

II. *Some Thoughts and Experiments Concerning Vegetation* By John Woodward, M. D. of the College of Physicians, & R.S. & Professor of Physick in Gresham College.

THE *Ancients* generally intituled the *Earth* to the Production of the *Animals*, *Vegetables*, and *other Bodies* upon and about it : and for that reason 'twas that they gave it so frequently the Epithets of *Parent* and *Mother* \*. They were of opinion that it furnished forth the *Matter* whereof *those Bodies* consist : and received it all back again at their Dissolution for the Composition of *others*. Even those who asserted *four Elements*, supposed that the *Earth* was the *Matter* that *Constituted* those *Bodies* : and that *Water* and the *rest*, serv'd only for the *Conveyance* and *Distribution* of that *Matter*, in order to the *forming* and *composition* of them. 'Tis true, *Thales*, a Philosopher of the first rank in those early Ages, has been thought to have Sentiments very different from these ; but that without just Grounds ; as I think I have sufficiently proved in another Paper, which I am ready to produce.

But tho' *Antiquity* thus gave its *Vote* for *Terrestrial Matter*, several of the *Moderns*, and some of very great *Name* too, both *here* and *abroad*, have gone quite Counter, and given *theirs* in behalf of *Water*. The *dignity* of the *Persons* that have espoused it, as well as their *number*, renders this *Doctrine* very considerable, and well worth our enquiring into. The great restorer of *Philosophy* in this last Age, my Lord *Bacon*, is of opinion, *That for Nourishment* of *Vegetables*, *the Water* is almost *all in all* : and that *the Earth* doth but keep the *Plant upright*, and save it from over heat, and over cold †. Others

\* Terra Patens.  
† ἡ γῆ  
πῶσιον.  
Terra Mater.

† Nat. Hist.  
Cent. 5. § 411.

to be the only *Principle* or Ingredient of all natural things. They suppose that, by I cannot tell what Process of Nature, Water is *transmuted* into *Stones*, into *Plants*, and, in brief, all other Substances whatever. *Helmont* || particularly, and his *Followers*, are very positive in this: and offer some *Experiments* to render it credible. Nay a very *extraordinary Person* of our own *Nation* \* tries those *Experiments* over again: and discovers a great Propensity to the same Thoughts and Opinion they had; declaring for this *Transmutation* of *Water* into *Plants* and *other Bodies*, tho' with great Modesty and Deference, which was his usual manner.

The *Experiments* they insist upon are chiefly two; the *first* is, that *Mint* and several *other Plants* prosper and thrive very greatly in *Water*. The *other* is this; they take a certain quantity of *Earth*, and *bake* it in an *Oven*; then they weigh it, and put it into an *Earthen Pot*. Having well water'd this *Earth*, they make choice of some fit *Plant*, which, being first carefully *weigh'd*, they *set* in it. There they let it grow, continuing to *Water* it for some time, till 'tis much advanced in *bigness*. Then they take it up; and tho' the *Bulk* and *Weight* of the *Plant* be much greater than when *first set*, yet upon *Baking* the *Earth*, and *weighing* it, as at first, they find it little or not at all *diminished* in *weight*; and therefore conclude 'tis not the *Earth* but *Water* that nourishes and is *turn'd* into the Substance of the *Plant*.

I must confess I cannot see how *this Experiment* can ever be made with the *nicety* and *justness* that is requisite, in order to *Build* upon it so much as *these Gentlemen* do. 'Tis hard to weigh *Earth* in that *quantity*, or *Plants* of the *size* of those they mention, with any great *exactness*: or to *bake* the *Earth* with that *Accuracy*, as to reduce it *twice* to just the *same Dryness*. But I may wave all this, for *this Experiment* be never so ea-

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fily practicable, and all the Accidents of it exactly as they set forth, yet nothing like what they *infer* can possibly be concluded from it; unless *Water*, which they so plentifully bestow upon the *Plant* in *this Experiment*, be *pure, homogeneous*, and not charged with any *terrestrial Mixture*; for if it be, the *Plant* after all may owe its *growth* and *encrease* intirely to *that*.

Some *Waters* are indeed so very *clear* and *transparent*, that one would not easily suspect any *terrestrial Matter* were latent in them: but they may be *highly saturated* with such *Matter*, tho' the *Eye* be not presently able to descry or discern it. 'Tis true, *Earth* is an *opaque Body*; but it may be so far dissolved, reduced to so extreme small *Particles*, and these so *diffused* through the *watery Mass*, as not sensibly to impede *vision*, or render the *Water* much the less *diaphanous*. *Silver* is an *Opake*, and indeed a very *dense Body*; and yet, if perfectly dissolved in *Sp. of Nitre*, or *Aqua Fortis*, that is *rectified* and thorowly *fine*, it does not *darken* the *Menstruum*, or render it less *pellucid* than before \*. And other Instances there are, that oftentimes *great quantities* of *Opake Matter* are sustain'd in *Fluids*, without considerably striking the *Eye*, or being perceived by it. So that were there *Water* any where found so *pure*, that the quickest *Eye* could discover in it no *terrestrial intermixture*; that would be far short of a *Proof*, that in reality there was *none*.

\* Provided the *Silver* be pure and absolutely retin'd: For the least admixture of Copper will produce a blue Tincture in the *Menstruum*; that of some other Bodies, different.

But after all, even the *clearest Water* is very far from being *pure* and wholly *defecate*, in any part of the *World*, that I can learn. For *Ours* here, I have had an Opportunity of Examining it over a good part of *England*: and cannot say I ever met with any, that, however *fresh* and *newly* taken out of the *Spring*, did not exhibit, even

to the naked Eye, *great numbers* of exceeding small *terrestrial Particles* disseminated through all parts of it. *Thicker* and *crasser Water* exhibits *them* in still greater *Plenty*.

*These* are of two general *kinds*. The one a *vegetable terrestrial Matter*, consisting of very different *Corpuscles*; some whereof are proper for the formation and increment of *one sort* of *Plant*, and some of *another*: as also some for the nourishment of *one part* of the *same Plant*, and some of *another*. The *other kind* of *Particles* sustain'd in *Water* are of a *Mineral Nature*. *These* likewise are of *different sorts*. In some *Springs* we find *Common Salt*, in others *Vitriol*, in others *Alum*, *Nitre*, *Sparr*, *Ochre*, &c. may frequently *several* of *these*, or other *Minerals*, all in the *same Spring*; the *Water* as it drains and passes thorow the *Strata* of *Stone*, *Earth*, and the like, *taking up* and *bearing* along such loose *Mineral Corpuscles*, as it meets with in the pores and interstices of those *Strata*, and bringing them on with it quite to the *Spring*. *All Water* whatever is much charged with the *Vegetable Matter*, this being *fine*, *light* and *easily moveable*. For the *Mineral*, the *Water* of *Springs* contains more of it than that of *Rivers*, especially when at *distance* from their *Sources*: and that of *Rivers* more than the *Water* that falls in *Rain*. This I have learn'd from several *Tryals*, which I must not give Account of here; my *Drift* in this place being only to evince the *existence* of *terrestrial Matter* in *Water*.

Any one who desires *further satisfaction* in this, may easily obtain it, if he only put *Water* into a clear *Glass Viol*, stopping it close, to keep *Dust* and other exterior *Matter* out, and letting it stand, without stirring it for some *Days*. He'll then find a considerable *Quantity* of *terrestrial Matter* in the *Water*, however pure and free it might appear when first put into the *Viol*. He'll  
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in a very short time observe, as I have frequently done, the *Corpuscles* that were at first, while the *Water* was agitated and kept in *Motion*, separate, and hardly visible \*, by degrees, as the *Water* permits, by its becoming more still and at rest, assembling and combining together; by that means forming somewhat larger and more conspicuous *Moleculæ*. Afterwards he may behold these joining and fixing each to other, by that means forming large thin Masses, appearing like *Nubeculæ*, or Clouds in the *Water*; which grow more thick and opaque, by the continual appulse and accretion of fresh Matter. If the said Matter be chiefly of the *Vegetable* kind, 'twill be sustained in the *Water*: and discover at length a green colour; becoming still more and more of that Colour, I mean an higher and more saturate *Green*, as the Matter thickens and encreases. That this matter inclines so much to that Colour, is the less strange, since we see so large a share of it, when constituting *Vegetables*, wearing the same Colour in them. But if there be any considerable quantity of meer *Mineral Matter* in the *Water*, this, being of a greater *Specifick gravity* than the *Vegetable*, as the *Particles* of it unite and combine in such Number, till they form a *Molecula*, the impetus of whose *Gravity* surpasses that of the *Resistance* of the *Water*, subsides a great deal of it to the bottom. Nor does it only fall down it self, but, frequently entangling with the *Vegetable Nubeculæ*, forces them down along with it.

The reason why *Bodies*, when dissolved and reduced to extreme small parts, are sustain'd in *Liquors* that are of less *Specifick Gravity* than those *Bodies* are, hath been pointed at by a late ingenious Member of this Society \*. He is indeed far from having adjusted all the *Momenta* of this affair; however it must be admitted, that, in the dividing or solution of *Bodies*, their *Surfaces* do not decrease in the same Proportion that their *Bulk* does.

Now

\* To say nothing of those that were not discernible.

\* Mr. W. Moli-neux, Philos. Trans. N° 181.

Now the *Gravity* of a *Body* which is the *Cause* of its *sinking* or tendency downwards, is commensurate to its *Bulk*: but the *Resistance* that the *Liquor* makes is proportion'd, not to the *Bulk*, but to the extent of the *surface* of the *Body* immered in it. Whence 'tis plain, a *Body* may be so far divided, that its *Parts* may be sustain'd in a *Fluid*, whose *Specifick Gravity* is less than that of the said *Body*. Nay, 'tis matter of *Fact* that they frequently are so: and we daily see *Menstrua* supporting the *Parts* of *Metalls*, and other *Bodies*, that are of six, ten, nay almost twenty times the *Spec. Grav.* of those *Menstrua*. And as the *Parts* of *Bodies* when *divided* are thus supported in a *Fluid*: So when they occur and unite again, they must sink of Course, and fall to the *Bottom*.

Upon the whole, 'tis palpable and beyond reasonable Contest, that *Water* contains in it a very considerable Quantity of *terrestrial Matter*. Now the Question is to which of these, the *Water*, or the *Earthy Matter* sustain'd in it, *Vegetables* owe their *Growth* and *Augment*. For deciding of which I conceive the following *Experiments* may afford some *Light*: And I can safely say they were made with due *Care* and *Exactness*.

Anno 1691.

I chose several *Glass Viols*, that were all, as near as possible, of the same *shape* and *bigness*. After I had put what *Water* I thought fit into every one of them, and taken an *Account* of the *weight* of it, I strain'd and ty'd over the *Orifice* of each *Viol*, a piece of *Parchment*, having an hole in the middle of it, large enough to admit the *Stem* of the *Plant* I design'd to set in the *Viol*, without *confining* or *straightning* it so as to impede its *Growth*.

*Growth.* My intention in *this*, was to prevent the enclosed *Water* from *Evaporating*, or ascending any other way than only thorow the *Plant* to be set therein. Then I made choice of several Sprigs of *Mint*, and *other Plants*, that were, as near as I could possibly judge, alike *fresh, sound, and lively*. Having taken the *weight* of *each*, I placed it in a *Viol*, ordered as above : and as the *Plant* imbibed and drew off the *Water*, I took care to add more of the same from time to time, keeping an *Account* of the *weight* of all I *added*. Each of the *Glasses* were, for better *distinction*, and the more easy keeping a *Register* of all *Circumstances*, noted with a different Mark or *Letter*, *A, B, C, &c.* and all set in a *Row* in the same *Window*, in such manner that all might partake alike of *Air, Light, and Sun*. Thus they continued from *July* the Twentieth, to *October* the Fifth, which was just *Seventy Seven Days*. Then I took them out, *weigh'd* the *Water* in each *Viol*, and the *Plant* likewise, adding to its *Weight* that of all the *Leaves* that had *fallen off* during the time it stood thus. And Lastly, I computed how much each *Plant* had *gain'd* : and how much *Water* was *spent* upon it. The *Particulars* are as follows.

A Common

A. *Common Spear-Mint*, set in *Spring-Water*. The Plant weigh'd, when put in *July 20.* just 27 Grains: when taken forth, *Octob. 5.* 42 grains. So that in this space of 77 days, it had gain'd in weight 15 grains.

The whole quantity of Water expended, during these 77 days, amounted to 2558 gr. Consequently the weight of the Water taken up was  $170\frac{2}{3}$  times as much as the Plant had got in weight.

The Weight of the Plant when first set in Water	The Wt. of the Pl. when tak'n again out of the Water	The Wt. gain'd by the Plant during the 77 days	The Wt. of the W <sup>r</sup> . expended upon the Plant	The Proportion of the Increase of the Plant to the Expence of the Water.
gr. 27	gr. 42	gr. 15	gr. 2558	As 1 to $170\frac{2}{3}$

B. *Common Spear-Mint: Rain water*. The Mint weigh'd, when put in, gr.  $28\frac{1}{2}$ ; when taken out gr.  $45\frac{1}{2}$ . having gain'd in 77 days gr.  $17\frac{1}{2}$ .

The dispendium of the Water gr. 3004. which was  $171\frac{2}{3}$  times as much as the Plant had received in weight.

gr. $28\frac{1}{2}$	gr. $45\frac{1}{2}$	gr. $17\frac{1}{2}$	gr. 3004	As 1 to $171\frac{2}{3}$
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C. *Common Spear mint: Thames Water*. The Plant when put in gr. 28. when taken forth, gr. 54. So that in 77 days it had gain'd gr. 26.

The Water expended amounted to gr. 2493. which was  $95\frac{2}{3}$  times as much as the additional weight of the Mint.

gr. 28	gr. 54	gr. 26	gr. 2493	As 1 to $95\frac{2}{3}$
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D. *Common Solanum, or Nightshade: Spring Water.* The Plant weigh'd, when put in, gr. 49 : when taken out 106. having gain'd in 77 days 57 gr.

The Wat. expended during the said time was 3708 gr. which was  $65\frac{3}{4}$  times as much as the augmentation of the Plant.

This specimen had several Buds upon it, when first set in the Wat. These in some days, became fair Flowers, which were at length succeeded by Berries.

The Weight of the Plant when first set in Water	The Wt. of the Pl when taken again out of the Water	The Wt. gain'd by the Plant during the 77 days	The Wt. of the Wat. expended upon the Plant	The Proportion of the Increase of the Plant to the Excess of the Water.
gr. 49	gr. 106	gr. 57	gr. 3708	As 1 to $65\frac{3}{4}$ .

E. *Lathyris seu Cataputia Gerb.* Spring Water. It weigh'd, when put in, gr. 98. when taken forth, gr. 101 $\frac{1}{2}$ . The additional weight for this whole 77 days being but gr. 3 $\frac{1}{2}$ .

The quantity of Wat. spent upon it during that time, gr. 2501. which is  $714\frac{4}{7}$  times as much as the Plant was augmented.

gr. 98	gr. 101 $\frac{1}{2}$	gr. 3 $\frac{1}{2}$	gr. 2501	As 1 to $714\frac{4}{7}$ .
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Several other Plants were try'd, that did not thrive in Water, or succeed any better than the *Cataputia* foregoing : But 'tis besides my purpose to give a particular Account of them here.

F, G. These Two *Viols* were fill'd, the former (F) with Rain, the other with *Spring Water*, at the same time as those above-mentioned were : and stood as long as they did. But they had neither of them any Plant;

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my Design in these being only to inform my self, whether any *Water exhaled* out of the *Glasses*, otherwise than *thorow* the *Bodies* of the *Plants*. The Orifices of these Two Glasses were cover'd with *Parchment*; each piece of it being perforated with an hole of the same bigness with *those* of the *Viols* above. In this I suspended a bit of Stick about the thickness of the *Stem* of one of the aforesaid *Plants*, but not reaching down to the *Surface* of the included *Water*. I put them in thus, that the *Water* in *these* might not have more scope to evaporate than *that* in the other *Viols*. Thus they stood the whole 77 days in the same Window with the rest; when, upon Examination, I found *none* of the *Water* in these *wasted* or *gone off*. Tho' I observed, both in *these*, and the *rest*, especially after *hot Weather*, small *drops* of *Water*, not unlike *Dew*, adhering to the *insides* of the *Glasses*, that part of them I mean that was above the *Surface* of the enclosed *Water*.

The *Water* in these two Glasses that had *no Plants* in them, at the end of the Experiment, exhibited a *larger* quantity of *terrestrial Matter* than *that* in any of *those* that *had* the *Plants* in them *did*. The *Sediment* at the bottom of the *Viols* was *greater*: and the *Nubeculæ* diffus'd through the Body of the *Water* *thicker*. And of *that* which was in the *others*, some of it proceeded from certain small *Leaves* that had fallen from that part of the *Stems* of the *Plants* that was within the *Water*, wherein they *rotted* and *dissolved*. The *terrestrial Matter* in the *rain Water* was *finer* than that in the *Spring Water*.

Anno 1692.

The Glasses made use of in this, were of the same sort with those in the former Experiment: and cover'd over with Parchment in like manner. The Plants here were all *Spear mint*: the most kindly, fresh, sprightly Shoots I could choose. The Water, and the Plants, were weigh'd as above: and the Viols set, in a Line, in a *South-Window*; where they stood from *June 2d*, to *July 28*. which was just 56 days.

H. *Hyde-Parke Conduit-Water*, alone. The *Mint* weigh'd, when put in, 127 gr: when taken out, 255 gr. The whole quantity of Water expended upon this Plant amounted to 14190 gr.

This was all along a very kindly Plant: and had run up to above two foot in height. It had shot but one considerable collateral branch: but had sent forth many and long *Rootes*, from which sprung very numerous tho' small, and short lesser *Fibres*. These lesser *Rootes* came out of the larger on two opposite sides, for the most part; so that each *Root*, with its *Fibrillæ*, appear'd not unlike a small *Feather*. To these *Fibrillæ* adher'd pretty much *terrestrial Matter*. In the *Water* which was at last thick and turbid, was a green substance resembling a fine thin *Conserua*.

The Weight of the Plant when first set in Water	The Wt. of the Pl. when taken again out of the Water	The Wt. gain'd by the Plant during the 56 days	The Wt. of the Wat. expended upon the Plant	The Proportion of the Increase of the Plant to the Ex- pence of the Wa- ter.
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gr.	gr.	gr.	gr.	
127	255	128	14190	As 1 to 110 $\frac{710}{127}$ .

I. The *same Water*, alone. The *Mint* weigh'd, when put in, 110 gr: when taken out, 249. Water expended, 13140 gr.

This *Plant* was as kindly as the former, but had not no collateral Branches. Its *Roots*, the *Water*, and the *green Substance*, all much as in the former.

The Weight of the Plant when first put in Water.	The Wt. of the Pl. when tak'n again out of the Water.	The Wt. gain'd by the Plant during the 56 days.	The Wt. of the Wat. expended upon the Plant.	The Proportion of the Encrease of the Plant to the Expence of the Water.
gr. 110	gr. 249	gr. 139	gr. 13140	As 1 to 94 $\frac{74}{113}$

K. *Hyde-Park Conduit-Water* in which was dissolved an Ounce and half of *Common Garden Earth*. The *Mint* weigh'd, when put in, 76 gr: When taken out 244 gr. Water expended, gr. 10731.

This *Plant*, tho' it had the Misfortune to be annoyed with many small *Insects* that happened to fix upon it, yet had not very considerable *collar. Branches*: and at least as many *Roots* as either that in H. or I; which had a *much greater* quantity of *terrestrial Matter* adhering to the extremities of them. The *same green Substance* here, that was in the two preceding.

gr. 76	gr. 244	gr. 168	gr. 10731	As 1 to 63 $\frac{47}{108}$
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L. *Hyde-Park Water*, with the same quantity of *Garden Mould* as in the former. The *Mint* weigh'd, when put in, 92 gr: when taken out 376 gr. The *Water* expended, 14950 gr.

This *Plant* was far more flourishing than any of the Precedent: had several very considerable collateral *Branches*: and very numerous *Roots*, to which *terrestrial Matter* adhered very copiously.

The *Earth* in both these *Glasses* was very sensibly and considerably *wasted*, and *less* than when first put in. The same sort of *green Substance* here as in those above.

M. *Hyde-Park Water*, distilled off with a gentle *Still*. The *Mint* weigh'd, when put in, 114 gr: when taken out, 155. The *Water* expended, 8803 gr.

This *Plant* was pretty kindly: had 2 small collat. *Branches*, and several *Rootes*, tho' not so many as that in H or I, but as much *terrestrial Matter* adhering to them as those had. The *Water* was pretty *thick*; having very numerous small *terrestrial Particles* swimming in it, and some *Sediment* at the bottom of the *Glass*. This *Glass* had none of the *green Matter* above-mentioned, in it.

The Weight of the Plant when first put in Water.	The Wt. of the Pl. when tak'n again out of the Water.	The Wt. gain'd by the Pl. during the 56 days.	The Wt. of the Wat. expended upon the Plant.	The Proportion of the Encrease of the Plant to the Expence of the Water.
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gr.	gr.	gr.	gr.	
92	376	284	14950	As 1 to 52 $\frac{182}{174}$

gr.	gr.	gr.	gr.	
114	155	41	8803	As 1 to 214 $\frac{22}{21}$

N. The *residus* of the *Water* which remain'd in the *Still* after that in M. was distilled off. It was very *turbid*, and as high-coloured (reddish) as ordinary *Beer*. The *Mint* weigh'd, when put in, 81 gr : when taken out, 175 gr. *Water* expended, 4344 gr. This *Plant* was very lively : and had sent out six collateral *Branches*, and several *Roots*.

The Weight of the Plant when first set in Water.	The Wt. of the Pl. when tak'n again out of the Water.	The Wt. gain'd by the Pl. during the 56 days.	The Wt. of the Wat. expended upon the Plant.	The Proportion of the Evanesce of the Plant to the Expende of the Water.
gr. 81	gr. 175	gr. 94	gr. 4344	As 1 to 46 $\frac{2}{3}$

O. *Hyde-Park Conduit-Water*, in which was dissolved a Drachm of *Nitre*. The *Mint* set in this suddenly began to *wither* and *decay*; and *died* in a few Days. As likewise did two more *Sprigs*, that were set in it, successively. In another Glass I dissolved an Ounce of good *Garden Mould*, and a Drachm of *Nitre* : and in a third half an Ounce of *Wood Ashes*, and a Drachm of *Nitre* ; but the *Plants* in these succeeded no better than in the former. In other Glasses I dissolved several other sorts of *Earths*, *Clays*, *Marles*, and variety of *Manures*, &c. I set *Mint* in *distill'd Mint-Water* ; and other *Experiments* I made, of several kinds, in order to get light and information what *hastened* or *retarded*, *promoted* or *impeded Vegetation* ; but these do not belong to the *Head* I am now upon.

P *Hyde Parke Conduit Water*. In this I fixed a *Glass-Tube* about ten Inches long, the *Bore* about one sixth of an Inch in Diameter, fill'd with very fine and white *Sand*, which I kept from falling down out of the *Tube* into the *Viol*, by tying a thin piece of *Silk* over that end of the *Tube* that was downwards. Upon immersion of the lower end of it into the *Water*, this by little and little *ascended* quite to the upper Orifice of the *Tube*.

And

And yet, in all the fifty six days which it stood thus, a very inconsiderable quantity of *Water* had gone off, viz. scarcely Twenty Grains; tho' the *Sand* continued moist up to the top till the very last. The *Water* had imparted a *green Tincture* to the *Sand*, quite to the very top of the *Tube*. And, in the *Viol*, it had precipitated a *greenish Sediment*, mixt with *black*. To the bottom and sides of the *Tube*, as far as 'twas immers'd in the *Water*, adher'd pretty much of the *green Substance* described above. Other like *Tubes* I fill'd with *Cotton*, *Lint*, *Pith of Elder*, and several other porous *Vegetable Substances*; setting some of them in *clear Water*: Others in *Water* tinged with *Saffron*, *Cochinele*, &c. And several other *Trials* were made, in order to give a *Mechanical Representation* of the *Motion* and *Distribution* of the *Juices* in *Plants*: and of some other *Phenomena* observable in *Vegetation*, which I shall not give the particulars of here; as being not of Use to my present *Design*.

Q, R, S, &c. Several *Plants* set in *Viols*, ordered in like manner as those above, in *October*, and the following *colder Months*. These thrive not near so much: nor did the *Water* ascend in nigh the quantity, it did in the *hotter Seasons*, in which the before recited *Trials* were made.

### Some Reflections upon the foregoing Experiments.

I. In *Plants* of the same kind, the less they are in Bulk, the smaller the Quantity of the *Fluid Mass* in which they are set is drawn off; the *Dispendium* of it, where the *Mass* is of equal thickness, being pretty nearly proportioned to the Bulk of the *Plant*. Thus that in the *Glass* Mark'd A, which weigh'd only 27 gr. drew off but

but 2558 grains of the *Fluid*: and that in B, which weigh'd only 28 $\frac{1}{2}$ , took up but 3004 gr. whereas that in H, which weigh'd 127 grains, spent 14190 gr. of the *Liquid Mass*.

The *Water* seems to ascend up the *Vessels* of *Plants* in much the same manner as up a *Filtre*: and 'tis no great wonder that a *larger Filtre* should draw off *more Water* than a lesser: or that a *Plant* that has *more and larger Vessels* should take up a *greater share* of the *Fluid*, in which 'tis set, than one that has *fewer and smaller ones* can. Nor do I Note *this* as a thing very considerable in it self, but chiefly in regard to what I am about to offer *beneath*: And that it may be seen that, in my *other Collations* of *Things*, I made *due Allowance* for this *Difference*.

2. *The much greatest part of the Fluid Mass that is thus drawn off and convey'd into the Plants, does not settle or abide there: but passes through the Pores of them, and exhales up into the Atmosphere.* That the *Water* in these Experiments, ascended *only* through the *Vessels* of the *Plants* is certain. The *Glasses* F and G, that had *no Plants* in them, tho' disposed of in like manner as the *rest*, remain'd, at the End of the *Experiment*, as at first: and *none* of the *Water* was gone off. And that the *greatest part* of it flies off from the *Plant* into the *Atmosphere*, is as certain. The *least proportion* of the *Water* expended was to the *Augment* of the *Plant*, as 46 or 50 to 1. And in some the weight of the *Water* drawn off was 100, 200, nay, in one above 700 times as much as the *Plant* had received of *Addition*.

This so continual an *Emission* and *Detachment* of *Water*, in so great *Plenty* from the *Parts* of *Plants*, affords us a manifest reason why *Countries* that abound with *Trees* and the *larger Vegetables* especially, should be  
 very



very obnoxious to *Damps*, great *Humidity* in the *Air*, and more frequent *Rains*, than *others* that are more *open* and *free*. The great *Moisture* in the *Air*, was a mighty inconvenience and *annoyance* to those who first settled in *America*; which at that time was much over-grown with *Woods* and *Groves*. But as *these* were *burnt* and *destroyed*, to make way for *Habitation* and *Culture* of the *Earth*, the *Air* mended and *cleared* up apace: changing into a *Temper* much more *dry* and *serene* than before.

Nor does this *Humidity* go off *pure* and *alone*; but usually bears forth with it many *parts* of the *same Nature* with *those* whereof the *Plant*, through which it passes, consists. The *Crasser* indeed are not so easily born up into the *Atmosphere*: but are usually deposited on the *Surface* of the *Flowers*, *Leaves*, and other *Parts* of the *Plants*. Hence come our *Manna's*, our *Honies*, and other *Gummosus Exsudations* of *Vegetables*. But the *finer* and *lighter Parts* are with greater ease sent up into the *Atmosphere*. Thence they are conveyed to our *Organs* of *Smell*, by the *Air* we draw in *Respiration*: and are *pleasant* or *offensive*, *beneficent* or *injurious* to us, according to the *Nature* of the *Plants* from whence they arise. And since *these* owe their *Rise* to the *Water* that ascends out of the *Earth* through the *Bodies* of *Plants*, we cannot be far to seek for the *Cause* why *they* are more *numerous* in the *Air*, and we find a greater quantity of *Odours* exhaling from *Vegetables*, in *warm*, *humid seasons*, than in any others whatever.

3. *A great part of the terrestrial Matter that is mixt with the Water, ascends up into the Plant as well as the Water.* There was *much more* terrestrial *Matter* at the end of the *Experiment*, in the *Water* of the *Glasses* *F* and *G*, that had *no Plants* in them, than in those

that had *Plants*. The *Garden-Mould* dissolved in the Glasses K and L was considerably *diminished*, and *carried off*. Nay the *terrestrial* and *Vegetable Matter* was born up in the *Tubes* filled with *Sand, Cotton &c.* in that *quantity* as to be *evident* even to *sense*. And the *Bodies* in the *Cavities* of the other *Tubes* that had their lower *Ends* immers'd in *Water* wherein *Saffron, Cochinele, &c.* had been infused, were *tinged* with *Yellow, Purple, &c.*

If I may be permitted to look abroad a while, towards our *Shores* and *Parts* within the *Verge* of the *Sea*, these will present us with a large scene of *Plants* that, along with the *Vegetable*, take up into them *meer mineral Matter* also in *great abundance*. Such are our *Sea-Purflains*, the several sorts of *Alga's*, of *Sampires*, and other *Marine Plants*. These contain *common Sea-Salt*, which is all one with the *Fossil*, in such *Plenty*, as not only to be plainly distinguished on the *Palate*, but may be drawn forth of them in *considerable quantity*. Nay, there want not *those* who affirm there are *Plants* found that will yield *Nitre*, and other *mineral Salts*; of which indeed I am not so far satisfied that I can depend on the *Thing*, and therefore give this only as an *Hint* for *Enquiry*.

To go on with the *Vegetable Matter*, how apt and how much disposed this, being so very *fine* and *light*, is to *attend Water* in all its *Motions*, and *follow* it into each of its *Recesses*, is manifest, not only from the *Instances* above alledg'd, but many others. *Percolate* it with all the *Care* imaginable: *Filter* it with never so many *Filtrations*, yet some *terrestrial Matter* will remain. 'Tis true the *Fluid* will be *thinner* every time than other, and more disingaged of the said *Matter*: but never *wholly free and clear*. I have filtered *Water* thorow several ~~wholly free and clear~~ *Sheets* of *thick Paper*: and, after that, through very *close fine Cloth* twelve times *doubled*. Nay, I have  
done

done this over and over ; and yet a considerable quantity of this *Matter* discover'd it self in the *Water* after all. Now if it thus pass *Interstices* that are so very *small* and *fine* along with the *Water*, 'tis the less strange it should attend it in its passage through the *Ducts* and *Vessels* of *Plants*. 'Tis true, *filtering* and *distilling* of *Water* intercepts and makes it quit some of the *Earthy Matter* it was before impregnated withal : but then *that* which continues with the *Water* after this, is *fine* and *light* ; and such consequently as is in a peculiar manner fit for the *Growth* and *Nourishment* of *Vegetables*. And this is the Case of *Rain Water*. The quantity of *terrestrial Matter* it bears up into the *Atmosphere* is not great. But that which it does bear up, is mainly of that *light* kind of *Vegetable Matter* ; and that too perfectly *dissolved*, and reduced to single *Corpuscles*, all fit to enter the *Tubules* and *Vessels* of *Plants*. On which Account 'tis that *this Water* is so very *fertile* and *prolific*.

The reason why in *this Proposition* I say only a *great part* of the *terrestrial Matter* that is mix'd with the *Water*, ascends up with it into the *Plant*, is, because *all of it* cannot. The *mineral Matter* is a great deal of it not only *gross* and *ponderous*, but *scabrous* and *inflexible* : and so not disposed to enter the *Pores* of the *Roots*. And a great many of the *simple Vegetable Particles* by degrees *unite*, and form some of them small *Clods* or *Molecules* ; such as those mentioned in H, K, and L, sticking to the extremities of the *Roots* of those *Plants*. Others of them *intangle* in a *looser manner* : and form the *Nubeculae*, and *green Bodies* so commonly observed in *stagnant Water*. *These*, when thus *conjoyn'd*, are *too big* to enter the *Pores*, or ascend up the *Vessels* of *Plants*, which *singly* they might have done. They who are conversant in *Agriculture* will easily subscribe to *this*. They are well aware that, be their *Earth* never so *rich*, so *good*, and

to fit for the Production of *Corn* or other *Vegetables*, little will come of it, unless the *Parts* of it be *separated* and *loose*. 'Tis on this Account they bestow the Pains they do in *Culture* of it: in *Digging*, *Plowing*, *Harrowing*, and *Breaking* of the *Clodded Lumps* of Earth. 'Tis the same way that *Sea-Salt*, *Nitre*, and other *Salts* promote *Vegetation*. I am sorry I cannot subscribe to the *Opinion* of those *Learned Gentlemen* who imagine *Nitre* to be *essential* to *Plants*: and that nothing in the *Vegetable Kingdom* is transacted without it. By all the *Tryals* I have been able to make, the thing is quite *otherwise*: and when contiguous to the *Plant* it rather destroys than nourishes it. But this, *Nitre* and other *Salts* certainly do: they *loosen* the *Earth*, and *separate* the *concreted Parts* of it; by that means fitting and disposing them to be *assumed* by the *Water*, and *carried up* into the *Seed* or *Plant*, for its *Formation* and *Augment*. There's no Man but must observe how apt all *sorts* of *Salts* are to be wrought upon by *Moisture*: how easily they *liqueate* and *run* with it; and when these are *drawn off*, and have *deserted* the *Lumps* wherewith they were incorporated, *those* must *moulder* immediately, and fall *asunder* of Course. The hardest *Stone* we meet with, if it happen, as frequently it does, to have any sort of *Salt* intermixt with the *Sand* of which it consists, upon being expos'd to an *humid Air*, in a short time dissolves and crumbles all to pieces: and much more will *clodded Earth* or *Clay*, which is not of near so *compact* and *solid* a *Constitution* as *Stone* is. The same way likewise is *Lime* serviceable in *this Affair*. The *Husbandmen* say of it, that it does not *fatten*, but only *Mellowes* the *Ground*. By which they mean, that it does not contain any thing in it self that is of the same *Nature* with the *Vegetable Mould*, or afford any *Matter* fit for the *formation* of *Plants*: but meerly *softens* and *relaxes* the  
*Earth*;

*Earth*; by that means rendering it more capable of *entering* the *Seeds* and *Vegetables* set in it, in order to their *Nourishment*, than otherwise it would have been. The *Properties* of *Lime* are well known: and how apt 'tis to be put into *ferment* and *commotion* by *Water*. Nor can such *Commotion* ever happen when *Lime* is *mix'd* with *Earth*, however *hard* and *clodded* that may be, without *opening* and *loosening* of it.

4. *The Plant is more or less nourish'd and augmented in proportion as the Water in which it stands contains a greater or smaller quantity of proper terrestrial Matter in it.* The Truth of this Proposition is so eminently discernible through the *whole Process* of these *Tryals*, that I think no *doubt* can be made of it. The *Mint* in the *Glass C.* was of much the same *Bulk* and *Weight* with those in *A.* and *B.* But the *Water*, in which *that* was, being *River Water*, which was apparently stored more copiously with *terrestrial Matter* than the *Spring* or *Rain Water*, wherein *they* stood, were; it had *thriven* to almost *double the Bulk* that either of them had; and with a *less Expence* of *Water* too. So likewise the *Mint* in *L.* in whose *Water* was dissolved a small quantity of good *Garden Mould*, tho' it had the disadvantage † to be *less* † *Confer. Prop.*  
I. *Supra.*  
when first set than either of the *Mints* in *H.* or *I.* whose *Water* was the very same with this in *L.* but had none of that *Earth* mix'd with it; yet, in a short time the *Plant* not only *overtook*, but much *out-stripp'd* those, and at the end of the Experiment was very considerably *bigger* and *heavier* than either of them. In like manner the *Mint* in *N.* tho' *less* at the beginning than *that* in *M.* being set in that *thick, turbid, feculent Water*, that remained behind, after *that*, wherein *M.* was placed, was *Still'd* off, had in fine more than *doubled* its *original weight* and *bulk*: and received above *twice* the *additional Encrease*

crease that *that* in M. which stood in the *thinner destill'd Water*, had done. And, which is not less considerable, had not drawn off *half* the *Quantity* of *Water* that *that* had.

Why, in the beginning of this Article, I limit the *Proportion* of the *Augment* of the *Plant* to the *Quantity* of *proper* terrestrial Matter in the *Water*, is, because *all*, even the *Vegetable Matter*, to say nothing of the *Mineral*, is not *proper* for the Nourishment of *every Plant*. There may be, and doubtless are, *some Parts* in *different Species* of *Plants*, that may be much alike, and so ow their supply to the same *common Matter*: but 'tis plain *all* cannot. And there are *other Parts* so *differing*, that 'tis no ways credible they should be form'd all out of the *same sort* of *Corpuscles*. So far from it, that there want not good *Indications*, as we shall see by and by, that *every Kind* of *Vegetable* requires a *peculiar* and *specifick Matter* for its *Formation* and *Nourishment*. Yea, *each Part* of the *same Vegetable* does so: and there are very *many* and *different Ingredients* go to the *Composition* of the same individual *Plant*. If therefore the *Soil*, wherein any *Vegetable* or *Seed* is planted, contains *all* or *most* of *these Ingredients*, and those in due *quantity*, 'twill grow and *thrive* there: otherwise 'twill *not*. If there be not as many *sorts* of *Corpuscles* as are requisite for the *Constitution* of the *main* and *more essential* Parts of the *Plant*, 'twill *not* prosper at all. If there be *these*, and not in sufficient *Plenty*, 'twill starve, and never arrive to its natural *Stature*. Or if there be any the *less necessary* and *essential* *Corpuscles* wanting, there will be some *Failure* in the *Plant*: 'twill be defective in *Taste*, in *Smell*, in *Colour*, or some other way. But tho' a *Tract* of *Land* may happen not to contain *Matter* proper for the *Constitution* of some one *peculiar kind* of *Plant*: yet it may for several *others*, and those much *differing*

fering amongst themselves. The *vegetative Particles* are *commixt* and blended in the *Earth*, with all the *diversity* and *variety*, as well as all the *uncertainty* conceivable. I have given some *Intimations* of this *elsewhere* †, and shall not repeat them *here*: but hope in *due time* to put them into a much *better light* than *that* they *there* stand in. & seq.

† Nat. Hist. Earth, p. 228.

It is not possible to imagine how *one, uniform, homogeneous Matter*, having its *Principles* or *Original Parts* all of the *same Substance, Constitution, Magnitude, Figure*, and *Gravity*, should ever constitute *Bodies* so egregiously *unlike*, in all *those respects* as *Vegetables* of *different kinds* are: nay even as the *different Parts* of the *same Vegetable*. That *one* should carry a *Resinous*, another a *Milky*, a third a *Yellow*, a fourth a *Red Juice*, in its *Veins*: one afford a *Fragrant*, another an *offensive smell*: one be *sweet* to the *Taste*, another *bitter, acid, acerb, austere, &c.* that one should be *nourishing*, another *poisonous*, one *purging*, another *astringent*: in brief, that there should be that vast *difference* in them in their several *Constitutions, Makes, Properties, and Effects*, and yet *all* arise from the very *same sort of Matter*, would be very *strange*. And, to Note that by the by, this *Argument* makes *equally strong* against *those* who suppose *meer Water* the *Matter* out of which all *Bodies* are *form'd*.

The *Cataputia* in the *Glass E.* received but very little *Encrease*, only three grains and an half all the while it stood, tho' 2501 grains of *Water* were spent upon it. I will not say the reason was because *that Water* did not contain in it *Matter* fit and *proper* for the *Nourishment* of that *peculiar* and *remarkable Plant*. No, it may be the *Water* was not a *proper Medium* for it to grow in: and we know there are very *many Plants* that will *not thrive* in it. Too much of that *Liquor*, in some *Plants*,  
may

may probably *hurry* the *terrestrial Matter* thorow their *Vessels* too fast for them to *arrest* and lay hold of it. Be that as it will, 'tis most certain there are *peculiar Soils* that suit *particular Plants*. In *England*, *Cherries* are observed to succeed best in *Kent*: *Apples* in *Herefordshire*: *Saffron* in *Cambridgeshire*: *Woad* in two or three of our *Midland Counties*: and *Teazles* in *Somersetshire*. This is an *Observation* that hath held in *all Parts*, and indeed in *all Ages* of the *World*. The most *ancient Writers* of *Husbandry* \* took Notice of it: and are not wanting in their *Rules* for making choice of *Soils* suited to the *nature* of each kind of *Vegetable* they thought *valuable* or *worth propagating*.

\* Vid. Varronem, Columellam, & reliquos Rei Rusticæ Scriptores.

But, which is a further *Proof* of what I am here endeavouring to advance, that *Soil* that is *once proper* and fit for the *Production* of some one sort of *Vegetable* does not ever continue to be so. No, in *Tract* of *time* it looses that *Property*: but *sooner* in *some Lands*, and *later* in *others*. This is what all who are conversant in these things know very well. If *Wheat*, for Example, be sown upon a *Tract* of *Land* that is proper for that *Grain*, the *first Crop* will succeed very well: and perhaps the *second*, and the *third*, as long as the *Ground* is in *Heart*, as the *Farmers* speak. But in a *few Years* 'twill produce *no more*, if sowed with *that Corn*. Some *other Grain* indeed it may, as *Barly*. And after *this* has been sown *so often* that the *Land* can bring forth *no more* of the same; it may afterwards yield good *Oats*: and perhaps *Pease* after them. At length 'twill become *Barren*; the *Vegetative Matter*, that at first it *abounded* withal, being *educed* forth of it by those *successive Crops*, and most of it *born off*. Each sort of *Grain* takes forth *that peculiar Matter* that is proper for its own *Nourishment*. First the *Wheat* draws off *those Particles* that suit the *Body* of *that Plant*; the rest lying all *quiet* and  
undisturb'd



undisturbed the while. And when the *Earth* has yielded up all them, *those* that are proper for *Barly*, a *different Grain*, remain *still behind*, 'till the successive *Crops* of *that Corn* fetch *them* forth too. And so the *Oats*, and *Pease*, in their *Turn*; 'till in fine all is *carried off*, and the *Earth* in great Measure *drain'd* of *that sort* of *Matter*.

After all which, *that very Tract* of *Land* may be brought to *produce* another *Series* of the *same Vegetables*: but never 'till 'tis supplied with a new *Fund* of *Matter*, of like sort with *that* it at first contain'd. This *supply* is made *several ways*. By the *Grounds* lying *fallow* for some time, 'till the *Rain* has pour'd down a *fresh stock* upon it. Or by the *Tiller's Care* in *Manuring* of it. And for further Evidence that *this supply* is in reality of *like sort*, we need only reflect a while upon those *Manures* that are found by constant *Experience* best to promote *Vegetation*, and the *fruitfulness* of the *Earth*. These are chiefly either *Parts* of *Vegetables*, or of *Animals*; which indeed either derive their own *Nourishment* immediately from *Vegetable Bodies*, or from other *Animals* that do so. In particular, the *Blood*, *Urine*, and *Excrements* of *Animals*: *Shavings* of *Horns* and of *Hoofs*: *Hair*, *Wool*, *Feathers*: *calcin'd Shells*: *Lees* of *Wine*, and of *Beer*: *Ashes* of all sorts of *Vegetable Bodies*: *Leaves*, *Straw*, *Roots*, and *Stubble*, turn'd into the *Earth* by *Plowing* or otherwise, to rot and *dissolve* there; *these* I say are our best *Manures*, and, being *Vegetable Substances*, when refunded *back* again into the *Earth*, serve for the *formation* of *other like Bodies*.

Not wholly to Confine our *Thoughts* to the *Fields*, let us look a while into our *Gardens*; where we shall meet with still further *Confirmations* of the same thing. The *Trees*, *Shrubs*, and *Herbs* Cultivated in *these*, after they have *continued* in one *Station* till they have *derived*

thence the greater Part of the *Matter fit* for their *Augment*, will *decay* and *degenerate*, unless either *fresh Earth*, or some *fit Manure*, be applied unto them. 'Tis true, they may *maintain* themselves *there* for some time by sending forth *Roots* further and further to a *great extent* all round, to fetch in *more remote Provision*; but *at last* all will fail: and they must either have a *fresh supply* brought to them, or they *themselves* be *removed* and *transplanted* to some Place *better furnished* with *Matter* for their *Subsistence*. And accordingly *Gardeners* observe that *Plants* that have *stood a great while* in a *Place*, have *longer Roots* than usual; part of which they *cut off* when they *transplant them* to a *fresh Soil*, as now not of any further *use* to them. All these *Instances*, to pass over a great many *others* that might be alledged, point forth a *Particular terrestrial Matter*, and not *Water*, for the *Subject* to which *Plants* owe their *increase*. Were it *Water only*, there would be no need of *Manures*: or of *transplanting* them from place to place. The *Rain* falls in all *Places* alike: in *this Field* and in *that* indifferently: in *one side* of an *Orchard* or *Garden* as well as *another*. Nor could there be any reason why a *Tract* of *Land* should yield *Wheat* one *Year* and not the next; since the *Rain* showers down *alike* in *each*. But I am sensible I have carried on *this Article* to too great a *length*: which yet on so *ample* and *extensive* a *Subject* 'twas not easy to avoid.

5. *Vegetables* are not form'd of *Water*: but of a certain *peculiar Terrestrial Matter*. It hath been shewn, that there is a *considerable Quantity* of this *Matter* contain'd both in *Rain*, *Spring*, and *River Water*: that the much greatest part of the *fluid Mass* that ascends up into *Plants* does *not settle* or *abide* there, but passes *through the Pores* of them and *exhales* up into the *Atmosphere*:  
that

that a *great part* of the *terrestrial Matter*, mixt with the *Water*, *passes up* into the *Plant* along with it: and that the *Plant* is more or *less augmented* in proportion as the *Water* contains a *greater* or *smaller Quantity* of that *Matter*. From all which we may very reasonably infer, that *Earth*, and not *Water*, is the *Matter that constitutes Vegetables*. The *Plant* in E drew up into it 2501 grains of the *Fluid Mass*: and yet had received but gr. 3 and a half of *Encrease* from all that. The *Mint* in L. tho' it had at first the disadvantage to be much less than that in I, yet being set in *Water* where-with *Earth* was *plentifully mix'd*, and that in I only in *Water* without any such *additional Earth*, it had vastly outgrown the other, weighing at last 145 gr. more than that did, and so having gain'd above twice as much as that had. In like manner that in K, tho' 'twas a great deal less when put in than that in I, and also was *impair'd* and *offended* by *Insects*, yet being Planted in *Water* wherein *Earth* was *dissolved*, whereas the *Water* in which I stood had *none*, it not only *over-took* but considerably *surpass'd* the other; weighing at last 29 gr. more than that in I, and yet had not expended *so much Water* as that by above 2400 gr. The *Plant* in N, tho' at first a great deal less than that in M, yet being set in the *foul crass Water* that was left in the *Still*, after that in which M was set was drawn off, in Conclusion had gain'd in weight *above double* what that in the *finer* and *thinner Water* had. The *Proportion* of the *Augment* of that *Plant* that *throve most* was, to the *Fluid Mass* spent upon it, but as 1 to 46. In *others* 'twas but as 1 to 60, 100, 200: nay in the *Cataputia* 'twas but as 1 to 714. The *Mint* in B took up 39 gr. of *Water* a day, one day with another; which was much more than the *whole weight* of the *Plant* originally: and yet with all *this* it gain'd not one fourth of a grain a day in *weight*. Nay

that in H took up 253 gr. a day of the *Fluid*, which was near *twice* as much as its *original Weight*, it weighing, when first set in the Water but 127 gr. And after all, the *daily encrease* of the *Plant* was no more than gr.  $2\frac{1}{8}$

6. *Spring and Rain-water contain pretty near an equal Charge of Vegetable Matter: River-water more than either of them.* The *Plants* in the *Glasses* A. B. and C. were at first of much the *same size and weight*. At the End of the Experiment the *Mint* in A had gain'd 15 gr. out of 2558 gr. of *Spring-water*: that in B gr. 17 and an half, out of 3004 gr. of *Rain-water*: but that in C had got 26 gr. out of only 2493. gr. of *River-water*. I do not found this Proposition *solely* upon *these Tryals*; having made *some more*, which I do not relate here, that agree well enough with these. So that the *Proportions* here delivered will hold for the *main*: but a *strict and just Comparison* is hardly to be expected. So far from it; that I make no doubt but the *Water* that falls in *rain*, at *some times*, contains a *greater share* of *terrestrial Matter* than that which falls at others. A more *powerful and intense Heat* must needs hurry up a *larger quantity* of that *Matter* along with the *humid Vapors* that form *rain*, than one more *feeble* and *remiss* ever possibly can. The *Water* of one *Spring* may flow forth with an *higher Charge* of this *Matter*, than that of another; this depending partly upon the *quickness* of the *Ebullition* of the *Water*: and partly upon the *Quantity* of that *Matter* latent in the *Strata* through which the *Fluid* passes, and the *greater or less laxity* of those *Strata*. For the same Reason the *Water* of one *River* may *abound* with it more than that of another. Nay the *same River*, when *much agitated* and in *commotion*, must bear up *more* of it, than when it *moves* with *less rapidity* and *violence*.  
That

That there is a *great quantity* of this *Matter* in *Rivers* : and that it *contributes* vastly to the *ordinary fertility* of the *Earth*, we have an illustrious Instance in the *Nile*, the *Ganges*, and *other Rivers* that *yearly overflow* the neighbouring *Plains*. Their *Banks* shew the *fairest* and *largest Crops* of any in the *whole World*. They are *even loaded* with the *multitude* of their *Productions* : and those who have not seen them will hardly be induced to believe the mighty *Returns* those *Tracts* make in comparison of *others* that have not the Benefit of like *Inundations*.

7. *Water serves only for a Vehicle to the terrestrial Matter which forms Vegetables : and does not it self make any addition unto them.* Where the *proper terrestrial Matter* is wanting, the *Plant* is not augmented tho' never so much *Water* ascend into it. The *Cataputia* in E took up *more Water* than the *Mint* in C, and yet had grown but very *little*, having received only three grains and an half of *additional weight* : whereas the other had received no *less* than twenty six grains. The *Mint* in I was planted in the same sort of *Water* as that in K was ; only the *latter* had *Earth* dissolved in the *Water* ; and yet *that* drew off 13140 gr. of the *Water*, gaining it self *no more* than 139 gr. in weight : whereas the other took up *but* 10731. gr. of *Water*, and was *augmented* 168 gr. in weight. Consequently *that* spent 2409 gr. more of the *Water* than *this* in K did, and yet was not *so much* increased in *Weight* as *this* by 29 gr. The *Mint* in M stood in the very *same kind* of *Water* as that in N did. But, the *Water* in M having *much less* terrestrial Matter in it than *that* in N had, the *Plant* bore up 8803 gr. of it, *gaining* it self only 41 gr. the while : whereas that in N drew off *no more than* 4344 gr. and yet was *augmented* 94 gr.. So that it spent 4459 gr.

of

of *Water* more than *that* did : and yet was not *it self* so much encreased in weight as *that* was by 53 gr. This is both a very *fair* and a very *conclusive* Instance : on which Account 'tis that I make oftner use of it. Indeed they are *all so* : and to add any thing further on *this Head* will not be needful.

'Tis evident therefore *Water* is not the *Matter* that composes *Vegetable Bodies*. 'Tis only the *Agent* that conveys that *Matter* to them : that *introduces* and *distributes* it to their several *Parts* for their *Nourishment*. That *Matter* is sluggish and *inactive* : and would lye eternally confin'd to its *Beds* of *Earth*, without ever *advancing up* into *Plants*, did not *Water* or some like *Instrument*, fetch it *forth* and carry it unto them. That therefore there is that plentiful *Provision* and vast *Abundance* of it supplied to *all Parts* of the *Earth* is a mark of a *natural Providence* superintending over the *Globe* we inhabit : and ordaining a due dispensation of that *Fluid*, without the *Ministry* of which the Noble *succession* of *Bodies* we behold, *Animals*, *Vegetables*, and *Minerals* would be all at a stand †. But to keep to *Plants* ; 'tis manifest *Water*, as well on this, as upon the other *Hypothesis*, is absolutely necessary in the *Affair* of *Vegetation* : and it will not *succeed* without it. *Which* indeed gave occasion to the *Opinion* that *Water it self* nourished, and was *changed* into *Vegetable Bodies*. They saw, tho' *these* were planted in a *Soil* never so *rich*, so *happy*, so *advantageous*, nothing came of it unless there was *Water* too in considerable quantity. And it must be allowed *Vegetables* will not *come on* or *prosper* where *that* is wanting : But yet what *those Gentlemen* inferr'd *thence* was not, we see, well grounded.

This *Fluid* is capacitated for the *Office* here assign'd it several ways. By the *Figure* of its *Parts* ; which, as appears from many *Experiments*, is exactly and mathematically

† *Conf. Nat. Hist. Earth,* p. 47. & seq. uti & p. 128, &c.

matically *Spherical*; their *surfaces* being perfectly *po-  
lite*, and without any the least *inequalities*. 'Tis evi-  
dent, *Corpuscles* of such a *Figure* are *easily susceptible*  
of *Motion*, yea far above *any others* whatever: and con-  
sequently the most capable of *moving* and *conveying* other  
*Matter* that is not so *active* and *voluble*. Then the *In-  
tervalls* of Bodies of that *Figure* are, with respect to their  
*Bulk*, of all others the *largest*: and so the most fitted  
to *receive* and *entertain* foreign *Matter* in them. Be-  
sides, as far as the *Tryals* hitherto made inform us, the  
*Constituent Corpuscles* of *Water* are each singly confi-  
der'd *absolutely solid*: and do not *yield* to the greatest  
*external Force*. This secures their *Figure* against any *Al-  
teration*: and the *Intervalls* of the *Corpuscles* must be al-  
ways alike. By the *latter* 'twill be ever disposed to *re-  
ceive Matter* into it: and by the *former*, when once *re-  
ceived*, to *bear* it on along with it. *Water* is further ca-  
pacitated to be a *Vehicle* to this *Matter*, by the *tenuity*  
and *fineness* of the *Corpuscles* of which it *consists*. We  
hardly know any *Fluid* in all *Nature*, except *Fire*, whose  
*constituent Parts* are so exceeding *subtil* and *small* as  
those of *Water* are. They'll pass *Pores* and *Interstices*  
that neither *Air* nor any other *Fluid* will. This enables  
them to enter the *finest Tubes* and *Vessels* of *Plants*, and  
to introduce the *terrestrial Matter*, conveying it to *all*  
*Parts* of *them*; whilst each, by means of *Organs* 'tis  
endowed with for the purpose, *intercepts* and *assumes* in-  
to it self such *Particles* as are suitable to its own *Nature*,  
letting the *rest* pass on through the *common Ducts*. Nay  
we have almost every where *Mechanical Instances* of  
much the *same Tenor*. 'Tis obvious to every one how  
*easily* and *suddenly Humidity*, or the *Corpuscles* of *Wa-  
ter* sustained in the *Air*, pervade and *insinuate* themselves  
into *Cords*, however tightly twisted: into *Leather*, *Parch-  
ment*, *Vegetable Bodies*, *Wood*, and the like. This it is  
that

that fits them for *Hygrometers*: and to *measure* and determine the different *quantities* of *Moisture* in the *Air*, in different *Places* and *Seasons*. How freely *Water* *passes* and carries with it *terrestrial Matter*, through *Filters*, *Colatures*, *Destillations*, &c. hath been intimated already.

8. *Water* is not capable of performing this Office to *Plants*, unless assisted by a due Quantity of *Heat*: and this must concur or *Vegetation* will not succeed. The *Plants* that were set in the *Glasses* Q. R. S. &c. in *October* and the following *colder Months*, had not near the quantity of *Water* sent up into them, or so great an additional *Encrease* by much as those that were set in *June*, *July*, and the *hotter*. 'Tis plain *Water* has no power of moving it self: or rising to the vast height it does in the more tall and lofty *Plants*. So far from this, that it does not appear from any *Discovery* yet made, that even its own *Fluidity* consists in the intestine *Motion* of its *Parts*; whatever some otherwise very *Learned* and *Knowing Persons* may have thought. There's no need of any thing more, for solving all the *Phænomena* of *Fluidity*, than such a *Figure* and *Disposition* of the *Parts*, as *Water* has. *Corpuscles* of that make, and that are all absolutely *Spherical*, must stand so very tickle and nicely upon each other, as to be susceptible of every *impression*: and, tho' not perpetually in *Motion* yet must be ever ready and liable to be put into it, by any the slightest *Force* imaginable. It is true, the *Parts* of *Fire* or *Heat* are not capable of moving themselves any more than those of *Water*: but they are more subtil, light, and active, than those are, and so more easily put into *Motion*. In fine, 'tis evident and matter of *Fact* that *Heat* does operate upon and move the *Water*, in order to its carrying on the *Work* of *Vegetation*: but how 'tis agitated it self,



*self*, and where the *Motion* first begins, this is no fit *Place* to enquire.

That the Concourse of *Heat* in this *Work* is really necessary, appears, not only from the *Experiments* before us, but from *all Nature* : From our *Fields* and *Forests*; our *Gardens* and our *Orchards*. We see in *Autumn*, as the *Suns Power* grows gradually *less* and *less*, so its effects on *Plants* is *remitted*, and their *Vegetation* *slackens* by little and little. Its *Failure* is first discernible in *Trees*. These are *raised* highest above the *Earth* : and require a more *intense Heat* to *elevate* the *Water*, charged with their *Nourishment*, to the *Tops* and *Extremities* of them. So that for want of *fresh support* and *Nutrimment* they shed their *Leaves*, unless secured by a very *firm* and *hardy Constitution* indeed, as our *ever-Greens* are. Next the *Shrubs* part with theirs : and then the *Herbs* and *lower Tribes* ; the *Heat* being at length not sufficient to supply even *these*, tho' so near the *Earth* the *Fund* of their *Nourishment*. As the *Heat* returns the succeeding *Spring*, they all recruit again : and are furnish'd with *fresh supplies* and *verdure*. But first those which are *lowest* and *nearest* the *Earth*, *Herbs*, and they that require a *lesser degree* of *Heat* to raise the *Water* with its *Earthy Charge* into them. Then the *Shrubs* and *higher Vegetables* in their turns : and lastly the *Trees*. As the *Heat* encreases, it grows *too powerful*, and hurries the *Matter* with too great *rapidity* thro' the *finer* and more *tender Plants*. *These* therefore *go off*, and decay : and others that are more *hardy* and *vigorous*, and require a greater *share* of *Heat*, succeed in their *Order*. By which *Mechanism* *provident Nature* furnishes us with a very various and differing *Entertainment* : and what is *best suited* to each *Season*, all the *Year* round.

As the *Heat* of the *several Seasons* affords us a *different Face of Things*; so the *several distant Climates* shew *different Scenes* of Nature, and *Productions* of the *Earth* \*. The *Hotter Countries* yield ordinarily the *largest and tallest Trees*: and those too in much greater *variety* than the *colder* ever do. Even those *Plants* which are *common to both*, attain to a much *greater Bulk* in the *Southern* than in the *Northern Climes*. Nay there are some *Regions* so *bleak and chill*, that they raise no *Vegetables* at all to any *considerable size*. This we learn from *Groenland*, from *Island*, and other *Places* of like *cold Site* and *Condition*. In these no *Tree* ever appears: and the very *Shrubs* they afford are *few, little, and low*.

Again, in the *warmer Climates*, and such as do furnish forth *Trees* and the *larger Vegetables*, if there happen a *remission* or *diminution* of the *usual heat*, their *Productions* will be *impeded* and *diminished* in *Proportion*. Our *late Colder Summers* have given us *Proof* enough of this. For tho' the *Heat* we have had was sufficient to raise the *Vegetative Matter* into the *lower Plants*, into our *Corns*, our *Wheat*, *Barley*, *Pease* and the like: and we have had plenty of *Strawberries*, *Rasberries*, *Currans*, *Goosberries*, and the *Fruits* of such other *Vegetables* as are *low and near the Earth*: Yea and a moderate store of *Cherries*, *Mulberries*, *Plums*, *Filberts*, and some others that grow at a somewhat greater *Height*;

yet our *Apples*, our *Pears*, *Walnuts*, and the *Productions* of the *taller* † *Trees* have been *fewer*, and those not so *kindly*, so *thorowly ripen'd* and brought to that *Perfection* they were in the former more *benign* and *warm Seasons*. Nay even the *lower Fruits* and *Grains* have had some

\* *Conf. Nat. Hist. Earth. Pag. 267. & seq.*

\* *The Dwarf Apple and Pear-Trees have succeeded better. And indeed in Trees of the same Kind, those that keep closest to the Earth always produce the most and best Fruit. For which Reason 'tis that the Gardiners check and restrain the Growth of their better Fruit-Trees: and prevent their running up to too great a Height.*

some share in the Common Calamity : and fallen short both in *Number* and *Goodness* of what the *hotter* and kinder *Seasons* were wont to shew us. As to our *Grapes*, *Abricots*, *Peaches*, *Nectarins*, and *Figs*, being transplanted hither out of *hotter Climes*, 'tis the less wonder we have of late had so general a *Failure* of them.

Nor is it the *Sun*, or the ordinary emission of the *Subterranean heat* only, that promotes *Vegetation* : but *any other* indifferently, according to its *Power* and *Degree*. This we are taught by our *Stoves*, *Hot Beds*, and the like. All *Heat* is of like kind : and where-ever is the same *Cause*, there will be constantly the same *Effect*. There's a *Procedure* in every *Part* of *Nature*, that is perfectly *regular* and *geometrical*, if we can but find it out : and the further our *Searches* carry us, the more shall we have *Occasion* to *admire* this, and the better 'twill *compensate* our *Industry*.