very much, and that their Pores are more numerous than those of the Stalks or Trunks of Plants. There was likewise this remarkable difference between the Leaves and Trunks, namely, that the Trunks did indeed emit whole Streams of Air from their open Ends, but that there were none, or very few, Air-bubbles externally upon the Bark: Whereas on the contrary, there seemed to be very little Air flowing from those Parts of the Leaves where they were cut, but a great many Bubbles upon their Superficies.

Perhaps by comparing all this together, there might be a Foundation for a probable Hypothesis, to shew the manner how the Sap is circulated in Plants, namely, by the Rarefraction of the Air in the Day-time, when 'tis warmed by the Sun, and by the Cessation thereof in the Cold of the Night; but this is not our Purpose here, and a greater

greater Number and Series of Experiments would be requisite to confirm the same. Our view in mentioning these Matters, is, *First*, to shew that we ought not to doubt of what has been advanced concerning the Plants by those Gentlemen that have examined them so far with Microscopes: And, *Secondly*, to open a way whereby the Manner of Growing, and the Circulation of the Sap in Plants, may be traced after another manner than by the help of Microscopes; and thus by using different Methods to discover these surprising Wonders of the Creator, a greater progress may be made for his Glory and Honour.

Sect. XXVII, *and* XXVIII. *The Structure of Flowers, with their Supporters, and without.*

If we pass from the Leaves to the Flowers, which consist of the same Matter as all other Plants, *viz.* of Air and several Sap-Vessels, otherwise termed Wood-Vessels, and of a vessical Structure, besides which, we find that most Flowers proceed from a Bud or Knot (which the Florists call the *Calyx*) the Leaves or Parts of which do first cover the Flower contained therein, whilst it is yet unable to bear the Inconveniences of the Weather, and defend it from the same; and after that the Flower is blown, they keep up its Leaves, that they may not hang confusedly together, but regularly represent their Beauties to the Eyes of the Beholders. Let us contemplate a Carnation, for Instance, and see first how its green Bud secures the Leaves of the Flower, and then keeps together the little weak Stalks thereof, that it may nourish the Seed; and moreover, how it is indented at Top, in order to close the Flower the better while it is in Bud, and afterwards to spread

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out more largely, in order to support the Leaves more strongly. Let us observe the same in Roses, and a thousand other Flowers, all which are furnished with such a Calyx and Supporters proceeding out of it, some with one circular Leaf, as is the Carnation, others of more, as the *Roses*, others of little Leaves lying upon one another, like the Scales of Fishes, as the *Cyanos* or *Corn-Flower*; others after infinite other Manners, yet all serving for the same Use; so are the Artichoaks made of such Cups only, with Leaves lying upon one another.

Now since these things (all concurring to the same End in such an infinite number of Flowers) cannot be ascrib'd to mere Chance, to the end, that no Body may deduce the same from an ignorant Necessity flowing from the Structure of all Flowers, since this happens in almost all that stand in need of being preserved in the Bud, and of being supported when blown, we shall see, that in all Flowers, the Leaves of which are strong and powerful enough not to want such Supporters, such Cups or Leaves distinct from the Flowers are not to be found at all: Of this kind are white Lillies, all Tulips, and many sorts of other Bulbous or Onion Flowers, which are cover'd in the Bud with a thin green Leaf, and when blown, support themselves by the Strength of their own Leaves only: Thus we see in Crocus or Saffron, which comes up in the Spring, and which having no *Calyx* or Bud sufficient to cover it, that it is provided with a white membranous Tegument, by which its Flower is preserved from the pernicious Effects of the Air whilst it is yet tender.

Sect. XXIX. *Some Particulars about Flowers.*

Of the Leaves of Flowers, and of their ravishing Agreements, as they affect the Sight and Smell of every Body, we shall not take any notice here, they being so well known; only it is to be observed, that as the Cup and Leaves surround and preserve the Flowers, so likewise the Flower-Leaves do secure the Heart or inmost Part thereof, and that many of 'em are cloathed with a Down or Natural *Farina* about their Heart, in order to provide a softer and warmer Lodging for the little Sprout in the middle of 'em.

We shall likewise pass by all the wonderful Particulars that *Malpighi* and *Grew* have already noted in Flowers, such as their little Horns and little Hairs, their Magazines and Store-Houses of slimy and terebinthinous Matters; particularly the Places where a Sweet and Honey Liquor is separated and preserved in their Leaves. They that see this Liquid Matter gather'd by the Bees, and serving so many Purposes to Mankind, will at least learn thereby, that it is not without reason, that he who acknowledges a Glorious God for the Maker of all things, may, besides the Adorableness of his Wisdom, observe also from hence, the Greatness of his Bounty and Favour to us.

Nor shall we take upon us to describe in this place the Parts of Flowers exclusive of their Buds and Leaves, forasmuch as the same are not yet compleatly known to us; such as for Instrance the Places in the Heart or Middle thereof, in which the Seed is formed; nor yet the little Threads, nor the stiff long Excrescences that bear other little Bodies, full of a certain fine Dust at the Top of 'em, such as Lillies and the like; the former of which

which the Botanists call *Stylus*, and the other *Stamina*.

Sect. XXX. *The little Threads, &c. and Convictions from thence.*

Only let us finally make this Remark, and ask, whether an Atheist seeing the Branches of a Vine so weak that they can't possibly support themselves, does not believe, that it is with a wise Design, that they are furnished with those Threads by which the Joynts or Knots fasten and support themselves on every thing that sticks out? and, whether he does not observe a Design therein, especially, since those Threads, after having twisted themselves about any solid Matter, are yet unable to bear the weight of the Bunches hanging upon 'em, were it not that the Matter of which they are composed, was incomparably tougher than any thing else in the whole Vine.

Thus it is likewise with the Cucumbers, the Branches of which would easily be broken by the Wind, were they not strengthen'd by some other Threads and Supports. If there be not a wise End and Design in all this, how comes it that the *Ivy*, which grows never better than against a Wall, shoots out of its Side, as it were, little Roots or Sprouts, which having a glutinous Moisture in 'em, do thereby cleave to the said Walls, and so support such a great Apparatus of Leaves and Branches; which how wonderfully it comes to pass in the *Canada Vine*, has been described by Mr. *Malpighi*.

Now to convince an Infidel by some farther Instances, if it be possible, can Chance be the Cause of all things in Plants, each of which bears a Seed, from which exactly the same, and never

any other Plant proceeds when ſowed in a proper Ground; as for example, a Vine never produces Figs or any other Fruit beſides its own Grapes.

Pears, Apples, Grapes, *&c.* ripen firſt neareſt their Stalks; Figs, Melons, Peaches, Plumbs, Abricots, *&c.* fartheſt from their Stalks.

In Carnations, Jeſſamine, and others, the higheſt Flowers, or ſuch as are moſt remote from the Root, come firſt to Perfection; in Lillies and Hyacinths, *&c.* the loweſt in Rasberries, this happens indifferently.

The Trees of Apples, Pears, Peaches, Abricots, Cherries, *&c.* bear Fruit at two Years growth, but Grapes, Nuts, Rasberries are produced the firſt Year.

Thus in many Trees thoſe Leaves that are fartheſt from the Root wither firſt in Autumn; but in Peaſe, Beans, Artichoaks, and many others, yea, even in Peach and Almond-Trees we ſee the contrary,

In many Plants the Fruit proceeds from the ſame Part where the Bloſſom was, as is well known; but in the Small-Nut, Hazle, and Cheſnut-Trees, and alſo in *Turkiſh* or *Indian* Corn, the Fruit comes where the Bloſſom never was.

Almoſt all Fruits are preceded by their Bloſſoms; but the Fig grows perfect without a Flower; and in Melons, Cucumbers, *&c.* the Fruit is ſeen before the Flower.

In Fruit-bearing Wood, the Fruit and Leaf are moſtly together, but in Vines it is chiefly the contrary, where the Grapes and Leaves are on different Sides.

In ſome Trees the Branches are long, becauſe their extream Parts are lengthen'd out, which is moſt uſual; but in Vines, in Tulips, in Carnations, *&c.* the extream Part remains without ſhoot-

ſhooting out farther, and the Lengthening is made by the growing of that which is below.

They that would ſee more of theſe Remarks, may meet with 'em in the Reflections upon Agriculture, of Mr. *de la Quintenye*, Ch. XVIII. and judge from thence, whether the All-wiſe GOD can ſhew more plainly, that his Power of directing all things acccording to his good Pleaſure, is confined to no neceſſary Laws, than by making us ſee in Plants, that there is nothing in one part of 'em which he cannot produce in another, after a ſeeming contrary manner, to the ſame End and Purpoſe.

SECT. XXXI. *The Curſe of the Earth.*

THEY that have obſerved the Frankneſs and Sincerity of this famous Floriſt, and Director of all the Royal Gardens in *France*, in ſeveral Expreſſions of the aforeſaid Treatiſe, will not be ſurpriſed at the blunt Acknowledgment of his Ignorance in the following Words of the XVIth Chapter: *I cannot conceive how it comes to paſs, that the Earth grows Weak and Lean, with reſpect to thoſe Plants which are in ſome meaſure Strangers to it, as for inſtance, Corn, Herbs and Trees; but yet ſeems to have preſerved its whole Strength; nor does its Fruitfulneſs appear by any means to be diminiſhed, with reſpect to its Production of Thorns and Thiſtles, and an infinite Number of other ill Weeds.* Every one who makes uſe of his Reaſon and Experience, as a Naturaliſt, and no otherwiſe, will doubtleſs be at a loſs to aſſign the true Cauſes of this Fact: I ſpeak here of the true Cauſe only, becauſe it is not ſo difficult to advance an Hypotheſis, and from thence to deduce a ſeeming Effect of Nature; and we all know that there are many ſuch laid down, of which never-

theleſs none come up to the Truth. We ſhall not here diſpute about the Natural Cauſe thereof; but only ask an Unbeliever, when he reads the Curſe pronounced againſt the Earth by the Creator thereof, for the Sin of our firſt Parents; *Gen.* iii. 17, 18, &c. *Curſed is the Ground for thy ſake; in ſorrow ſhalt thou eat of it, all the Days of thy Life: Thorns alſo and Thiſtles ſhall it bring forth to thee; and thou ſhalt eat the Herbs of the Field.* Whether, tho' he did not allow all theſe Words to be Divine, he be not obliged to own, that the *Contemplation* of Nature would teach him the ſame thing: And that it is worthy of his moſt ſerious Reflection, that the Earth, without any Diminution of its Strength, is able of itſelf to produce Thorns and Thiſtles, and other uſeleſs Herbs in Abundance; but when it comes to bring forth all kind of Grain, and other Plants proper for Food, it becomes then Lean and loſes its Fertility. Now if he does not with us deduce this from the above-mention'd Curſe, and yet will ſatisfie himſelf, and any other reaſonable Perſon; it behoves him, *Firſt*, to ſhew the Cauſe why this happens not only now, but has come to paſs after the ſame manner in all Ages, and in all Places. *Secondly*, If he thinks he has diſcover'd the true Reaſons thereof, it will lye upon him to prove likewiſe, that this will neceſſarily follow from the Structure of the Univerſe, and that it could not fall out otherwiſe, but that the Earth muſt needs produce Thorns and Thiſtles, and other Weeds, without impairing its Strength; and that juſt the contrary muſt happen, when it produces the things that are uſeful to Mankind.

SECT. XXXII, XXXII. *Plants do not yield so much as they are able, and a Proof thereof shewn in Trees.*

MOSES adds farther in the said 3d *Chap.* of *Genesis*, v. 17. *in sorrow shalt thou eat of it* (the Ground) *all the Days of thy Life.* And in the 19th Verse,—*in the Sweat of thy Face shalt thou eat Bread.* But we have touched upon this already in *Contempl.* XX. However, we see in these Places such things foretold, which hitherto have been compleatly fulfilled; and whereof, (unless the Cause be ascribed to the aforesaid Curse) the universal and necessary Consequence can never be proved by any Body: The rather, since this particular Curse denounced a second time against the Earth, on Account of the Murder of *Abel*, by his Brother *Cain*, is still daily fulfilling in our Sight, *Gen.* iv. *v.* 12. *When thou Tillest the Ground, it shall not henceforth yield unto thee her Strength.* Which may be inferr'd from the Structure of Trees and Plants, that seem to be made to yield incomparably more Fruit than we see them now do; and which, by what follows, shall be undeniably proved.

I acknowledge, that it has been formerly objected to me as something very obscure, (when GOD was pleased to say to Man; *Behold, I have given you every Herb bearing Seed, which is upon the face of all the Earth, and every Tree in which is the Fruit of a Tree yielding Seed; to you it shall be for Meat)* how it could be possible, and be made to agree with the Plants and Trees, that they should have furnished to all Mankind the necessary Support and Food, in case Sin had not come into the World, and Men had thereupon continued Immortal, according to the Structure we observed above in their Bodies, which represents a compleat

Perpetuum Mobile, or a Machine of an everlasting Motion. For tho' it had pleased God to have taken them after a while from the Earth (into which, as having not been revealed to us, we shall not here enquire farther) yet it seems to be very probable, that the Earth would have been incomparably more Peopled than now, when so many are so suddenly snatch'd away by Death.

But that which seems perfectly to solve this Difficulty, and yet more, to confirm the Curse of God, under which the Plants do likewise groan, is the Structure of Trees, by which it appears, that unless there was something to hinder their Natural Fruitfulness from being exerted, very few of 'em would be able to feed and sustain a far greater Number of Men and Beasts, than is now done by a great many, according to our present Experience: To speak more clearly of this Matter, we see a powerful Example of the wonderful Structure of Trees; forasmuch, as if the Branches of a Vine, and of several other Trees, whether cut off or growing still to the Mother-Plant, when set in the the Earth, will put forth both Roots and Branches; as also, that the Roots of many such, as Plumb-Trees and others, will oftentimes raise a whole Wood of new Plants round about the Tree which they feed; from whence the Strength of a Tree increasing its Fruits by new Plants, does manifestly appear. But not to treat of all in particular here, it is well known; 1. That each Branch of a Tree produces several Buds or Knots. 2. That each of these Buds has also the Power and Faculty of still producing another Branch, which will likewise have its Buds or Fruits. 3. These Buds must pass for so many Wonders with every one that rightly contemplates them; forasmuch as each of 'em, if they be fitted there-

to,

to, will grow up to a large and perfect Tree, which again will yield thousands of other Buds and Fruits. The Modern Inoculation or Grafting of Trees, is a notable Instance thereof; for in this Case, as it is well known, a little slice or bit of the Bark, in which there is a Bud contained, is thrust in between the Bark and Wood of another Tree, and so, if it grows, does commonly produce a perfect Tree: And to the end, that we may be ascertained, that such a Tree does only proceed from the said Bud, and not from the Trunk of that into which it was grafted, we need only observe, that the whole Btanch will be of the same kind with that Tree from whence the Bud was separated; nor shall we perceive one only Fruit or Leaf upon it that was peculiar to the Trunk. Thus, if an *Abricot* be grafted upon a *Plumb*, a *Peach* upon a *Plumb* or *Abricot*, and a *Pear* upon a *Quince*, &c. there will only proceed an Abricot from the first, a Peach from the second, and a Pear from the third. Moreover, we are taught by the known Observations of Gardeners, that if the little Trunk of the Inoculated Bud be pluck'd off, and the Cavity that was made in the Bark remain unfilled up, the said Inoculation will not grow on, altho' the Tree should be strong enough. I will not now ask an Atheist, as one might justly do, whether any reasonable Man can imagine, that the Structure of these Buds (each of which comprise the whole Tree in little, and which Tree is produced, and as it were rolled out by the increasing and nourishing Saps) could be formed by Chance, and without a Wisdom which had in view the growth of Trees, Branches and Fruits? And for the farther Conviction of an Infidel, and to prove from the foregoing Remarks about Buds only, that Trees are capable of producing vastly more Fruit than we now experi-

mentally find, we need only ſuppoſe, that the firſt Branch of a Graft will bear ten Buds in the firſt Year, and that each of thoſe in the following Year will yield a Branch with ten Buds, and ſo on for twelve Years together, which is but a ſmall part of the Years that many Trees attain to; there will be then found in the laſt or twelfth Year 1000,000.000,000; or a thouſand times a thouſand Millions of Buds upon the ſame Tree, each of which, according to the Nature of Trees, will produce one or more Fruits.

It muſt not be here objected againſt us, that ſuch a Tree which produces Branches from all its Buds, would become a thick, cloſe and confuſed Wood, inſomuch that it would be able to yield no Fruit at all; becauſe, beſides that, no Body can tell how the growth or encreaſe of Trees would have been, in caſe they had been free from the Curſe, the Augmentation only of the length of the Branches between two Buds would have ſolved the ſame. And if we ſhould ſuppoſe, for Argument ſake, and for a greater Conceſſion, that the three uppermoſt Buds of each Branch ſhould only be Wood-Buds, and that the ſeven undermoſt ſhould produce Fruit in their Seaſon; there will be after this manner likewiſe Air and Room enough between every Branch of the Tree; which after having ſtood twenty Years, without reckoning the Fruits of the intermediate Years, would be able to yield in the 20th or laſt Year, a great many thouſand Millions of Fruits from ſo many Buds.

Yea, that at preſent there are innumerable Buds that remain uſeleſs and fruitleſs upon Trees, may be ſeen by lopping the moſt and greateſt Branches of one that is ſtrong and ſound; where one ſhall ſee a vaſt Number of young Branches peeping

peeping out at ſeveral Places. Now that they cannot ſhoot out but at the ſame place where there were Buds firſt, may appear plain enough to any one that but takes the Pains of ſlitting a ſlender Branch through its Bud lengthwiſe, by which he will be convinced, that in the Buds only are the Paſſages through which the Wood-Fibres or Veſſels can run outwards. Beſides that, there may be many others that eſcape our Sight; as on both Sides, in the Seam of each Branch where it is faſten'd to the Wood, there are two Buds that few People have obſerved: Which, if the Branch be cut acroſs, of the thickneſs of a Crown-piece, do almoſt always afford two Fruit-Branches; or only one on that ſide of the Tree that the Perſon who cuts it has a Mind to produce it, eſpecially if with his Knife he cuts away the other Bud. [See *La Quintinye, Part.* IV. *Cap.* XVII, *and* XXI.]

They that would be informed of ſomething almoſt incredible concerning the Fertility of Trees, may conſult the Tranſactions of the *Royal French Academy*, for the Years 1700, and 1701, where he will likewiſe find the ſame proved as to Sorrel, Parſly, and other Garden-ſtuff, by a Calculation made upon the Number of Branches and Sprigs, cut off from Trees and other Plants, and by counting the Seed found in each Branch thereof, and in particular the wonderful Fruitfulneſs of a Grain of Wheat, in many Ears exceeding the Number of thoſe we commonly find produced thereby; but we have dwelt two long upon this Subject, and therefore ſhall paſs forwards.

Sect. XXXV. *Convictions from the foregoing Observations.*

To conclude; Let any one who has read the foregoing Sheets, and particularly what we have quoted from the *Transactions* of the *French Academy*, tell us, whether he be not convinced, that the Plants by their Structure are disposed to much greater Encrease than they really produce. Certainly the Gentlemen Members of the said Academy, who so diligently and nicely observe every thing, do own, that they are convinced and satisfied therewith, by ushering in a new Dissertation with these Expressions; *No Plant does ever arrive to its entire Perfection, in comparison of the Parts with which it is furnished.* [See the *Memoirs* 1701. *p.* 326.] From whence the foregoing Objection is solved; it appearing thereby, that altho' there were incomparably more Men in the World, the Plants would be more than sufficient for their Food, if they were as fruitful as they are capable of being by the present Structure of their Parts. And it is also true, that there must be a Cause or Power in Nature, whereby among so many thousand Plants, in so many thousand Years, there has been hardly one but what has been hinder'd from doing what it seemed to be made for, that is, from putting forth all the Buds contained in them, and the Fruit that should proceed from thence. Now let an Atheist or Infidel shew us the Reason and the Necessity why this Obstruction should have any place in Nature, notwithstanding that the Structure and Faculty of all Trees does unquestionably tend to the contrary. If any Body should pretend to ascribe this to any defect in the Sun, Air or Earth, it would be very probable, that in so

so many Climates and Soils there might at least one Tree have been found capable of exerting all that Fruitfulness to which its natural Structure had disposed it. But this not being so, any where, it must be owned, that the thing itself shews, that those who deduce it from the Curse of an angry GOD, as his Holy Word has taught us, do furnish us with an Argument that gives the greatest Light to that which is, and would otherwise remain obscure to every Body, tho' it should not be allowed to be true. However, that which can be by no means denied, is, that that Sentence which was pronounced in the beginning of the World, has been hitherto undeniably and incessantly executed; and that so illustrious a Man, who had so much Honour to lose, as the Writer of the Holy Scriptures, must have had more than a humane Certainty of what was afterwards to happen in Nature, who durst, with so much Assurance, foretell a thing that was likely to be opposed by all Men of Judgment and Understanding, from the beginning of the World to this time: For 'tis beyond all doubt, that so long as the World has lasted, every Man that has concerned himself in the least in the Business of Agriculture, has exerted his utmost Diligence to find out Methods to increase the Fertility of all useful Plants, and to diminish the same in the hurtful ones.

SECT. XXXV. *Of Sea-Plants.*

NOW it seems proper that something should be said here about the Plants that grow at the Bottom of the Sea, of which they that would see a brief Account, may find it in the *Transactions* of the *French Academy* for the Year 1700. where it will

will appear like so many Wonders, to see them springing out of something that has no resemblance of Roots, and in Places entirely unfruitful; forasmuch as being formed of a smooth, flat, roundish Body, with Parts like Leaves, without any Appearance of Fibrous Roots, they adhere to Rocks, Stones and Shells, and other hard Bodies, thro' which there does not seem the least Sap to be conveyed for their Nourishment. Mr. *Tournefort* reckons up four several Kinds of this Sort of Plants in the abovemention'd Place.

Now that which is to our purpose in this Matter, is, that in order to convince those that deny the Divine Perfections, that Plants are neither produced by Chance, nor by any ignorant necessary Causes, the Great Creator thereof has been pleased to shew hereby; *First*, That whereas all other Plants seem absolutely to require to live in Air, his unlimited Power, which only operates according to the Council of his own good Pleasure, will not be bound by such Laws; causing for that very End certain Plants to grow and live in the deepest Bottom of the Sea, where all others would certainly die. And, *Secondly*, to shew, that mere Chance can have no place here, he has furnished them with all the Instruments that are requisite for the Growth, Production, and farther Structure of a determinate Sea-Plant. The same Proof has been likewise used above in the Comparison between Fishes and other Animals that live in the Air; and it appears from both, that this Wisdom is not confined either to Number, forasmuch as the Fishes and Sea-Plants are innumerable; nor to Kind, since there is so great a variety of both; but that it does all things for its own Glory, and in Conformity to its own Pleasure.

Sect. XXXVI. *Convictions from all that has been said above.*

Now to draw a Conclusion from all this, and to see what those Mathematicians, who stand in the first Rank among the Enquirers into Nature, have thought upon these Matters, we cannot do better than to quote the Expressions of Mr. *Huigens* in his *Cosmotheoros*, p. 18, and 19. *No Body, I think, will deny that there is something greater and more wonderful in the Structure, Life, Manner of Growth, and Production of Plants and Animals, than of lifeless and insensible Bodies; tho' these latter may be more remarkable for their Magnitude, such as Mountains, Rocks, Seas, and the like. Moreover, in both those kinds of Animate things, the Glory of the Divine Providence and Wisdom appears much more differently and eminently. For tho' a Disciple of* Democritus, *or of* Cartesius, *should perhaps say, that in order to shew how every thing that we see both in Heaven and Earth has acquired its Existence, nothing more is necessary than Atoms or little Particles of Matter and Motion; yet he will in vain endeavour to apply the same to Plants and Animals, nor be able to bring any thing probable from their first Existence and Structure: Since it appears but too plainly, that such things can never proceed from a simple and accidental Motion of Bodies, forasmuch as all things are found therein to be adapted to certain Ends and Purposes, with the utmost Foresight and penetrating Knowledge of the Laws of Nature and Mathematicks; to say nothing of the Wonders of their Production.*

I thought this Passage, of which kind I could have produced many more from great and good Philosophers, very proper in this Place; *First*, Because an unhappy Atheist might learn from hence how vain that Expectation is wherewith many

many of 'em are wont to flatter themselves, namely, that Men of the greatest Judgment have entertained the same Sentiments with them: Since we here meet with so famous a Naturalist, and one so highly esteemed by the learned World, with whom few of these Infidels can have the Confidence to compare themselves, speaking after a manner entirely different from their ill grounded Opinions of the Divine Wisdom and Providence. *Secondly*, Because what we have just now quoted shews, with how much reason Atheism ought to be suspected by itself of Error and Falsity, since we see such great Mathematicians openly acknowledging that which an Infidel must deny, if he would quiet his own Mind. *Thirdly*, Every one that has read this Book of Mr. *Huigens*, must likewise own, that he does therein make a very careful Difference between what can be proved *True*, and that which is Uncertain, and can only pass for mere *Conjecture*: Since this great Mathematician expressly declares, that he would not have several of the Opinions which he there proposes, to be received for more than Guesses and Uncertainties.

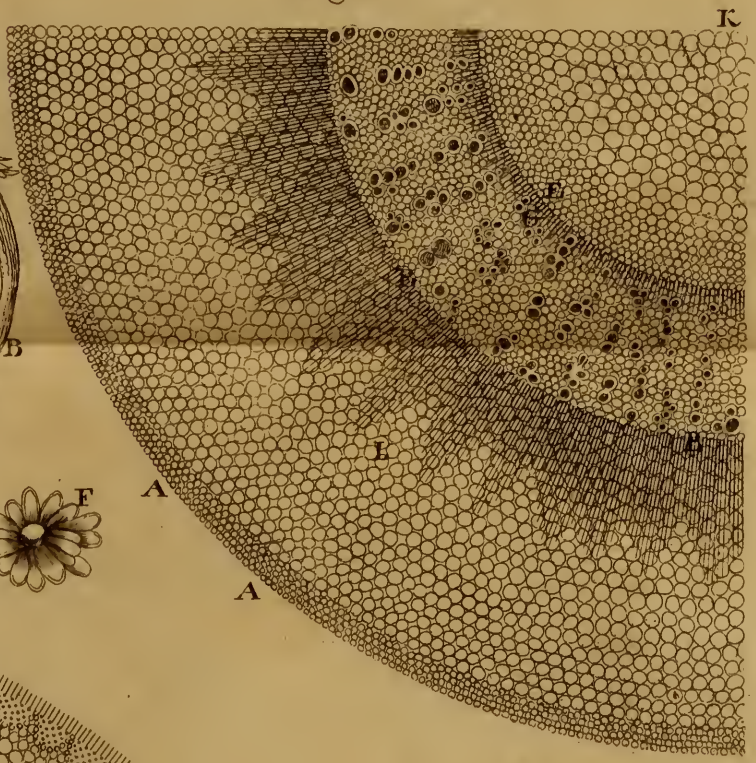
Now let an Atheist examine himself, whether he can by far alledge so much Probability for his Sentiments, as is to be found in these Conjectures, and let him compare the one with the other.

This worthy Author (that we may carry the Comparison yet farther) lays down in his *Cosmotheoros* some settled Mathematical Truths, and which Experience has render'd certain; and shews how his Conjectures may be made to agree therewith: Now what has an Atheist ever done like this, who never could advance any other than his own simple Notions for a Foundation to his Sentiments?

place this at the end of y^e 2^d Sect.

TAB. XVIIII

Fig. 1



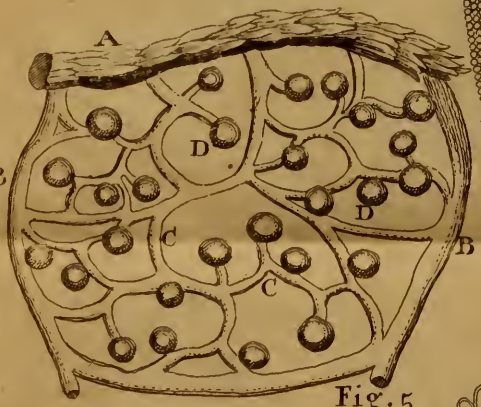


Fig. 5

Fig. 3

Fig. 4

Moreover, if Mr. *Huigens* ſuppoſes, that it cannot be proved to be impoſſible in Nature, that there is Land and Sea-Animals, Plants, and the like in the Planets; he ſhews likewiſe, by an undeniable Experience, that ſomething analogous is found upon this Globe. On the contrary, an Atheiſt maintains, that ſuch ſurpriſing Maſterpieces, as Animals and Plants are produced by Chance, at leaſt, without the Wiſdom of the Maker; in which, however, ſo many well adapted Inſtruments, and ſo many different Motions, all ſerving to the ſame Purpoſe, are to be ſeen: Notwithſtanding which, he has never yet been able to ſhew any thing like them in Works of much leſſer Skill and Artifice, ſuch as Watches, Mills, or even in the ſimple Structure of Houſes and Chambers, which for the number of Inſtruments and multiplicity of Motions, fall infinitely ſhort of any living Creature or Plant.

Finally, Notwithſtanding all theſe things, this Gentleman confeſſes all his Speculations to be no more than Conjectures; whilſt the Atheiſt, that cannot advance near ſo far, and who has the analogous Experiments perfectly againſt him, will have his Notions paſs for irrefragable Truths, even with the Danger of everlaſting Miſery.

The End of the Second Volume.