

*A further Account concerning the Existence of Veins in all kind of Plants; together with a Discovery of the Membranous substance of those Veins, and of some Aërs in Plants resembling those of Sense; as also of the Agreement of the Venal Juice in Vegetables with the Blood of Animals, &c. Communicated by Mr. Lister in a Letter of Januar 8. 1672. and exhibited to the R. Society.*

SIR,

WE have formerly given you certain reasons for the Existence of *Veins*, (analogous to those in Animals) in all Plants whatsoever, not Mushromes excepted: To which we might add others of later notice; as the skin of a plant may be cut sheer off with part of the spongy *parenchyma*, and no signs of Milky juice follow, that is, no breach of a vein. Again, we have stript the Plant of its skin, by pulling it up by the roots, and exposing it to the wet weather, untill it became flaccid as a wet thong, without any injury to the Veins, which yet upon incision would freshly bleed. These Experiments, I say, make against the general opinion of one only sap loosely pervading the whole plant, like water in a sponge.

And though we have made these and many other Experiments to facilitate an ocular demonstration of these Veins; yet we have not been able to effect it to our mind, and subject them as nakedly to our eye as we could wish, for a through-information of their Use, and a minute and accurate discovery of all the particular Accidents belonging to them as such vessels. This, I say, is a work of much labour and patience; and that which renders matters very difficult, is the infinite number, smallness and perplexity of these Plants.

In the Transverse cuts of Plants, we see as it were a certain Order and Number of the bloody orifices of dissected veins. We observe also in a Leaf, which we take to be the simplest part of a plant,

1. That

1. That the Veins keep company with the Ribbs and Nerves (as we vulgarly call them,) and are distributed into all the parts of the Leaf, according to the subdivisions of those nervous lineaments, and are disposed with them into a certain net-work; whether by Inosculations or bare contact only, we pretend not to determine.

2. That in a Transverse cutt of a Leaf, the middle Fibre or nerve, for example, seems to yield one big drop of a Milkie juice, springing as it were from one vein; yet the Microscope plainly shews us, that there are many veins which contribute to the making up of that drop.

3. That if a Fibre or nerve be carefully taken out of the Leaf, the Veins will appear in it like so many small hairs or pipes running along and striping the nerve.

4. That those many veins are all of an equal bigness, for ought we have yet discerned to the contrary.

5. That though we seem to be more certain of the ramifications of the Fibres, wherein those veins are, we yet are not so, that those veins do any where grow less and smaller, though probably it may be so. That which makes us doubt it, is the exceeding smallness of these veins already, even where we might probably expect them to be Trunk-veins and of the largest size; and being there also in very great Numbers and running in direct lines along the fibre, we guess, that one or more of them may be distributed and fall off on either hand with the subdivisions of the fibres, and not suffer any diminution in their bulk.

6. That we cannot discern any where throughout the whole plant larger or more capacious veins, than those we see adhering to the fibres of the Leaves; which do also appear from comparing the bleeding Orifices in a transverse cutt. I have found it a difficult and laborious task, to trace and unravel them throughout the whole plant.

Our opinion is, that these Veins do still keep company with their respective Fibres. And as all the Fibres of the Leaf are joined in the Stalk of the Leaf, and that stalk ex-

plicated in cloathing the Twig or Stem of the plant, (which we take to be the reason of the orderly breaking forth of the Leaves,) so do we think of the Veins, their perpetual companions. And, as we have said, the Fibres of the Leaves are joined in the Twigs; so are those of the twigs in the Branches; those of the branches in the Trunk or body of the tree: The like also in an inverted order we seem to observe in the several Coats and Ramifications of the Root. This the several Circles of bleeding Orifices in transverse cuts seems to confirm.

But moreover in the Roots of plants, if a simple Coat be separated and exposed betwixt your eye and the light, the Veins appear to be strangely intangled and implicate, and not in the same simple order as in the Leaves. The like we think of the Bark of the bodies of Trees, which we cannot distinguish from the Roots of plants; though there is, indeed, something (at least at certain seasons of the year) in the Root, which is not to be found in any part of the plant besides.

From what hath been said, it may well be doubted, whether there is any *funus* or common Trunk, into which all the veins are gathered? But rather, that there are a multitude of equally big veins, each existing apart by it self. We indeed have found it very difficult so to exhaust the plant of its milkie juice, as to kill it, though we have given it very many incisions to that purpose. Divers other instances there are, which favour the Discontinuance of the Veins, and the little relation and intercourse they have with one another; as one branch of a Tree having fair and well grown fruit, before the other branches of the same tree and fruit blossom or have leaves; from the different situation and other circumstances of culture; the indefinite and perpetual growth of a Tree; the Cyon governing, &c.

And thus far we have taken our information concerning these Veins, partly by the appearance they make in transverse cuts, and partly by the help of a Microscope; which last indeed has shewed us something of their number, mag-

magnitude, order, distributions, &c. And yet neither of these helps in our hands has satisfactorily discovered to us other particulars belonging to these vessels, as external Figure, Coats, Cavities, &c.

The substance of these veins seems to be as truly *Membranous*, as the Veins of Animals: A Leaf will not give way and be extended, but the Veins in a leaf, if freed of all the woody Fibres, will be stretched out to one third part at least, and vigorously restore themselves again, just like a Vein, Gut, or any other membranous *ductus* of an Animal. Again these membranous Pipes are exceeding thin and transparent, because they suddenly disappear and subside after their being exhausted of their Juice; and particularly in that we see the liquor, they hold, quite through them, no otherwise than the blood through our Veins, or (in *Cheledonium majus*, for example) a tincture of Saffron in Crystalline Pipes.

Concerning the External Figure of these Veins and Cavities, as well as other Accidents, we thought, they would have been made more apparent to us, if it were possible to coagulate the Juice they hold without much shrinking the plant. We were in great hopes, *Freezing* would have effected this; which though it did not succeed as we promised our selves, in respect of the manifestation of these Accidents; yet it gave us some further light into the nature of the Juice of these veins. In the keenest frost, which hapned the other winter, we dissected the frozen leaves of the *Garden Spurge*. Here we observed, that all the Juice (besides that which these veins hold) was, indeed, frozen into perfect hard Ice, and to be expressed out in the figure of the containing pores; but the Milkie-Juice was as liquid as ever, but not so brisk as in open weather.

This Experiment we take to be good proof of the perfection of this Milkie Juice, and that it hath within it self so great a degree of fermentation, that it preserves it self and consequently the whole plant from the injuries of the weather; that is, the plant owes its life to it. Thus we have seen

seen Insects (as *Hexapoda*-worms, &c.) ly frozen upon the snow into very lumps of Ice, which did not only cause the glass to ring we struck them against, but did endanger the breaking of it: And yet, put under the glass and exposed to the warmth of the fire, they quickly recovered their legs and vigour to escape; which we think could not be, unless the Vital liquor of their veins, as in this Instance of plants, had been untouched and little concerned in the frost. Further, we hence also argue the different *Uses* as well as *Natures* of these Juices, and look upon the frozen Icicles or that copious dilute and Limpid sap as *Alimental*; the Milkie and not frozen Juice, as the only proper *Venal*.

As to the motion of these Juices, these things are certain;

1. That the *Milkie* Juice alwaies moves and springs briskly upon the opening of a vein; the *Limpid* sap but at certain seasons, and as it were by accident, and not (as I judge) from any vital principle or fermentation of its own.

2. The *venal* juice hath a manifest intestine motion or fermentation within it self; witness (besides what hath been just now said of it) its contributing (and the long continuance of) that motion to the most insensible of liquors; and likewise its thick and troubled bleeding, like the rising of yeast, which yet in a few hours after drawing falls, and the juice becomes transparent, as the Gum of the *Virginian Rhus*, &c.

I shall not desire any person to acquiesce wholly in a bare fermentation; but endeavour a happy discovery of the *Frame* of *all* the parts of a plant, on which perhaps this motion may much depend. In the mean time we must indeed needs think (according to the knowledge we yet have of the parts of plants,) that these juices move by a far different contrivance of parts from that of Animals; not yet here discovering any uniting of veins into one common Trunk, no Pulsation, no sensible stop by ligature, no difference in veins, &c. All which difficulties notwithstanding may, I hope, in time be happily overcome; and the Analogie betwixt Plants and Animals be in all things else,

as

as well as the motion of their juice, fully clear'd.

There seem to be in Plants manifest Acts of *Sense*. We instance in the suddain shrinking of some Plants; the frequent closing and opening of flowers; the critical erecting of the heads of Poppies from a pendulous posture, and particularly the *Vermicular* motion of the veins when exposed to the air. Again, the Veins of Plants may indeed be different, though at present we cannot tell wherein they are so. The Arteries within our heads are hardly to be known by the eye from the Veins. Further there are natural and spontaneous excretions or venting of superfluous moisture in plants, visible and constant, in the *Crown Imperial*, *Rorella*, *Pinguicula*, &c. As to the Ligature, as it hath been hitherto applied by us, it is not to be relyed on for the discovery of this motion; the Veins only of plants being the parts probably distendable.

Lastly we shall not omit to tell you, that either we must take that away from the other reasons given of the necessity of the Circulation of the blood in Animals, *viz* the hindring of its breaking and clodding; or we must grant the same motion to the *Venal* juice in Plants: we having undeniable Experiments to shew, that the Venal juice of Plants and the *Blood* of Animals agree in this, that they both, when they are once drawn from their respective veins, do forthwith break and coagulate, and that the *serum* in the one as well as in the other becomes a stiff gelly by a little standing.

But of the different natures of the juices of these veins in divers Plants and their motion we will remain your debtor, and acquit our selves when we shall find it convenient; at present only acquainting you, what variety of Experiments hath taught us, that probably more useful preparations and certainly a truer Analysis and separation of the parts of vegetable Drugs may be effected, whilst they are in bleeding and liquid, than after they are once become concrete and have lost their natural Fermentation.

I am, &c.

The