PHILOSOPHICAL TRANSACTIONS.

April, 17. 1671.

The CONTENTS.

Extracts of divers Letters, Written by Martin Lister *Esquire, to the Publisher; Touching some Inquiries and Experiments of the* Motion of Sap *in Trees, and relating to the Question of the* Circulation *of the same.*

1. *Januar.* 28. 167⅔. *York.*

YOu may be pleased to put this *Quærie* also, concerning the Bleeding of the *Sycamore*: What condition

the Soil is of, where ſuch Trees are planted, that ſhall either bleed, or refuſe to do ſo: whether Sandy, as that of *Nottingham*, or a wet Clay, as that of the two Trees, I have obſerved here at *York*. *

* Of both which, ſee this *Obſervers* Experiments formerly communicated, *No.* 68. *p.* 2067, 2068.

2. *Febr.* 8. 167$\frac{0}{1}$. *York*.

Concerning the Bleeding of the *Sycamore*, be pleaſed that I acquaint you with the following Experiment of very late date. The firſt inſtant it froze, the wind at North; the Froſt and Wind continued (ſome little Snow now and then falling) the 2d, 3d, 4th, 5th, 6th, until the 7th in the morning, when the wind came about to the South-Eaſt, and the weather broke up a pace, the *Sycamores* bled not all this while; but the ſeventh about noon, all Trees of that kinde bled very freely both at the Twigs and Body, and I ſtruck above a dozen.

At this ſame Critical ſeaſon, I was willing to repeat the Experiment upon other Trees, and to this end I forthwith ſtruck the *Haw-thorn*, *Hazel*, *Wild-Roſe*, *Gooſeberry-Buſh*, *Apple Tree*, *Cherry-Tree*, *Blather-Nut*, *Apricock*, *Cherry-lawrel*, *Vine*, *Wal-nut*; yet none bled but the laſt nam'd, and that but faintly in compariſon of the *Sycamore*. This is conſonant to our former Experiments: And if it did happen, as I ſaid in one of my former Letters *, that theſe *Sycamores* bled not all this Winter afore at the wounds made the firſt of *November*, I do now think, that if new wounds had been ſtill made at every breach of Froſt, ſome ſignes at leaſt of our *York-ſhire* bleeding *, might have been diſcovered before now: But I affirm no more than I have ſeen and tried.

* See *No* 68. *p.* 2068.

* See the ground for this diſtinction in the ſame *Numb.* 68. *p.* 2067, 2068.

In all the Monuments of the Ancients, collected by the great induſtry of *Pliny*, I finde but few inſtances of this nature. Amongſt thoſe few there is one, that is regiſtred with two or three remarkable circumſtances to our purpoſe. He tells us, that the *Phyſicians* of old, when they had a mind

a mind to draw the juyce of the *Mulberry-tree*, were wont to ſtrike it skin-deep only, and that about two hours after Sun-riſe. This Experiment is twice mention'd by him, and in both places as a ſtrange *Phœnomenon*. We might make our Comment upon thoſe places, but for this time are content only to tranſcribe the Texts. *Lib.* 16. *cap.* 38. *Mirum, hic (cortex) in Moro, Medicis ſuccum quærentibus, ferè horâ diei ſecundâ, lapide incuſſus manat, altius fractus ſiccus videtur.* Lib. 23. c. 7. *Mora in Ægypto & Cypro ſui generis, ut diximus, largo ſucco abundant, ſummo cortice deſquamato; altiore plagâ ſiccantur, mirabili naturâ.*

3. *Febr.* 15. 167$\frac{0}{7}$. *York.*

To continue our Experiments concerning the motion of the Sap in Trees; *Febr.* 11th, all was here cover'd with a white Froſt betwixt 9 and 11 in the morning. The weather changing I made the Experiments, which follow, upon the *Sycamore*, *Walnut*, *Maple*. A twig cut aſunder would bleed very freely from that part remaining to the Tree; and, for the part ſeparated, it would be altogether dry and ſhew no ſigns of moiſture, although we held it ſome prety time with the cut end downwards; But, if this ſeparated twig was never ſo little tipp'd with a knife at the other end, it would forthwith ſhew moiſture at both ends. The ſame day, late in the after-noon, the weather very open and warm, a Twig cut off in like manner as in the morning, would ſhew no moiſture at all from any part. Theſe Experiments we repeated very many times with conſtant and like ſucceſs on all the Trees above-mentioned. I enter'd this Experiment with theſe *Quæries* for the next opportunity. 1. Whether a Twig, or the ſmall part of a Root cut aſunder, will not bleed faſter, upon the breaking up of a Froſt, from the part remaining to the Tree, than from the part ſeparated; and whether the part ſeparated will bleed at all, and ſhew no more ſignes of moiſture, than a Twig cut from the top of the Tree, unleſs that ſmall Root be likewiſe cut off at the other end alſo? 2. Whether when it ſhall happen, that a *Sycamore* ſhall be found to bleed upon the ſetting in of a great Froſt, the top

twigs and ſmall roots will not both of them bleed freelier from the parts ſeparated, in proportion to their bigneſs? 3. And if it ſhall not ſo prove in the Tryal, that in cold weather the Sap moves *inwards* from Root and Branch to the Trunk, and that upon the breaking of a Froſt, the Sap moves *outward* from the Trunk to the extremities of both Root and Branch; I ſay, if this prove not ſo, whether there be any different motions of Sap at a time in the divers parts of one and the ſame Tree; and where ſuch motions of Sap begin, and whither they tend? 4 Whether the Sap, when it will run, moves longer in the Branches than in the Roots; or whether it begin not to move in all parts of a Tree at a time, and reſt every where at a time? 5. When it reſts, whether it retires to the Body of the Tree, from the Roots and Branches, or ſinks down to the Root, or is any way ſpent by inſenſible ſteams, or is quiet and lodged in every part of the Tree in proportion?

I ſhall long to hear the ſucceſs of your Experiments in the Queſtion of the *Circulation* of the Sap. I have many years been inclin'd to think, that there is ſome ſuch motion in the Juyces of Vegetables. The reaſons which induced me, are; 1. Becauſe I finde, that all the Juyce of a Plant is not extravaſate and looſe, and like Water in a Spunge; but that there are apparent Veſſels in Plants, analagous to Veins in Animals: which thing is moſt conſpicuous and clear in ſuch Plants, whoſe Juyce is either White or Red, or Saffron-colour'd; for inſtance, in each kind of Juyce we propoſe *Lactuca*, *Atractilis*, *Chelidonium majus*. 2. Becauſe that there are very many Plants (and theſe laſt named are of the number) whoſe Juyce ſeems never to be at reſt, but will ſpring at all times freely, as the Blood of Animals, upon Inciſion.

The way of Ligature by Metalline Rings, by you mention'd, is an Expedient I have not uſed; but other Ligatures I have, upon a great number of our Engliſh Plants, not without the diſcovery of many curious *Phœnomena*. The ſucceſs of an Experiment of this Nature upon *Cataputia minor Lobel.* was as followes: I tied a ſilk-thread upon one

one of the Branches of this Plant, as hard as might be, and not break the skin; there follow'd no greater ſwelling, that I could diſcern, on the one ſide of the ſilk than on the other; although in often repeating the Experiment, ſome ſilks were left hours and dayes unlooſed, and yet the dimple which the thread had made in the yielding branches, had a little raiſed the immediate ſides, but both alike: the Plant in like manner would bleed very freely both above and under the Tye. This was alſo, I thought, very remarkable, amongſt other things, in this Experiment, that in drawing the Raſour round about the branch juſt above or below the Tye, the Milky Juyce would ſuddenly ſpring out of infinite ſmall holes, beſides the made orifice, for more than half an inch above and below the Tye: which ſeems to argue, that though there was no Juyce intercepted in appearance from any turgeſcence, (as in the proceſs upon the members of a Sanguineous Animal) yet the Veins were ſo over-thronged and full, that a large orifice was not ſufficient to diſcharge the ſudden *impetus* and preſſure of a ſome-ways ſtreighten'd Juyce.

I have endeavour'd many wayes to diſcover the Configuration of the Veins of Vegetables and their other conſtituent parts and Texture; but enough of this in one Letter.

4. *March* 17. 167$\frac{6}{7}$. *York.*

To the end that I might ſatisfie my ſelf about ſome of the doubts I ſent you, I have been moſt concern'd, according to former thoughts and inclinations, in examining the Truth of theſe Quæries, *viz. Whether Saps are not to be found at all ſeaſons of the Year in a much like Conſiſtence and Quantity in the reſpective parts of a Vegetable; and what Communication one part of a Plant may have with another in relation to the Aſcent and Deſcent of Sap?*

Now, becauſe Sap is then ſaid to Aſcend from the Root, when it is found to move in Tapping; I lopp'd off certain Branches of a *Sycamore*, the morning betimes of a hard Froſt (*Febr.* 21.) before they would bleed, or ſhew any ſigne of moiſture. This I did to vary the *Effecient*, not willing to wait the Change of the Weather, and the *Suns* heat;

heat; but brought them within the Air of the *Fire*: And by and by, as I expected, they bled apace, without being ſenſibly the warmer.

The Experiment repeated afforded me divers *Phænomena*, which follow; and proved *almoſt* an Univerſal way of Bleeding all ſorts of Trees, even thoſe, which of themſelves would not ſhew any ſignes of moiſture.

1. Poles of *Maple*, *Sycamore* and *Walnut*, cut down in open weather, and brought within the warmth of the Fire, did bleed in an inſtant. Alſo *Willow*, *Hazel*, *Cherry*, *Wood-bind*, *Blather-nut*, *Vine*, *Elder*, *Barbery*, *Apple-tree*, *Ivy*, &c. *Whicking* and *Egge-berry* Tree (i.e. *Padus Theophraſti*) tried in the ſame manner in *Craven*.

2. *Briar* and *Rasberry-rods* were more obſtinate. *Aſh* utterly refuſed, even heated hot.

3. Branches, that is, Poles with their tops entire and uncut, bleed alſo when brought to the Fire ſide; but ſeem not ſo freely to drink up their Sap again when inverted, as when made Poles.

4. The ſame *Willow-Poles*, left all night in the graſs-ſpot, and return'd the next day to the Fire-ſide, bleed afreſh.

5. *Maple* and *Willow-Poles* bleed and ceaſe at pleaſure again and again, if quickly withdrawn and balanced in the hand, and often inverted to hinder the Falling and Expence of Sap: Yet being often heated, they will at length quite ceaſe, though no Sap was at any time ſenſibly loſt. And when they have given over bleeding, that is, ſhewing any moiſture, by being brought within the warmth of the Fire, the Bark will yet be found very full of Juyce.

6. An hard Ligature made within a quarter of an inch of the end of a *Wood-bind* rod, did not hinder its bleeding at all when brought within the warmth of the Fire.

7. *Maple* and *Willow-Poles*, &c. quite *bared* of *Bark*, and brought to the Fire, will ſhew no moiſture at all in any part.

8. One *Barbery*, or *Pipridge-pole* bared of its Bark, brought to the Fire, did ſhew moiſture from within the more inward Circles, though not any from the outward.

9. *Maple* and *Willow-poles*, &c. *half* bar'd of Bark, woud bleed

bleed by the Fire, from the half onely of thoſe Circles, which lay under the bark.

10. *Maple* and *Willow-poles*, ſplit in two and planed, would not ſhew any moiſture on the planed ſides, but at the ends only.

11. A Pole of *Ivy* did of it ſelf exudate and ſhew a liquid and yellowiſh roſin from the bark and near the pith; but when brought to the Fire-ſide, it bled a dilute, thin and colour-leſs Sap from the intermediat wood Circles.

12. A Pole of *Willow* (for Example) bent into a bow, will ouſe its Sap freely, as in bleeding either ſpontaneouſly or by the Fire.

Extract of a Letter, Written to the Publiſher by Francis Willoughby *Eſq; from his Houſe at* Middleton *in* Warwickſhire *March* 16. 167$\frac{6}{7}$. *relating to ſome particulars, above mention'd in M.* Lyſter's *Communications of* Feb. 15. 167$\frac{6}{7}$.

SIR, My buſineſs and want of time to proſecute Experiments, I hope will plead my excuſe for not anſwering yours of *Feb.* 18. ſooner. Since that, we have review'd our old notes, and made ſome few Experiments, and finde, that Branches of *Willow*, *Birch*, and *Sycamore*, cut off and held perpendicularly, will bleed *without tipping*; and that the cuting off of their tops does not ſenſibly promote the bleeding. We have not yet made trial in *Maple* and *Walnut*, the weather having been ſuch, that thoſe Trees have not run freely ſince the receipt of your Letter. We doubt not of Mr. *Lyſter*'s diligence and veracity, and wonder, our Experiments ſhould differ*. The Trials we have made this year, confirm thoſe we communicated to you formerly, *viz.* The *Sycamore* bleeds upon the firſt conſiderable Froſt, after the Leaf is fallen, as it did plentifully the 16th of *November* laſt: And both that, *Walnut* and *Maple* bleed all Winter long after froſts, when the weather relents, and the Sun ſhines out; but *Walnut* and *Maple* begin not ſo ſoon as the *Sycamore*. The *Birch* will not bleed till towards the Spring. This year it began ſomething ſooner than ordinary about the beginning of *February*.

* See this difference removed below, by Mr. *Liſter* himſelf.

We

We cut off pretty big branches of *Birch*, and, having tipp'd the ends, inverted them, and faſten'd a *Limbus* or ring of ſoft wax to the *great* ends, which we held upwards; making with the plane of the end a Veſſel of about an inch deep, where-into we powred water, which in a few minutes ſunk into the pores of the wood, and running quite through the length of the branch, dropp'd out of the ends conſiderably faſt, continuing ſo to do as long as we powr'd on water. The like Experiment we made by faſtening ſuch rings of wax to the *leſſer* ends, and powring in water, which run through the wood, and dropp'd out of the greater ends, as faſt or faſter. This we tried once upon a *Sycamore* without ſucceſs.

Extract of a Letter of the above-mentioned Mr. Liſter, *written to the Publiſher from* York, *April* 8. 1671. *both in relation to the further Diſcovery of the Motion of Juyces in Vegetables, and removing the difference noted in the next fore-going Letter.*

SIR, Yours of the 4th inſtant came ſafe to my hands. This laſt Month hath been a buſie time with me in my private concerns, ſo that I have but a few things to return to what you have been pleaſed to communicate to me, in relation to the further diſcovery of the Motion of Juyces in Vegetables. And I muſt acquaint you, that theſe Notes following are above 14 dayes old; for I have ſcarce buſied my head, or put my hand to any Experiment of later date.

One or both ends of the pith of a *Willow-pole* ſeal'd up with hard wax, will yet freely bleed by the warmth of the Fire. This was tried, when the laſt Experiments, I ſent you, were; and were then, I think, omitted.

March 24th. was the greateſt Froſt and Snow we have had this Winter in theſe parts about *York*. Some Twigs and Branches of the very ſame *Willow-tree*, as formerly, and likewiſe of many other Willow-trees, taken off this morning. *March* 25th, when brought within the Air of the Fire, would ſhew no moiſture at all; no not when heated warm, and often and long turn'd.

March 24th, the ſame *Willow-branches*, which yeſterday would not bleed, and were thrown upon the Graſs-ſpot all night

night; did, both they and others, new cut down by the Fire-ſide, freely ſhew moiſture and bleed this morning upon the breaking up of the Froſt.

Aſh-poles and *branches* this day, nor yeſterday, would by the Fire be no more moiſt, than when I formerly tried them.

The ſame morning *March* 23th, a Twig of *Maple*, which had had the top cut off the 7th of *February* laſt paſt, and which then bled, this day being quite taken off from the Tree, and brought within the Air of the Fire, and held with the formerly cut-end downwards, did not run at all at the end, but held on in that poſture, it did run apace at the other new-cut end uppermoſt, ſo as to ſpring and trickle down.

Note, That this doth well agree with my Experiments made the laſt year at *Nottingham*, where I obſerv'd wounds of ſome months ſtanding to bleed apace at the breaking up of every hard Froſt. For *firſt*, in theſe parts there hath been no hard Froſt this year, not comparable to the laſt year. *Again*, thoſe *Nottingham*-trees I wounded in the Trunk, and they ſtood againſt a Brickwall, and the wounds were on the ſide next it; and beſides had Horſe-dung ſtopp'd in all of them for ſome reaſons; which things did undoubtedly defend them much from the Air and Winds, and keep the wounds ſtill green and open: Whereas the tops of theſe *Maple-twiggs*, ſpoken of in the laſt Experiment, were expos'd in an open hedge to the Air and Winds; as alſo the two *Sycamores* here at *York*, mention'd in my *former* Letter to have been wounded in *November* laſt, and not to have ſhew'd any ſignes of moiſture, for that very cauſe, that they were not freſh ſtruck at Bleeding times.

Concerning the Bleeding of *Poles* and entire Branches held perpendicular, Mr. *Willoughby* is in the right, and ſome Experiments in my laſt to you of *March* 17th confirm it. Yet it is very true what I obſerv'd, though the Cauſe I did not then well take notice of, when I firſt made the Experiment and ſent you an accompt of it. For, I held the Twigs, which I had cut off, a ſlope, joyning and holding up the cuts together in my left hand, that I might the better obſerve, which part or cut would bleed or not bleed the faſter; and becauſe I found, that the cut of the ſeparated Twig did not in that poſture (holding it upwards, as I ſaid, for the advantage of my eye) bleed at all, when as the Cut of the Branch remaining to the Tree did freely bleed;

I therefore inverted the ſeparated Twig and held it perpendicular with the cut end downward, and found, that that little they were expos'd to the Air in an upright poſture, had ſo very much check'd the motion of the Sap, that I concluded they would not bleed at all; and yet ſtriking off their tops, and making Poles of them, I found ſome of them, if not all, that I chanc'd to try, as I remember, would ſhew moiſture: But I am convinced ſince, that it was rather ſome unheeded accident, as violently bending them, or perhaps the warmth of my hand and ſeaſon, or place, which cauſed this new motion of Sap, than meerly the ſtriking off their Tops.

Some Communications, about an early Swarm of Bees, *as alſo concerning Cyder; Deſcent of Sap; the Seaſon of Tranſplanting Vegetables: Sent to the Publiſher out of* Herefordſhire *by that Intelligent Gentleman,* Richard Reed *Eſq; in a Letter dated March* 14. 167⅞. *at* Lugwardine.

ON Thurſday laſt, the 9th of Inſtant, there was at the next houſe to mine a *Swarm* of *Bees*. It was a very fair day to entice them; but elſe *we* never have them till the middle of *May*. I had it from the owner, one *Parry*, now in my work, and I enquir'd of him, whether they did not all leave the Hive, as ſometimes they do unſeaſonably, either for want of food, or out of diſtaſte? He told me, no, but there are as many left behind as came forth. But I (who have ſometime ſtudied the Regiment of that little induſtrious wiſe creature) do conceive, that Poverty drew them abroad to ſeek their fortunes; the infinite Wiſdom having imparted ſuch a Providence to that little Commonwealth, as to ſend part of their Company abroad to ſhift, before their whole ſtock of food ſhall be conſumed, to the deſtruction of them all, (*Deus Maximus in Minimis.*)

And now to what I formerly promiſed. I have read that excellent Book of Mr. *Evelyns*; eſpecially his *Pomona*, and have learnt many things out of it, which I before had not obſerv'd; and particularly the new way of Planting therein mention'd out of the papers of my Ancient and worthy Friend Mr. *John Buckland*, whom I do never remember but with very great reſpects: As alſo the New way of making *Pepin-Cyder* by Sir *Paul Neil*, to whom (unknown) I do, and our whole Country ought to return very many thanks. For certainly, the reaſons, rendred by him of the harſhneſs and the cure of it in

Pepin-