Some Observations, Directions and Inquiries Concerning the Motion of Sap in Trees, in pursuance of what was formerly begun therein, about the latter end of 1668. and the next following Spring, by Dr Ezerel Tonge, *and* Francis Willoughby *Esq*;

We shall here begin, according to the order of time, with the late Communications of D. Tonge, *which are as follows*;

I Now begin my Inquiries and remarks upon the last publisht Observations of those Ingenious persons Mr *Willoughby* and Mr *Wray* in your *Ph. Transact.* N. 48. *June* 21. 1669. And *First*, to the 3d and 4th Experiments I propose this Inquiry; At what Season of the year, Month, day, and in what wind and weather, Branches and young Trees (especially small Branches) are so full of Sap, that, being held perpendicular, they will bleed at both ends, as is there related; and Roots, both wayes? And what gage the Barometers and Thermometers then held? And in what forwardness their Buds and Leaves, or Chats were then shot, or broken? And of what Diameter such Roots were?

The latter part of the 4th Experiment *appearing* so manifestly to disagree with some Experiments, I have made this Year, as well as formerly, in Roots and Branches of Trees; whereby I found, that not only Cold weather, but Cold Wind and Sun-setting stopped or abated the Motion of Sap in the Sycamore: Which puzleth me, how to direct an Inquiry to find out the Cause of this singular Experiment, and of the Observations also in the 11th Experiment, which highly confirms this. The best directions *I* can at present devise, (untill the Experimenters shall please to give us an accompt of the Time, Season, and that **not only** by the Month, day, hour, but also by the wind, and the motions of the weather-glass, before, after, and at the instant of those Observations;) are the ensuing; which we shall conclude with some other inquiries.

1. What the difference of the Seasons of that Experiment was from the foregoing? 2 Whether the Heat were so great, when the Sycamores so sensibly abated, that it coagulated their Juyce, and, by thickning it into Jelly and so into wood, ended the running? And therefore 3. Whether this Experiment of Cold, promoting, and of Heat, stopping the bleeding, were not in the later end of their running only, and not in the former? And if so, Whether 4. the rising of Sap be not rather to be attributed to the *Degree* of heat, than the *Abatement* of Heat? 5. Whether the reason, that the *Birch* increased, when the *Sycamore* abated, be not also to be imputed to this, that the Birch runs not ordinarily till *March* (unless in a forward season) and the Sycamore and lesser Maple in *January*; and so the season of the ones Sap, beginning sooner, doth also end sooner: And whether thereupon it be not observed, that the season of the Birches Jellying into wood will not commence till a greater heat, as that of *May*; whereas the Maple-Sap probably will condense to Jelly and wood in a lesser heat, as that of *March* going out, or *April* beginning? 6. Whether this be not also probably the reason of what is observed in the 12th Experiment in the same N. 48. *viz.* the *Sycamores* running more on the *North*, and less on the *South*-side, contrary to my yesterdayes Observation (*March* 1 $16\frac{69}{70}$,) the Southern branches yet dropping in the afternoon when others ceased? 7. Whether the *Birch* also in such seasons, after the *Maple* and *Sycamore* cease running, will not bleed more in colder weather, suppose in the middle or beginning of *May*, or latter end of *April*, and so verifie my Experiment of the *Sycamore* running in hotter, and staying in colder seasons, or in the sign *Pisces*, the latter end of *February*, and the beginning of *March*; and on the contrary, running in colder and staying in hotter seasons, *viz.* of *Aries* or the latter end of *March* and the beginning of *April*: Or briefly, In what *Signes*, and what weather as to wet and dry chiefly, the *Birch* and *Maple* bleed in hot, and stay in cold weather, *& vice versa*? Which temper of weather I would have accurately observed by Weather-glasses and Barometers. 8. If this be found to verify my Conjecture, then Whether by the running and staying of these Trees, and the first rising and ceasing of their Sap, may not probably (in some measure, by diligent Observation and comparing Ob-

ſervations of time, ſeaſon, weatherglaſſes,) be found the difference of Climats, Land, and Situation; as alſo of Years forwardly or late fruitful, or of years unfruitful? 9. Whether the Obſervations of *Quality* as well as *Quantity* of Sap by Diſtillations after fermentation, &c. may not alſo conduce to the Prognoſtique of the Fruitfulneſs or Barrenneſs of a year, eſpecially in *Walnuts*, and ſuch Fruit-Bearers as yield plenty of Sap, and by analogy and obſervation from them to others: As (e. g.) whether a fruitful or unfruitful year of Hazel or Filbert-nuts may not probably be diſcovered by their Scarlet-bloſſoms, not appearing this year till now? (*March* 2.) 10. Whether Ablaqueation (or digging about and baring the roots of Trees) will retard the riſing of Sap in the Walnut &c. and what other effect it will have on fruit, &c? And whether ſuch Baring of Roots of Pear, Plum and Cherry-trees (which are as much forwarder than Apples, as Maples are than Birch &c.) and generally of all forwarder Trees, ſhould not be made in different ſeaſons (accordingly) from Mulberries and ſuch like? 11. Whether Amendment of ground, laid after the Sap ceaſeth, be not fruitleſs as to that year, or much leſs beneficial than what is layd before? 12 Whether the ſeaſonableneſs of watering may not be found and promoted by a right Inquiry, and by a due ſatisfaction to theſe Queries? 13. Whether Ablaqueation, watering, Amendment, &c, according to theſe ſeaſons, may not be ſo directed, as to encreaſe Fruit, Wood, or both, or either at pleaſure? 14. Whether Ablaqueation, which ſo alters the riſing of Sap, that it curdles them, when it ſhould run, doth not hurt? 15. Whether the ſame hath influx on the Leaves, Suckers and outward products of the Tree, or on the inward alſo, as fruit; or only increaſes their quantity, by accident hindring the growth and draught of other parts which did robb the fruit? 16. Whether the Cool ſeaſons of the Night afford not ſome temperament in theſe caſes, ſo that thereby, as tis in cool ſeaſons, the Sap runs and Jellies by day, as it runs by night? 17. Whether in ſome warm days, in which the *Sycamore* runs not at Noon or in the heat of the day, it run in the Night, or the Cool of the day, and, on the contrary, the *Birch* run by day or about Noon. and ceaſe at Night or Sun-ſet, in the ſame ſeaſons? 18. The ſame Queries might alſo be proſecuted in the Hop, which runs after the extream heat of the Summer, after the Hops are ripe and gathered, or any other Plant, that runs in Summer or Autumne, if there be any ſuch.

So far the Inquiſitive Doctor for this time: To which we cannot but ſubjoyn the Letter of that Worthy and Obſerving Gentleman, Mr. Willoughby, *containing an Anſwer to ſuch of the precedent remarks and Inquiries, as concerned him, and therefore were imparted to him. It runs thus.*

Sir, 'tis no wonder, that Dr *Tonges* Experiments concerning the Bleeding of the *Sycamore* do not agree with ours, they being made in a different ſeaſon; his, in *February*, and ours towards the end of *March*, viz the Cold, which cauſed the Increaſe of the bleeding in the *Sycamore* and *Walnut*, hapned upon the 23. 24. 25. 26. *March*; and one *Sycamore*, which ceaſed to bleed from the 11th of the ſame Month, bled afreſh copiouſly from wounds that had been made ſo long before: The Buds before the cold were Juſt ready to open into Leaves, and the Sap had begun to coagulate above a fortnight before. This year, making inciſions in the *Sycamore* and common Maple, in *January*, immediately upon the relenting of the firſt Froſt, we found that they both bled, and faſter, as the weather grew hotter; nor did the ſucceeding Cold promote, but rather hinder their bleeding. So that the Learned Doctor doth moſt ingeniouſly conjecture, that the Aſcent of Sap in Trees depends upon a certain Degree of heat, ſufficient to *raiſe*, but not to *coagulate* their reſpective Juyces. In thoſe Months, wherein the Heat *ordinarily* falls ſhort of that Degree, an accidental heat or warmth of weather promotes the bleeding; but in thoſe Months, wherein the ordinary temper of the Air exceeds that Degree, an extraordinary fit of colder weather makes them bleed again.

The Experiments concerning the *Northern* and *Southern* ſides of *Sycamores* were made at the ſame time; and are well ſolved by the ſame *Hypotheſis*.

In *Walnut*-trees, we never yet found, that Heat promoted their bleeding, but always Cold. From a wound, made in a *Walnut*-tree, in *January*, and the beginning

of

of this preſent *March*, in mild weather, nothing iſſued; but the weather changing and growing colder, it bled plentifully: Which ſeems not well to conſiſt with that Hypotheſis, and muſt be better examin'd.

Laſt year, the 6th and 7th of *March* we made the Experiments of the Bleeding of Poles (held perpendicular) at both ends, in Willow, Birch, and Sycamore: which may ſo eaſily and certainly be found to ſucceed, in a great latitude both as to the bigneſs of the boughs and temper of the weather, in the beſt Bleeding ſeaſon, that there needs no ſuch exact niceneſs in the Obſervation of thoſe particulars. The 11th of *March*, Roots of Birch, great and ſmall, bled both ways; and about the ſame time, Sycamore roots alſo. Of all which I doubt not, but Dr *Tonge* is by this time fully ſatisfyed by his own Experiments. The ſame Birch, which firſt began to bleed the 3d of *March* this Year, bled 3 weeks ſooner laſt year.

Tryal would be made, whether Cold will diſſolve the Sap already coagulated: Elſe it will be hard, in the Doctors Hypotheſis, to give an accompt of the Trees dropping a new in Cold weather.

It was laſt Autumne obſerv'd by our ingenious Friend Mr *Martin Liſter*, that upon the firſt Froſt, which hapn'd in *November*, a Sycamore bled copiouſly; ſo that the Sap cannot be ſaid to riſe in *January*, but immediately after the Fall of the leaf, in this Tree.

Our Experiments, which you have already printed, are moſt true, and according to the Doctors Hypotheſis, will very well agree with his. His Deductions and Inquiries are very rational and well deſerve to be made publick. Various interruptions have hindred us from the diligent proſecuting of theſe Experiments this *Spring*; which that I may more critically make hereafter, I muſt procure two Sealed Thermometers and two Barometers. I am &c. Dat. Middleton in Warwick-ſhire *March* 20. $16\frac{69}{70}$.

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