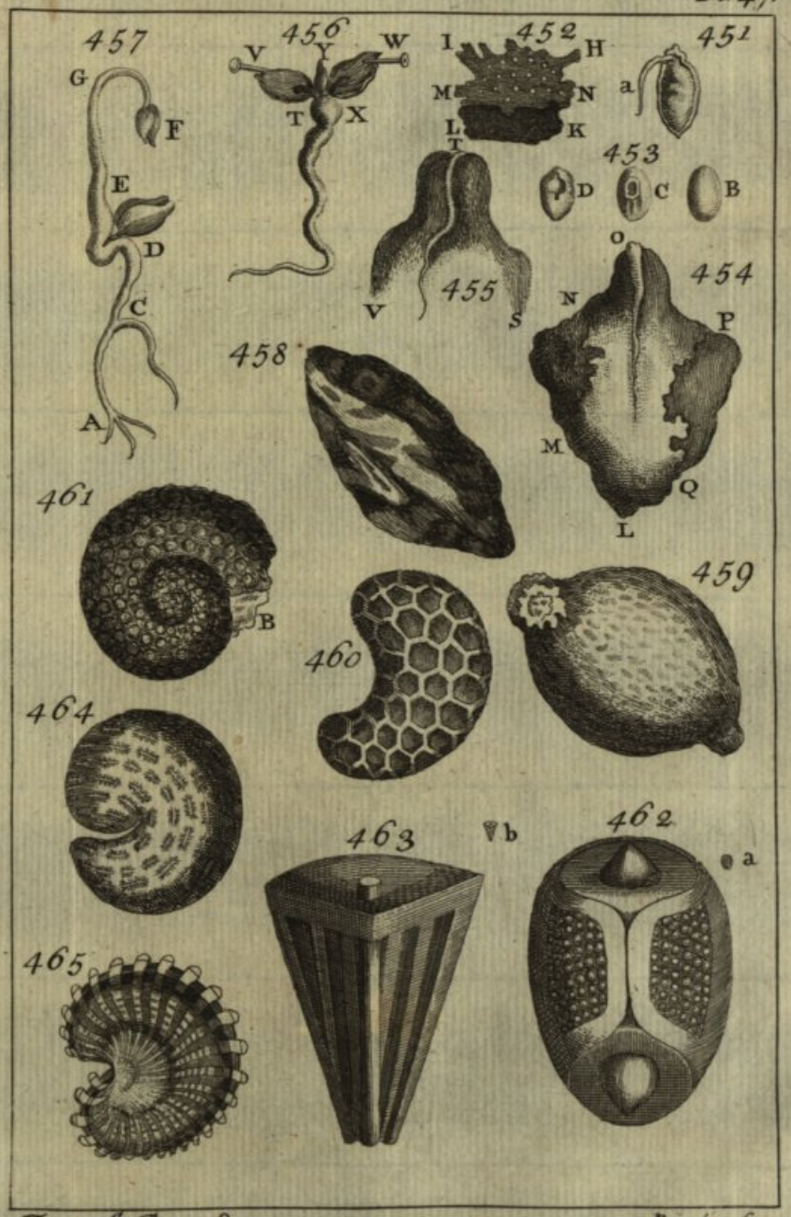


Front.ᵍ Pag. 184.

Bowles sc.

I muſt not here omit a curious Phenomenon in the Natural Hiſtory of Plants, and that is, when the *Radicle* in ſowing happens to light loweſt, it is no wonder the Root ſhould ſpread itſelf under Ground, and the Stem of the Plant riſe up perpendicularly: But when the *Radicle* falls uppermoſt, by what Means it is that it changes its Poſition, to favour the Aſcent of the Stem, is one of the Wonders of Vegetation.

M. Dodart firſt obſerved this Perpendicularity of Plants, and publiſhed it in an expreſs Eſſay of the Affectation of Perpendicularity, obſervable in the Stems or Stalks of Plants, *&c.*

The Matter of Fact is, that though almoſt all Plants riſe a little crooked; yet the Stems ſhoot up *perpendicularly*, and the Roots ſink down *perpendicularly*; even ſuch as by the Declivity of the Soil come out inclined, or are diverted out of the Perpendicular by any violent Means; again redreſs or ſtrengthen themſelves, and recover their Perpendicularity, by making a ſecond or contrary Bend, or Elbow, without rectifying the firſt.

A common Eye looks on this Affectation, without any Surprize; but a Man, who knows what a Plant is, and how formed, finds it a Subject of Aſtoniſhment.

It has been before ſhewn, that each Seed contains a little Plant, already formed, needing nothing but to be unfolded; the little Plant has its little Root and Pulp, which is generally ſeparable into two Lobes, and is the Foundation of the firſt Food the Plantule draws by its Root, when it begins to *germinate*.

If a Seed in the Earth be ſo diſpoſed, as that the Root of the little Plant be turned downwards, and Stem upwards, and even *perpendicularly* upwards; it is eaſy to conceive, that the little Plant coming to unfold itſelf, its Stalk and Root need only follow the Direction they have to grow perpendicularly. But,

It is very well known, the Seeds of all Plants, whether ſown of themſelves, or by the Help of Man, fall into the Ground at random; and among an infinite Number of Situations, with reſpect to the Stalk of their Plant, the *perpendicular* Direction upwards is but one.

It is therefore neceſſary that the Stalk redreſs or rectify itſelf in all the other Situations, in order to find its Way out of the Ground: But what Force is it that effects this Change, which is certainly a violent Action? Is it, that the Stalk finding a leſs Load of Earth above it, goes naturally that Way where it finds the leaſt Obſtacle; were it ſo, the little Root when it happens to be uppermoſt, muſt for the ſame Reaſon follow the ſame Direction, and mount on high.

Therefore *M. Dodart*, ſuppoſes the Fibres of the Stalks are of ſuch a Nature, as to contract and ſhorten by the Sun's Heat, and lengthen out by the Moiſture of the Earth; and on the contrary, that the Fibres of the

Roots contract by the Moiſture of the Earth, and lengthen by the Heat of the Sun.

Then when the Root of the Plantule is uppermoſt, the Fibres which compoſe one of the Branches of the Root, are not equally expoſed to the Moiſture of the Earth; the lower Part is more expoſed than the uppe, which muſt therefore contract the moſt; this Contraction is again promoted by the lengthening of the upper, whereon the Sun acts with the greateſt Force; conſequently this Branch of the Root muſt recoil towards the Earth, and inſinuating thro' the Pores thereof, get under the Bulb, *&c.*

By inverting this reaſoning, it will appear, how the Stalk comes to get uppermoſt.

In a Word, we may imagine, that the Earth attracts the Root to itſelf, and that the Sun contributes to its Deſcent; and, on the contrary, that the Sun attracts the Stem, and the Earth in ſome Meaſure ſends it towards the ſame. Again,

M. *de la Hire* imagines, that the Root draws a coarſer and heavier Juice, and the Stem and its Branches a more volatile one; which Difference of Juices, ſuppoſes larger Pores in the Roots than in the Stalks; therefore in the Plantule we may conceive a Point of Separation; ſuch, that all one Side of the Root ſhall be unfolded by the groſſer Juices, and all the other Side by the more ſubtle ones.

If now the *Plantule* be inverted when its Parts begin to unfold, the Juices which enter the Root being coarſeſt, when they have enlarged the Pores to admit Juices of a determinate Weight, thoſe Juices preſſing the Root more and more, will drive it downwards, and this the more as the Root is more extended or enlarged; for the Point of Separation, being conceived as the fix'd Point of a Lever, they will act by the longer Arm. At the ſame Time the volatile Juices having penetrated the Stalk, will tend to give a Direction from below upwards, and by Reaſon of the Lever, will give it more and more every Day till it be perfectly erect.

Mr. *Aſtruc* accounts for Perpendicularity of the Stems, and their redreſſing themſelves on theſe two Principals.

Firſt, that the nutritious Juice ariſes from the Circumference of the Plant, and terminates in the Pith. Second, That Fluids contain'd in Tubes, either parallel or oblique to the Horizon, gravitate on the lower Part of the Tubes, and not at all on the upper.

Whence it eaſily follows, that in a Plant poſited either obliquely or parallel to the Horizon; the nutritious Juice will act more on the lower Part of the Canals than on the upper; and by this Means inſinuate more into the Canals communicating therewith, and be collected more copiouſly therein; thus the Parts on the lower Side will receive more Accretion, and be more nouriſhed than thoſe on the upper; the Conſequences whereof muſt be, that the Extremity of the Plant will be obliged to bend upwards.

The

The ſame Principle brings the Seed into its due Situation at firſt; in a *Bean* planted upſide down, the Plume and Radicle are eaſily perceived with the naked Eye, to ſhoot at firſt directly for about an Inch; but thenceforward they begin to bend, the one downwards, and the other upwards, as in the Example of the Orange Seed, Fig. 457; the like is ſeen in a Heap of *Barley* to be made *Malt*, in a Quantity of *Acorns* laid to ſprout in a moiſt Place, *&c.* each Grain of *Barley* in the firſt Caſe, and each *Acorn* in the ſecond hath a different Situation, and yet all the Sprouts tend directly upwards, and the Roots downwards, and the Curvity or Bend they make, is greater or leſs as their Situation approaches more or leſs, to the Direction wherein no Curviture at all would be neceſſary. Now two ſuch oppoſite Motions cannot ariſe without ſuppoſing ſome conſiderable Difference between the two Parts; the only one we know of, is, that the *Plume* is fed by a Juice, imported to it by Tubes parallel to its Sides; whereas the Radicle imbibes its Nouriſhment at all the Pores in its Surface. As oft therefore as the Plume is either parallel or inclined to the Horizon, the nutritious Juice feeding the lower Parts more than the upper, will determine its Extremes to turn upwards, for the Reaſon already aſſigned. On the contrary, when the Radicle is in the like Situation, the nutritious Juice penetrating more copiouſly through the upper Part than the under; there will be a greater Accretion of the former than the latter; and conſequently the Radicle will be bent downwards: And this mutual Curvity of the Plume and Radicle muſt continue, till ſuch Time as their Sides are nouriſhed alike, which cannot be till they are perpendicular *.

Roots are generally diſtinguiſhed by their Figures, ſome being entire, as *Liquorice*; parted, as *St. Johnwort*; ſome parted at Bottom, as moſt Roots; others at Top, as *Dandelion*, &c. ſome parted and ramified, as *Comfrey*; others having divers Strings iſſuing from one Head, as *Crowfoot*; ſome ſtrait as *Radiſh*, crooked as *Biſtort*, ſmooth as *Bugloſs*, ſtringy all round as *Columbine*; ſome thick as *Rhubarb*, ſlender as the *Vine*, long as *Fennel*, ſhort as *Turnep*, &c. &c.

The Motions of Roots are ſometimes perpendicular, as *Parſnip*, level as *Hops*, *Ammi*, *Cinquefoil*, &c.

There is a kind of wreathing or twiſting in the Veſſels of ſome when the Bark is ſtripped off, in *Carduus*, *Sonchus*, &c. in which may be ſometimes ſeen two or three Circumvolutions.

But the moſt remarkable of all *Roots* are ſuch as are annually renewed or repaired out of the Trunk or Stalk itſelf, as *Arum*, *Rape-Crowfoot*, *Valerian*, *Brownwort*, *Bearsfoot*, *Tanſy*, *Lychnis*, *Sapier*, *Primroſe*, *Ammi*, *Avens*, *Wood-Sorrel*, *Iris*, and others; that is to ſay, the Baſis of the Stalk continually and by inſenſible Degrees, deſcending below the Surface of the Earth, and hiding itſelf therein, is both in Nature, Place and Office changed into

* *Men. d. l. Acad. Roy. des Science, n.* 1708.

a Root. So in *Brownwort* the Baſis of the Stalk ſinking down by Degrees till it lies under Ground, becomes the upper Part of the Root; and continuing ſtill to ſink, the next Year becomes the lower Part, and the next after that rots away, * a new Addition being yearly made out of the Stalk, as the older Parts annually rot away.

In a Diſſection of the *Root* we ſhall firſt find the *Skin*, next the *Cortical*, which when thin is commonly called the Bark; next within this are the woody Fibres, which together with all its Parts, are viſible in a Circle; its Pores being nothing near ſo numerous as that of the Cortical, but in ſome more open than in others, as may be ſeen on cutting a very thin tranſverſe Slice of the Branch of a Tree, and holding it againſt the Light, or placing it before the *Microſcope*. In *Currant* and *Gooſberry-Trees* it is leſs conſpicuous than in *Oak* or *Plumbs*, in *Damſins* it is more, and in Elder and Vines more; the cortical Body doth not only ſurround the Wood, but is as it were wedged into it in many Places, and is even inſerted therein as far as the Pith, and appears in a tranſverſe Section of a Root like Lines drawn from the Center to the Circumference.

Fig. 466. repreſents a tranſverſe Slice of the Root of *Aſparagus*, and Fig. 467, exhibits a *microſcopic* Picture of a Piece thereof cut out at a b, in which

A B ſhews the Skin.
A B C D the Bark, or all that Part analogous to it.
C D E F the Lympheducts on the inner Edge of the Bark.
E F G H the Wood in which the black Spots ſhew the Air Veſſels.
G H I the Pith.

Fig. 468. is a tranſverſe Slice of the *Root* of *Mallows*. Fig. 469. repreſents a Piece thereof, which was cut out at c d, as it appeared before the *Microſcope*; in which

A B C D ſhews the Skin.
C D E F the Bark, or all that Part of the Root which anſwers to it, in which the round Spots are the Muciducts.
E F G H the common Lympheducts.
G H I K the pithy Part of the Root.
I K L more Lympheducts, in both which the black Holes are the Air the Air Veſſels.

Fig. 470. repreſents a Slice of a *Vine Root* cut tranſverſly, out of which at e f was cut a ſmall Piece, which when placed before the *Microſcope* appeared as repreſented by Fig. 471. wherein

A B ſhews the Skin.
A B C D the Bark.
L S Parcels of Sap Veſſels.
L I Parcels of Wood in which the darker ſhaded Circles great and ſmall are the Air Veſſels.
E F parenchymous Inſertions between the Parcels of Wood.
G G others within them.

* *Grew. Anat. of Plants, p.* 59.

At

At Fig. 472. is ſeen a tranſverſe Slice of a *Horſe Radiſh* Root, and at a b the Place from whence a Gore was cut, which is repreſented as it appeared in the *Microſcope* by Fig. 473. whereof

AB is the Skin.
ABCD the Bark.
CDEFGHI the Sap Veſſels in Form of a Glory.
CDKL the Wood in which the darker Circles are the Air Veſſels.
KLMN a Ring of more Sap Veſſels.
MNO the Pith.

Fig. 474. exhibits a tranſverſe Section of *Bugloſe Root*, from which at c d was taken a ſmall Piece, that when magnified appeared as Fig. 475. in which

AB is the Skin.
ABCD the Bark.
ABEF the Bladders in the outer Part of the Bark; they are figured ſomewhat oblong, and are ranged in Circles.
EFCD the inner Part of the Bark in which the Bladders are ranged in curved Arches.
CDGH a Ring of Sap Veſſels,
II a parenchymous Inſertion, of which there are ſeveral in the whole Section.
LKKL the Wood in which the dark Spots are the Air Veſſels.
KKM the Pith.

SECT. II.

Of the Skin of Roots.

THE outer Part of all *Roots* is the *Skin*, which in *Skerrits* is white, yellow in *Dock*, red in *Potatoes*, brown in *Lovage*, black in *Bugloſs*, &c. their Surface is ſometimes ſmooth, as in *Horſe radiſh*, rough, as in *Scorzonera*. The Skins of the ſeveral Shells of a *Tulip-Root* freſh taken up, appear to be perforated with a Number of ſmall Holes. This Skin is very thin in *Parſnip*, thicker in *Bugloſs*, very thick in *Iris*, opake in ſome as the *Thiſtle*, and tranſparent in others, as the *Madder*.

Every *Root* hath two kinds of Skin, one of the ſame Age with the other Parts, and the other ſucceeding in the Place of the former; as in *Dandelion*, the old Skin ſeems to be that Part which compoſed the cortical Body the Year before, which by the Generation of a new Ring next the Wood, is now thruſt outward, and ſhrunk up into a Skin as at AB; in an *Horſe-radiſh* Root, Fig. 473. or at AB in a *Bugloſs Root*, Fig. 475. as far as the Bladders in the former, and Veſſels in the latter, are radiated; the cortical Body ſeems to ſhrivel up into a new Skin, as the old ones fall off, and probably the whole Body of the perpendicular Roots, except the woody Fibre in the Center, becomes the ſecond Skin, as in *Aſparagus*, Fig. 467.

This

This Skin is made up of two Kinds of Bodies, one parenchymous, generally compoſed of exceeding ſmall Cells or Bladders, which are plainly viſible, if viewed through a *Microſcope*, and appear as in Fig. 467. which repreſents a tranſverſe Piece of the Root of *Aſparagus* magnified; theſe Bladders are of different Sizes, being larger in *Bugloſs* than in *Aſparagus*, &c.

The other Part of this Skin is compoſed of tubular Wood-Veſſels, intermix'd with the Bladders before-mention'd.

If a *Root* be cut tranſverſly, and laid by for ſome Time, all the Parts where there are no Veſſels will ſhrink below the Surface of the cut End; but the Veſſels will all retain the ſame Length, at which Time they may be examined by the *Microſcope*.

Of the Bark of Roots.

THE *Bark* is ſituate juſt within the Skin, in ſome Roots it is yellow, as in *Dock*, red in *Biſtort*, but in moſt white, in ſome it is very thin, and in others it makes the greateſt Part of the Root, the thinneſt and thickeſt being all analogus.

It is exceeding porous both in Length and Breadth, as appears from its ſhrinking up equally both Ways, and dilating to its former Size on being ſoaked in Water. All this is apparent to the naked Eye; but the *Microſcope* confirms the Truth thereof, by ſhewing that theſe Pores are an infinite Number of little Cells or Bladders, ſometimes running in Ranks both the Length and Croſs-ways of the Root, as at A B C D in *Bugloſs*. Fig. 475. it may be ſeen both in a tranſverſe and upright Section, and always beſt after the Pieces ſo cut hath lain by ſome Time to dry.

This parenchymous Part is of an uniform Texture in many Roots, and diverſified in as many others; the Bladders, though very regular, yet differ in Shape, Size and Situation; in ſome Places like white Rays, ſtreaming from the inner Edge thereof outwards to the Circumference of the Bark, as is apparent in a tranſverſe Section of *Lovage*, *Melilot*, *Parſnip*, &c. continuing in direct Lines the whole Length of the Root.

The *Bark*, as before obſerved, is intermixed with a few lignous Veſſels, which are apparent in moſt Roots in the Reſemblance of Threads. Theſe tubular Threads do not run in direct Lines, but are frequently braced together in the Form of Network, as is apparent if the Bark be ſtripped off, and a Piece of it examined by the *Microſcope*.

In *Parſnips* theſe Veſſels yield a thin Lympha. It is certain that this clear Sap aſcends only in theſe Veſſels, becauſe no Liquor will do the like from any parenchymous Part; ſometimes they yield a thick mucilaginous Lympha as *Comfrey*; oftentimes theſe ſucciferous Veſſels yield a milky or white Sap, and ſometimes yellow, as in *Sonchus*, and moſt cichoraceous Plants; in *Angelica*,

gelica, and moſt umbelliferous; in *Burdock* and divers Thiſtles; in *Scorzonera*, *common Bells*, and many other Plants, not commonly taken Notice of to be milky. Theſe milky Saps, although of different Colours, Thickneſs, and other Qualities, agree in being more oily than any of the lymphous Saps; for the Mixture of the oily Parts, with ſome other limpid Liquor, cauſes them to be of a milky *, or other opake Colour. In the ſame Manner as common Oil, and a ſtrong Liquament of Tartar, ſhook in a Bottle, become white.

Sometimes the Oil will ſeparate, as is obſervable on cutting a *Fennel Root* tranſverſly, after it hath lain ſome Days out of the Ground. The ſame Veſſels, which before yielded Milk, will now yeild Oil.

All *Gums* and *Balſams* are likewiſe the Contents of theſe Veſſels, for theſe and Milks are nearly a-kin. The Milk of *Fennel* ſtanding ſome time, turns to a clear Balſam, of *Scorzonera*; *Dandelion*, and others, to a Gum. In the dried Root of *Angelica*, when ſplit, the Milk † is ſeen in Clods, in the Continuation of theſe Veſſels, condenſed into an hard ſhining Roſin. The Root *Helenium* cut tranſverſly, preſently yields a Balſam of a Citron Colour, ſo called becauſe it will not diſſolve in Water. The Root of common *Wormwood* yields a true Balſam, with all the defining Properties of a Terebinth; the Roots of *Trachelium* and *Enula*, yield both a Lympha and a Citron Balſam; and *Wormwood* both a Lympha and a Terebinth § at the ſame Time. It is doubtful whether all *Roots* have Lympha Ducts, but probably they have, and for the moſt Part ſtanding in a Ring, at the inner Verge of the *Bark*.

The Situation of theſe Veſſels are very curious, if viewed in a tranſverſe Section of the Root; ſometimes they only form a Ring at the inner Edge of the *Bark*, as at E F, in *Aſparagus*, Fig. 467. in which Poſition they are in moſt, if not all Roots; in ſome they ſtand in Rays, as *Borage*, or *Peripherial*, as in *Celandine*. Theſe vaſcular Rays are extended in ſome towards the Circumference of the Bark, about half Way, as between C D E F, in Bugloſs, Fig. 475. in all *Docks* and *Sorrels*, about $\frac{3}{4}$ths of the Thickneſs of the *Bark* toward the Circumference, ſeveral of them are alſo arched thereabout. In all, or many *Trefoils*, and of the leguminous Kind, only one Third of the Bark. In the umbelliferous, they are ſituate between the diametrical Portions of the Parenchyma. In the *Microſcope* they all of them appear to be real Circles; and in a tranſverſe Section, when the Milk has been licked off with the Tongue, till no more will riſe. They may alſo be ſoaked in Water, after which the Poſition of the Milk Veſſels will be viſible; in ſome *Roots* they run more parallel, and keep aſunder, as in *Monks-hood*, and join towards the Circumference of the *Bark*, in *Eryngo*. They terminate more circular, in *Briony* angular, or in the Form of a

* *Grew. An. Plant. p.* 67. † *Ibid. p.* 67. § *Ibid. p.* 68.

Glory,

Glory, as will appear alſo on viewing an *Horſe Radiſh Root*, C D E F G H I, Fig. 473. in the *Microſcope*. In ſome almoſt entire Circles, as in *Dandelion*; in others compoſed of ſhort Chords; in ſome theſe Specks are ſo exceeding ſmall, that to the naked Eye they ſeem continued Rings, but when viewed in the *Microſcope*, are diſtinct Veſſels, as in *Marſh-Mallows*, and *Liquorice*. In *Marſh-Mallows* the Lymphæducts appear in Rays, and the Lacteals in Rings, Fig. 469. In *Dandelion* they appear to the naked Eye like numerous Rings, but when viewed through the *Microſcope*, are found to conſiſt of very many ſmall Rays, ſtreaming from the inner Verge of the *Bark*, a-croſs three or four of the ſmaller Rings.

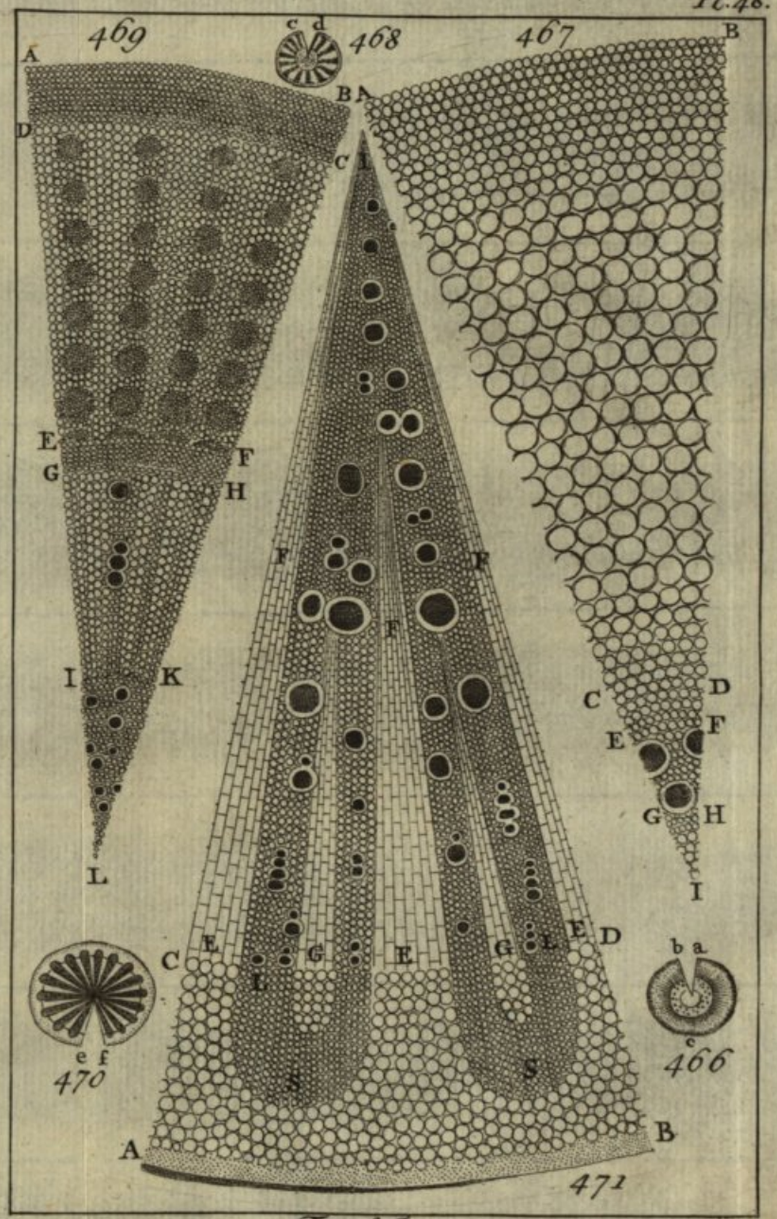
SECT. III.

Of the Wood of Roots.

THAT Portion of the *Root*, which is contiguous to, and within the Bark; in Trees, and ſhrubby Plants, is the Wood, which conſiſts of the Parenchyma and lignous Subſtance. The firſt of which is of the ſame Nature with that of the Bark. The Poſition of its ſeveral Parts are moſtly diametrical, running between the *lignous Parts*, from the Circumference towards the Center of the *Root*, and all together conſtitute that which is before called the Inſertment. Theſe Inſertments are moſt obſervable in the *Roots* of many Herbs, as *Comfrey*, which exhibits a good Notion of all other, as well Trees as Herbs; ſometimes this parenchymous Body is diſpoſed into Rings, as in *Fennel*. In moſt woody Roots, they ſtream between the Pith and Bark, like ſo many ſmall Rays. In ſome Roots they continue to the Center, as *Columbine*, in others not, as *Parſnip*; and ſometimes different in the ſame Root, as E F in the *Vine*, Fig. 471. They are compoſed of many ſmall Bladders, as in the Bark, but generally ſmaller. Their Shape uſually round, but ſometimes oblong and oval, as in *Borage*, or oblong and ſquare, as in the *Vine*.

The lignous Part alſo conſiſts of two Kinds of Bodies, ſucciferous, or lignous, and Air Veſſels. The lignous are of the Nature with thoſe of the Bark, and in a tranſverſe Section of the Root, emit a Liquor as thoſe do. Theſe Veſſels are no where interwove or braced together, but continue from one End of the Root to the other.

The Poſition of both theſe Kind of Veſſels is various, the ſucciferous or lignous are ſometimes ſituate in diametrical Lines, as in the *Vine*, Fig. 471. and moſt Trees, ſometimes oppoſite to the Areal, as in *Beet*, &c.



Front.d Pag. 192. Bowles. sc.

SECT. IV.

Of the Pith of Roots.

WIthin the woody Part, is the *Pith* which is not common to all Roots, for ſome have none, as *Nicotian*, *Stramoniam*, and others. The *Pith*, for the moſt Part, eſpecially in Trees, is a ſimple Body, yet like the Bark it is compounded, ſome ſucciferous Veſſels being mixed with it, as in *Jeruſalem Artichoke*, *Horſe Radiſh*, &c. many Roots that have no Pith at their lower Part, have one at the Top, as *Columbine*, *Lovage*, &c. Their Contexture by the *Microſcope*, appears to be of the ſame general Kind in all Plants, both in the Parenchyma of the Bark, in the Inſertment or diametrical Portions, and in the Pith, all being compoſed of *Bladders*, which are of very different Sizes, ſeldom leſs than thoſe of the Bark, as in *Aſparagus*, Fig. 467. but generally much bigger, as in *Horſe Radiſh*, Fig. 473. their Poſition ſeldom varies, but is uniform in a tranſverſe Section of all Parts of the Root piled up evenly one over another. In an upright Section they ſeem to run in direct Trains, length-ways; they are for the moſt Part orbicular, though in the larger Roots ſomewhat angular. On obſerving theſe Bladders with the *Microſcope*, their Sides will be found to conſiſt of ſeveral Ranks of exceeding ſmall Fibres, lying for the moſt Part evenly one over another, from the Bottom to the Top of every Bladder, and running a-croſs alſo from one Bladder to another. If the *Pith* be cut with a ſharp Razor, or Penknife, and ſo applied to the *Microſcope*, they will be ſeen diſtinctly.

All Plants exhibit this Spectacle, but thoſe beſt with the largeſt Bladders; nor the ſame *Pith* ſo well in any other Condition, as when dry; becauſe then the Sap being voided, the Spaces between the Fibres, and the Fibres themſelves are more diſtinctly ſeen. Yet it muſt not be dried after cutting, becauſe its ſeveral Parts will thereupon coincide and become deformed, but to be choſen while the Plant is growing, at which Time it may be often found dry and not deformed; as in the Trunks of *common Thiſtle*, *Jeruſalem Artichoke*, &c. cut off the white Bottoms of the Bladders of a *Bulruſh* tranſverſly, and they will appear like a curious Piece of Needle-work. The whole Body of a *Root* therefore conſiſts of Veſſels and Fibres, and probably theſe Fibres themſelves are tubular.

If you take the Roots of *Vine*, *Fennel*, *Dandelion*, *Plumb-tree*, *Elder*, *Willow*, &c. and lay them for ſome Time to dry, then cut off a thin Slice of each tranſverſly, and place it before the Microſcope, by pinching one Edge thereof between the Nippers, the Light will then be trajected through the Perforations of all the Veſſels both great and ſmall, they are ſcarce ever viſible in the freſh Slices of theſe Roots.

A clear and elegant Sight of the Fibres which compoſe the Air Veſſels, may be obtained by ſplitting a *Vine Root*, or a Piece of *Oak*, and may be ſeen in the Side of the greater Air Veſſels, in the Reſemblance of Needle-Work; the Spiration of the Fibres may be better obſerved in the *Trunk* than in the *Root*, and beſt in *young Plants*, but not ſo well by cutting as ſplitting, or by tearing off ſome ſmall Piece, through which they run; their Confirmation being by this Means not ſpoiled.

But in the Leaves or tender Stalks of all ſuch Plants as ſhew upon breaking, a kind of Down or Wool; they may be ſeen drawn out, and that ſometimes to the naked Eye. This Wool being nothing elſe but a certain Number of Fibres drawn out of their ſpiral Poſition, appearing more or leſs in the Leaves and other Parts of moſt Plants, as in the *Vine*, *Scabious*, &c. in the *Scales* of a *Squil* they are ſo eaſily ſeparable, as to ſhew the Plate or Zone into which the *Air Veſſels* are uſually reſolved, which is not one ſingle Piece, but made up of ſeveral round Fibres, running parallel, and knit together by other ſmaller ones tranſverſly in the Form of a Zone.

CHAP. XXXVII.

Of the Trunks of Trees.

SECT. I.

THE *Trunk* comes next under Conſideration, which conſiſts of the *Bark*, *the Wood*, the *Inſertions* or *Veins*, and the *Pith*.

The croſs Shootings of the Wood in Trunks of ſeveral Years Growth appear in Rings, ſo that we may judge by the Number of Rings of how many Years * Growth the Tree is; in each of theſe Rings is one Circle of large open Pipes, but the fewer of theſe the ſtronger the Timber.

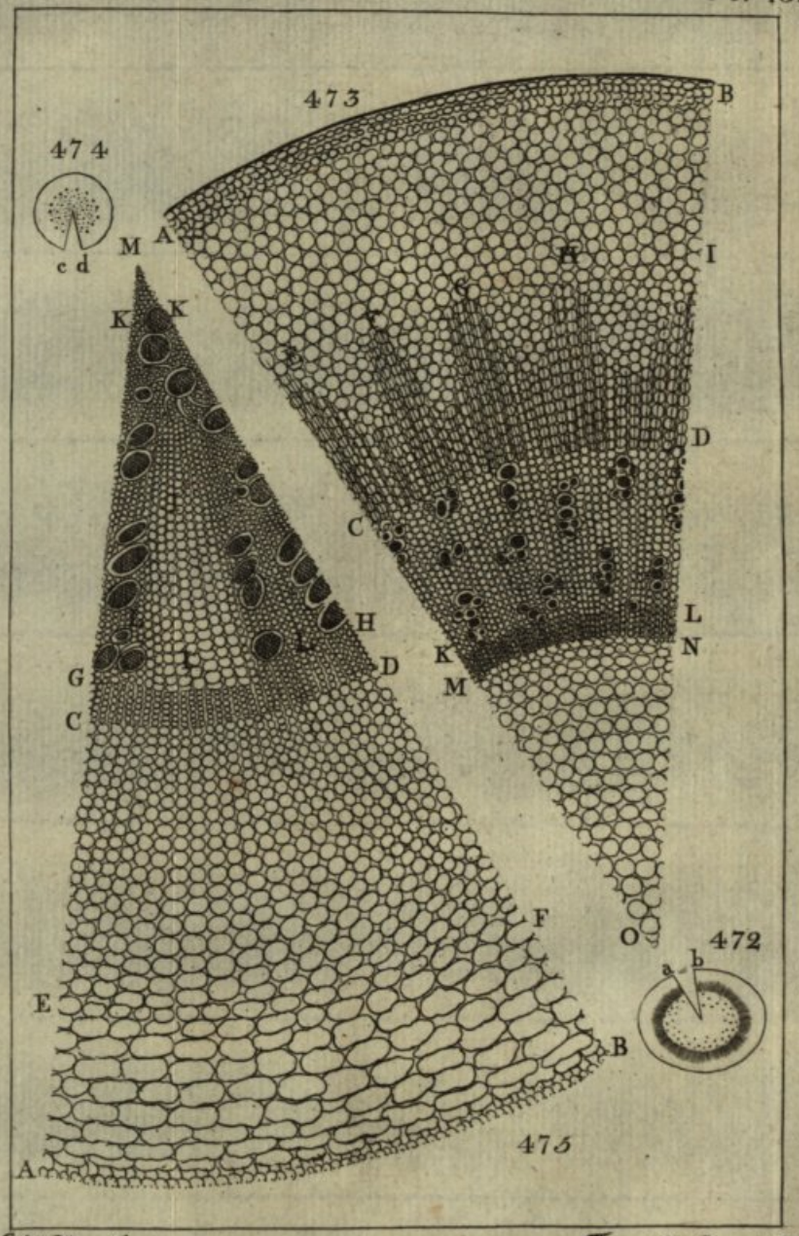
The Pores of the Wood in well-grown Timber are very conſpicuous both in an upright and tranſverſe Section thereof.

The lignous Body in the Trunks of Herbs are extremely viſible in the *Microſcope*, each Fibre thereof being perforated with 30, 50, 100, *&c.* Pores, as may be ſeen in a magnified Piece of Burdock, Fig. 477. and although each Fibre appears to the naked Eye to be but one, yet when magnified we plainly find them to be compoſed of a Number of Fibres, or rather hollow Tubes joined together, ſo that what we call the woody Part of a Tree, notwithſtanding all its Solidity, is nothing elſe but a Cluſter of innumerable and extraordinary ſmall vaſcular Fibres; ſome of which riſe from the Root upwards, and are diſpoſed in Form of a Circle, and the others which Dr. *Grew* calls *Inſertions*, tend horizontally from the Surface to the

* *Phi. Tranſ. No.* 213.

Center,

Pl. 49.



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Center, in ſuch a Manner as to croſs each other, and are interwove like the Threads of a Weaver's Web.

Theſe *Inſertions* are viſible on ſawing Trees Lengthwiſe, and ſhaving from thence very thin Slices. They are alſo diſcernable at their Entrance into the Wood on ſtripping off the *Bark*.

As the Pores or Veſſels are greater or leſs, ſo are alſo the Inſertions, to the naked Eye, the largeſt only are diſcernable; but by the Help of the *Microſcope* they appear very numerous.

The Inſertions in the Trunk are viſible in a tranſverſe Section, and are diſpoſed in even Lines or Rows throughout its whole Breadth; they are repreſented as they appear in the Root of a *Vine*, when viewed through a *Microſcope*, by E F, Fig. 471.

The Pores of the Pith are moſtly obſervable in the *Trunk*, being larger than in the Root; and through a *Microſcope* appear like ſo many Bubbles or Bladders, as in a Piece of Burdock, Fig. 477.

In the Piths of many Roots and Plants, ſome of the larger Pores or Bladders have ſmaller ones within them, ſome of which are divided with croſs Membranes, and between their ſeveral Sides other ſmaller Bladders are inſerted, in orderly Ranks Length-wiſe.

What Dr. *Grew* calls *Fibres* and *Inſertments*, or the lignous Body interwoven with that which he takes to be the cortical, that is the ſeveral Diſtinctions of the Grain, are called by Mr. *Liſter* Veins, * that is, ſuch Ducts as ſeem to contain and carry in them their nobleſt Juices, analagous to human Veins. Mr. *Liſter* makes it appear, that theſe Veſſels are not the Pores of the lignous Body, from a tranſverſe Section of *Angelica Sylveſtris magna vulgatior*; the Veins there clearly diſcovering themſelves to be diſtinct from the Fibres, obſervable in the Parenchyma of the ſame cortical Body, the milky Juices always riſing on the Side, and not in any Fibre. Alſo in a like Inciſion of *Burdock*, in *June* the Juice ſprings on each Side the Radii of the woody Circle, that is, in the cortical Body and Pith only; again where there is no Pith none of this Juice is obſerved.

In a tranſverſe Cut of a Leaf it is obſervable, 1. That theſe Veins accompany the Ribs and Nerves. 2. That the middle Fibre or Nerve ſeems to yield one big Drop of a milky Juice ſpringing as it were from one Vein, yet by the *Microſcope* it is plain there are many Veins, 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 therein like ſo many Pipes running along the Nerve, and yet theſe numerous Veins are all of an equal Bigneſs.

It is obſervable in the Motion of theſe Juices, that the milky Juice always moves and ſprings briſkly upon the opening of a Vein, † the limpid Sap only at certain Seaſons.

* *Phil. Tranſ.* No. 79. † *Ibid.* No. 90.

Dr. *Grew* aſſigns the Offices of the ſeveral Veſſels, *viz.* thoſe placed on the inner Verge of the Bark, he calls *Lymphæducts*, and ſuppoſes them deſtined for the Conveyance of the moſt watry Liquor; theſe Mr. *Bradley* calls the *new forming Veſſels*, which are annually produced, and help to increaſe the Bulk of the Tree.

Thoſe in the Middle of the Bark Dr. *Grew* calls *lactiferous* or *reſiniferous* Veſſels: Their Uſe, according to *Bradley*, is to return the ſuperfluous Sap: Theſe Veſſels *Grew* obſerves, are the principal Viſcera of Plants; and adds, that as the Viſcera of Animals are but Veſſels conglomerated; ſo the Veſſels of a Plant are Viſcera drawn out at length, all which will be eaſily underſtood by an Inſpection of the following Figures.

Fig. 476. repreſents a ſmall Piece cut out of a *walking Cane*, as it appeared in the Microſcope. A B E F ſhews a tranſverſe Section thereof, wherein are ſeen Cluſters of Air Veſſels ſurrounded with Rings of ſap Veſſels, and at A B C D the Pores in the outſide Skin or Bark of the Cane are plainly viſible.

Fig. 477. repreſents a magnified Piece of the Stalk of Burdock cut tranſverſly and down the Side.

Fig. 478. exhibits a Piece cut out of a Branch of *Pine*, wherein at A B C D is ſeen the Bark Side-ways, and at A B E E a tranſverſe Section thereof, through which the Turpentine Veſſels run Lengthwiſe. G H repreſents one of them cut down the Middle to ſhew the Inſide of it, and another is ſeen intire at I K.

Fig. 479. repreſents the Milk Veſſels in the Bark of *Sumach*, in the ſame Manner as the Turpentine Veſſels are repreſented in the foregoing Figure, and are expreſſed by the ſame Letters alſo.

Fig. 480. repreſents Part of a *Vine Branch* cut tranſverſly; and Fig. 481. a Piece cut out of the ſame at a b, as it appeared in the *Microſcope*; whereof A B C D ſhews the Skin Length-ways. At A B E F is ſeen a tranſverſe Section of the Wood and Air Veſſels, and between G H and I K part of the Wood and Bark is taken away to ſhew the ſame Lengthwiſe.

Fig. 482. a, is a tranſverſe Section of an *Apple Branch*, in which the ſeveral Circles of Wood that ſhew of how many Years Growth the Tree is, are viſible to the naked Eye. Fig. 482. b, repreſents a Gore cut out of the aforeſaid Slice at a b, as it appeared in the Microſcope; in which

A B repreſents the Skin.
A B C D the Bark.
H I ſpiral ſap Veſſels in arched Parcels.
O O the common ſap Veſſels which begin to turn into Wood.
C D E F the Wood of three Years Growth.
K L M N one Year's Growth, in which the dark Spots repreſent the Air Veſſels.
g g g the true Wood.
P P the Inſertions.
E F other ſap Veſſels.
E F G the Pith.

Fig.

Pl. 50.

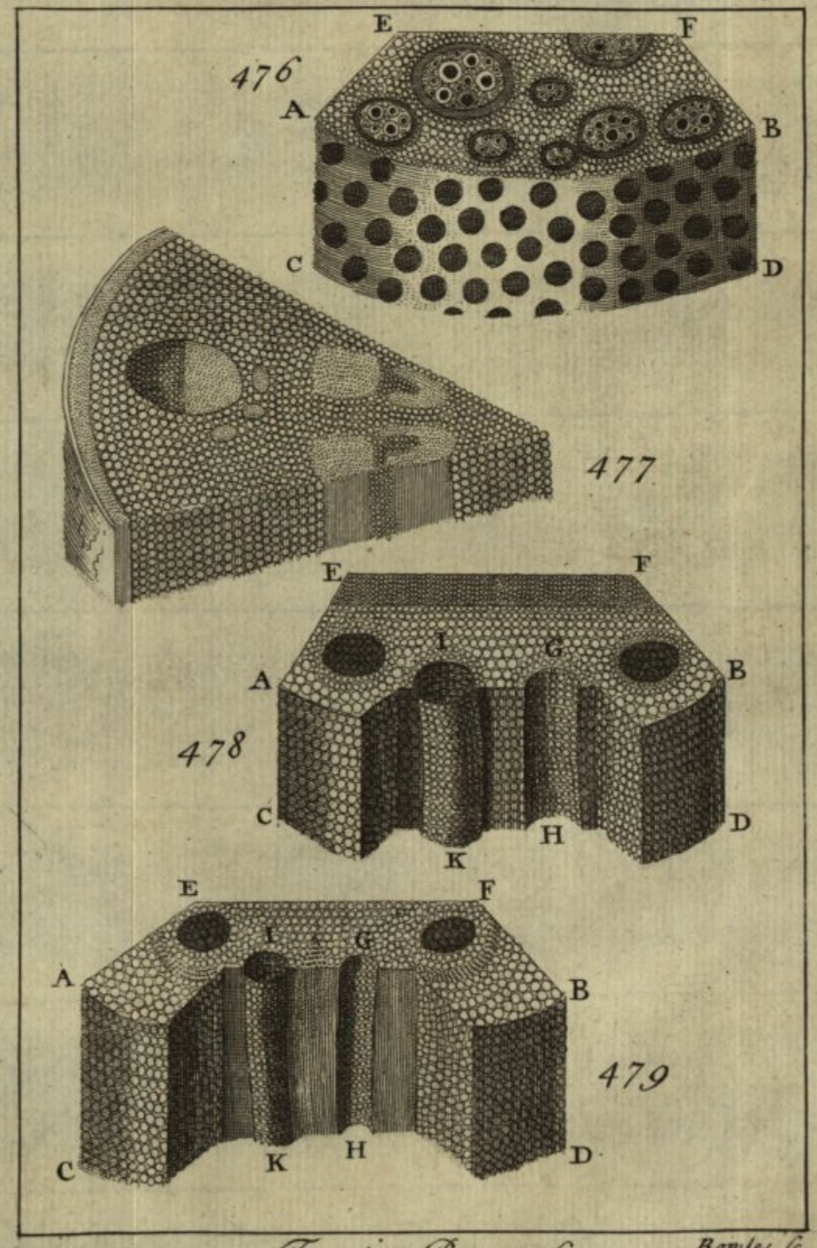

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Fig. 483. ſhews a tranſverſe Slice of a Hazel Branch, and Fig. 484 repreſents a Piece thereof, which was cut out at c d, as it appeared when placed in the *Microſcope*.

AB the Skin.
ABCD the Bark.
QQQ the ſimple Parenchyma.
HI a Ring of ſpecial Veſſels.
PP common ſap Veſſels.
CDEF the Wood of three Years Growth.
KLMN one Years Growth.
XXX great Inſertions.
PO leſſer between them, the black Parcels between theſe Inſertions are the Wood, which is compoſed of minute Tubes (although it is here repreſented in a Shade) in which the dark Spots are the Air Veſſels.
EFG the Pith.

Fig. 485. exhibits a tranſverſe Slice of a *Walnut Branch*, and Fig. 486. a *microſcopick* Picture of a Gore thereof cut out from e f, in which

AB is the Skin.
ABCD the Bark.
RR the Parenchyma.
HRI two Rings of ſpecial ſap Veſſels.
DC common Lympheducts.
DCEF the Wood of four Years Growth.
ddd the true Wood.
KLMN one Year's Growth.
Qd, Qd, part thereof whiter than the reſt, by the Mixture of ſap Veſſels, which are repreſented by the tranſverſe Lines.
MN the great Air Veſſels.
ce, ce Parcels of leſſer ones.
EF a Ring of other ſap Veſſels.
EFG the Pith.

At Fig. 487. is ſeen a Slice of a Branch of *Pine* cut tranſverſly, and at Fig. 488. a magnified Piece of the ſame cut out from g h.

ABCD the Bark.
MMM the Parenchyma.
DLC the Lympheducts.
HH Turpentine Veſſels.
DCEF the Wood in which the white Spaces tending to the Center ſhew the Inſertions.
EFG the Pith, the larger Holes both in the Wood and Pith are more Turpentine Veſſels.

Fig. 489. repreſents a tranſverſe Section of a *Wormwood-Stalk*, from whence a Piece i k was cut, which is exhibited as it appeared in the *Microſcope*, by Fig. 490. whereof

ABCD is the Bark.
AMB the Parenchyma.
HMI Balſamic Veſſels.
KL another Sort of ſap Veſſels in Parcels.
KLCD Lympheducts.
DCEF the Wood in which the dark Spots are the Air Veſſels.
MM the Inſertions.
R another balſamic Veſſel.
EFG the Pith.

Fig. 491. is a tranſverſe Section of a *Thiſtle-Stalk*, out of which at l m was cut a Piece, which is ſeen as it appeared in the *Microſcope* at Fig. 492.

ABCD

ABCD the Bark.
HI the Parenchyma.
e e a Sort of ſap Veſſels.
a a another Sort.
c c Milk Veſſels.
DCEF the Wood.
V V the Air Veſſels.
t t more Lymphæducts.
ſ ſ mere Milk Veſſels.
a t Inſertions.
EFG the Pith compoſed of angular Bladders, Bladders of Threads, and Threads of ſingle Fibres.

Fig. 493. ſhews a tranſverſe Section of *Sumach Stalk*, and Fig. 494 a magnified Gore thereof, which was cut out at n o.

AB a a the hairy Skin.
ABCD the Bark.
HWI the Parenchyma.
DMC the common Lymphæducts.
KML three Milk Veſſels.
HI another Sort of Lymphæducts, arched over the Milk Veſſels.
XX ſeems to be a third Sort of Lymphæducts.
DC EF the Wood.
the white Rays tending from M to M are the Inſertions.
YY the true Wood in which the dark Spots are Air Veſſels.
EF a Ring of Lymphæducts.
EFG the Pith.

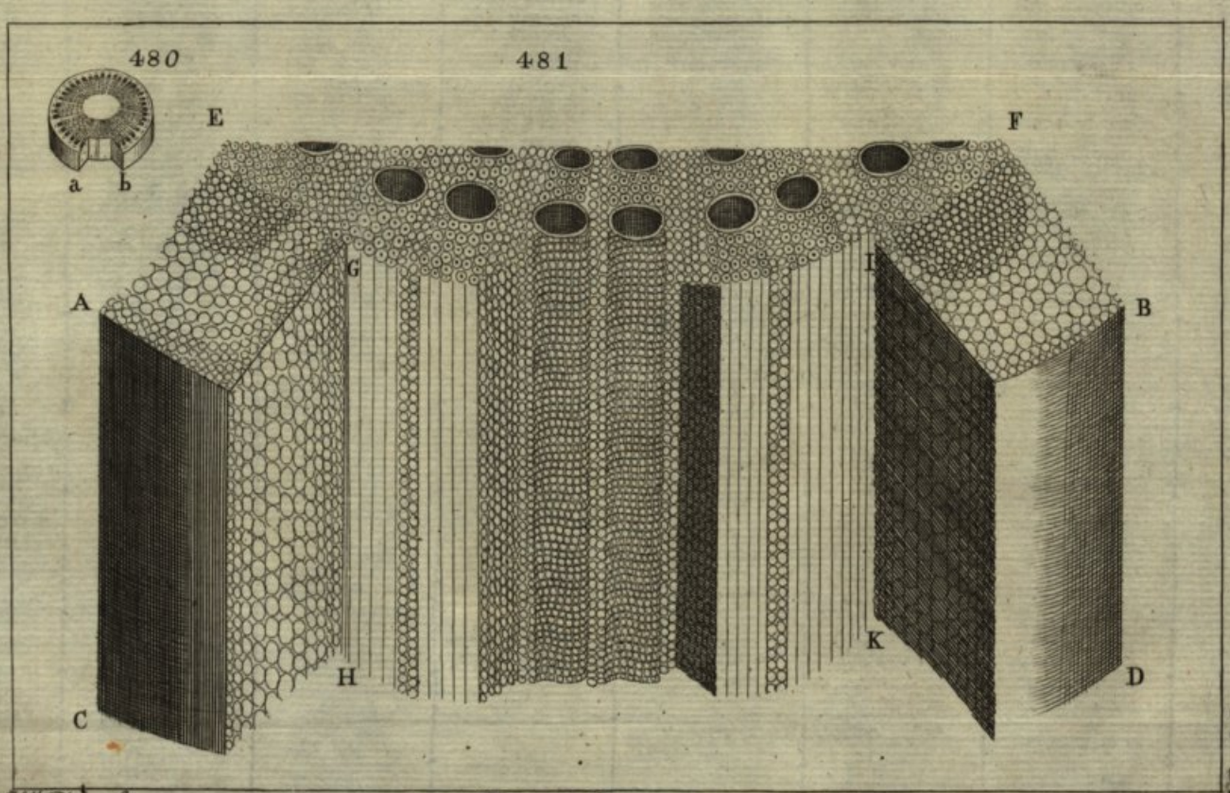
Fig. 495. repreſents part of a *Vine Branch* cut tranſverſly at ABG, and at ABC, and alſo ſplit half way down the Middle at GGBB, whereof

ABAB is the Skin.
ABCD, ABCD the Bark.
HHH ſap Veſſels in arched Parcels.
I the Parenchyma.
CDEF the Wood.
ddd the true Wood, in which the dark Spots are the Air Veſſels.
KK the Inſertions.
EF a Ring of other ſap Veſſels.
EFG the Pith.
Between GG, FF, is ſhewn the Poſition of the Bladders in perpendicular Rows.
Between DD and BB is ſeen the ſame of the Bark; and
Between FF DD is ſeen an upright Section of the Wood and Air Veſſels.

SECT. II.

Of the Bark of Trees.

THE exterior Part of Trees is the *Bark*, and ſerves them for a Skin or Covering; in general it is of a ſpongy Texture, and by many little Fibres, which paſs through the capillary Tubes whereof the Wood conſiſts, communicates with the Pith; ſo that the proper Nutriment of the Tree being imbibed by the Roots, and carried up through the fine arterial Veſſels of the Tree by the Warmth of the Soil, *&c.* to the Top of the Plant, is uſually ſuppoſed to be there condenſed by the cold Air; and returns by its own Gravity down the Veſſels, which do the Office of Veins, lying between the Wood and inner *Bark*, leaving, as it paſſes by, ſuch Parts of its Juice as the



Pl. 51.

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the Texture of the Bark will receive and requires for its Support. That ſoft whitiſh Rind or Subſtance, between the inner Bark and the Wood, which, Mr. *Bradley* thinks, does the Office of Veins; ſome account a third Bark, differing only from the others in the Cloſeneſs of its Fibres; 'tis this contains the liquid Sap, Gums, *&c.* found in Plants in the Spring and Summer Months. It hardens by little and little, by means of the Sap it tranſmits, and is imperceptibly converted into the woody Part of the Tree. There are few Trees but what have it; yet it is ſtill found in leſs Quantity as the Tree is more expoſed to the Heat of the Sun. It is here the Corruption of Trees generally begin; whence thoſe who fell and cut Trees ought always to take Care to leave as little of it on as poſſible.

The *Bark* conſiſts of two Parts, the outmoſt Skin and the main Body; the Skin is generally compoſed of very ſmall Veſicles or Bladders; but as the Plant grows, the Skin dries, and the Bladders ſhrink up and diſappear. Amongſt theſe ſkinny Bladders are intermixt a Sort of woody Fibres, as in *Mallow*, *Nettle*, *Borage*, *Thiſtle*, and moſt Herbs.

The Skin of the Trunk is ſometimes viſibly porous, as in the better Sort of *Walking Canes*, Fig. 476. A B C D.

The main Body of the Bark alſo conſiſts of two Parts, the Parenchyma and Veſſels; the Parenchyma is compoſed of an infinite Number of ſmall Bladders, and the Veſſels are very numerous ſtanding in or near the inner Margin of the Bark, and are always ſap Veſſels *.

The Properties of the ſaid Veſſels are diſtinguiſhed from one another in the ſame Plant, and in the ſeveral Species of Plants; which Properties are not accidental, but ſuch as ſhew the conſtant and univerſal Deſign of Nature.

For in the Figures 482, 484, 486, 488, the Veſſels of the *Bark* are only of two Kinds, which in the firſt two ſeem to be roriferous † and Lymphæducts (yet in all the four their Number and Poſition is very different.) In Hazel, Fig. 484, they are but few; in Apples, Fig. 482, they are more, and alſo in *Pear*, *Plumb*, *Elm*, &c. ſtill more numerous. As to their Poſition in *Hazel*, the Lymphæducts or Veſſels next the Wood, ſtand in ſemicircular Parcels; and in *Holly* they ſtand in Rays, yet ſo numerous and cloſe together as to make one intire Ring. In the Apple Branch, Fig. 482. the Lymphæducts O O are radiated, they are alſo radiated in the Pear and Plumb, *&c.* In *Hazel*, Fig. 484. the roriferous Veſſels H I, as Dr. *Grew* calls them, make an intire Ring. In *Apple*, Fig. 482, they are neither radiated nor make an intire Ring, but ſtand in peripherical Parcels, much after the ſame Manner they ſtand in *Elm*. In Aſh the Veſſels make two Rings, the inmoſt or Lymphæducts conſiſt in arched Parcels, and the outmoſt or roriferous of round ones; whereas in the foregoing the Lymphæducts are contiguous to the Wood, and the roriferous more or leſs diſtant

* *Grew. Ana. Plant, p.* 108. † *Ibid.* 109.

from

from the Skin; here, on the contrary, the firſt are diſtant from the Wood, and the latter contiguous to the Skin.

In the two next Branches, Fig. 486 and 488, the Veſſels of the *Bark* are alſo different in Number, Poſition, Size and Kind. In *Pine* they are leſs, and in *Walnut* more numerous; as to their Poſition, the inmoſt D C in *Pine*, Fig. 488, compoſe a radiated Ring, the utmoſt are ſtragling up and down without any certain Order. In *Walnut*, Fig. 486, the inmoſt D C make alſo a radiated Ring, and the utmoſt a double Ring H R I, not radiated but of round Parcels: As to their Kind, they differ moſt apparently from the Diverſity of Saps thoſe different Veſſels contain; which in the Bark of Pine, Fig. 488. are alſo of two Sorts, the inmoſt are Lymphæducts, as in the two former; the outmoſt are not Milk, but Gum Veſſels, or reſiniferous, and ſtand ſtraggling or ſingly about the Bark; all the clear Turpentine that drops from the Tree iſſues from theſe Veſſels, which are apparent even to the naked Eye; whereas thoſe of the Lymphæduct are not to be diſcerned without the Aſſiſtance of a *Microſcope*.

The two next Pieces of Branches are common Sumach, Fig. 494. and *common Wormwood*, Fig. 490, which are remarkable for their having three kind of Veſſels in the *Bark*, whereas the former have only two. Firſt then in *common Sumach* is a thick radiated Ring D M C of Lymphæducts, ſtanding on the inner Margin of the Bark contiguous to the Wood; theſe Veſſels exhibit their Lympha very apparently. The ſecond Kind of Veſſels X X compoſe a Ring, and are ſituate near the outward Margin of the *Bark*. Between theſe two Kinds ſtand the Milk Veſſels K M L, each of which being empaled or hem'd in by an Arch of roriferous Veſſels.

The next is a Branch of common *Wormwood*, Fig. 490, in the *Bark* of which are alſo three kinds of Veſſels; firſt there is a thin radiated Ring, C D L K of Lymphæducts, contiguous to the Wood, yet this Ring is not entire, but made up of ſeveral Parcels; which are intercepted by as many parenchymous ones, inſerted from the *Bark* into the Pith. The ſecond Sort of Veſſels K L, which ſeem to be roriferous, are ſituate near the Middle of the Bark, and ſtand in arched Parcels; theſe alſo compoſe a Ring.

Beyond theſe Arches, and towards the outer Margin of the *Bark*, ſtand a third Sort of Veſſels H M I, their Content is a kind of a *liquid*, *oleous* and *viſcid Gum*, which for its pleaſant Flavour may be called an *aromatick Balſam* *, becauſe it perfectly affordeth whatever is in the Smell or Taſte of Wormwood, being the Eſſence of the whole Plant, ſo that they are in all Reſpects analogous to the Turpentine Veſſels in Pine.

The Structure of the Milk and Gum Veſſels when viewed with the *Microſcope*, ſeem to be made by the Conſtipation of the Bladders in the Bark, that is to ſay, they are ſo many Chanels, not bounded by any Sides proper to

* *Grew An. Plants, p.* 111.

them-

themſelves, as a Quill thruſt into a Cork, or as the Air Veſſels in the Wood, but by the Bladders of the Parenchyma * which are ſo crowded up together, as to leave certain tubular Spaces throughout the whole Length of the Bark.

One Difference between thoſe Veſſels juſt deſcrib'd, and theſe hollow Tubes, *&c.* in the Pith, is this, that they are not originally formed with the Pith, but are formed partly by the ſtretching it undergoes from the Dilatation of the Wood, and partly from the drying and ſhrinking up of its Bladders, and of their component Fibres; whereas the Veſſels in the Bark are many of them originally formed † therewith; and thoſe which ſucceed them are not cauſed by any Rupture as thoſe in the Pith are, but from a regular Diſpoſition of the parenchymous Fibres, and Conſtipation of the Bladders thereof; all which will appear very plain upon viewing the three Figures 477, 478, and 479.

It has been before obſerved, that the lignous or towy Parts of all Plants are tubular, and that the Juices are conveyed the whole Length of the Plant through an infinite Company of ſmall Tubes.

Theſe very Tubes or Lymphæducts are likewiſe made up of other yet much ſmaller Tubes, ſet round together in a cylindrical Figure; by which alſo appears the admirable Smallneſs of theſe Fibres; for there are ſome Lymphæducts that may be reckoned 50 Times ſmaller § than an Horſe-hair, and that thoſe minute Fibres are alſo compoſed of other ſuch Fibres, but much ſmaller, is not altogether improbable; allowing therefore but 20 of theſe to compoſe a Thread no bigger than one of theſe Lymphæducts; then one of theſe Fibres muſt be 1000 Times ſmaller than an Horſe-hair.

They may be obſerved in a very white and clear Piece of Aſh torn carefully lengthways, and ſometimes alſo in a very white Piece of Fir.

In the *Eaſt Indies* they manufacture the *Bark* of a certain Tree into a kind of Stuff or Cloth; it is ſpun and dreſs'd much after the Manner of *Hemp:* The long Filaments which are ſeparated from it, upon beating and ſteeping it in Water, compoſe a Thread, of a middle Kind between Silk and common Thread, neither ſo ſoft or bright as Silk, nor ſo hard or flat as Hemp. Some of theſe Stuffs are pure *Bark*, and are called Pinaſſes, Biambonnes, *&c.* In others they mix Silk with the Bark, and call them Ginghams and Nillas; the Fontalungees too, are part Silk, part Bark, and are only diſtinguiſhed by being ſtripped.

* *Grew Ana. Plants, p.* 113. † *Ibid.* § *Ibid. p.* 112.

SECT. IV.

Of the Wood.

THE next general Part of a Branch is the Wood which lies between the Bark and Pith, it is compoſed of parenchymous and lignous Parts; the parenchymous Part of the Wood in all Trees, though much diverſified, is diſpoſed into many Rays or Inſertions running between as many woody Portions, from the Bark to the Pith. Theſe Inſertions are various according to the ſeveral Sorts of Trees or Plants, in Pine, Fig. 488, and Wormwood, Fig. 490. they are not ſo numerous as in Sumach, Fig. 494. in the Apple, Fig. 482, or in the Hazel, Fig. 484.

Theſe Inſertions do not run only through the Wood, but alſo ſhoot out beyond it into ſome Part of the Bark, as in *Elm*, *Sumach*, *Wormwood*, &c.

The Texture likewiſe of theſe Inſertions is alſo various in Wormwood and moſt Herbs, they are manifeſtly compoſed of ſmall Bladders, yet larger in theſe than in Trees.

The *Wood* is likewiſe compoſed of two Sorts of Bodies, that which is ſtrictly woody, and the Air Veſſels. The true *Wood* is nothing elſe but a Maſs of antiquated Lymphæducts, *viz.* thoſe which are originally placed on the inner Margin of the Bark; for in that Place there annually grows a new Ring of Lymphæducts, which by degrees loſing its firſt Softneſs, is at the latter End of the Year turned into a dry and hard Ring of perfect *Wood*. Whence it is evident that the Bark of a Tree is divided into two Parts, and diſtributed two contrary Ways; the outer Part falleth off towards the Skin, and at length becomes the Skin itſelf. The outward Skin of a Tree is not originally made a Skin, but was once ſome of the middle Part of the Bark itſelf, which is annually caſt off and dried into a Skin; the inmoſt Portion of the Bark is yearly diſtributed and added to the Wood, the parenchymous Part thereof makes a new Addition to the Inſertions within the *Wood*, and the Lymphæducts a new Addition to the woody Pieces between which the Inſertions ſtand; ſo that a Ring of Lymphæducts in the Bark this Year will be a Ring of Wood the next, and another Ring of Lymphæducts and of Wood ſucceſſively from Year to Year; ſo in Fig. 482, of part of an *Apple Branch* cut tranſverſly, three Years Growth, are repreſented in that of Sumach, Fig. 484. one Year only is exhibited, and in that of *Walnut*, Fig. 486. are ſhewn four Years Growth of Wood between the Letters DCEF.

Here alſo may be obſerved, that certain Parcels of Wood make either ſeveral ſmall white Rings, as in *Oak*, or ſeveral white and crooked Parcels tranſverſe to the Inſertions, as at DC, KL, *&c.* in *Walnut*, Fig. 486.

In the Branches of *Fir*, *Pine*, &c. are a few Turpentine Veſſels diſperſed up

up and down the *Wood*. The Air Veſſels with the Inſertions, and true Wood altogether, make up that which is commonly called the Wood of a Tree.

The Variety of the Air Veſſels are many, with reſpect both as to their Number, Size, and Poſition, and are not to be found alike in any two Sorts of Plants whatſoever: As to their Number it is very great, in *Apple*, *Pear*, *Hazel*, &c. but in different Degrees, they are repreſented by all the black Spots in the Wood, in all the Figures before referred to.

Their Sizes are as different as the Trees to which they belong, being at leaſt twenty Times bigger in *Elm* or *Oak*, than in *Holly* or *Pear*, &c.

Their Situation is alſo different: In *Apple*, Fig. 482. and in *Walnut*, *Fig*, &c. they are ſpread abroad in every annual Ring; in others they keep more in the Compaſs of ſome Line or Lines, either diametrical or peripherical. In *Holly*, &c. they are radiated or run in even diametrical Lines between the Pith and Bark.

Whether the Air Veſſels are irregular or radiated, Nature hath ſo diſpoſed them, as that many of them ſtand always near the Inſertions.

In *Aſh* the Air Veſſels ſtand in Circles on the inner Margin of every annual Ring. Theſe Circles are in ſome very thick, as in *Aſh* and *Barberry*, in ſome thin, as *Elm*, &c.

Their Form is ſuch that they are never ramified, but continued from one End of a Plant ſmall or great, quite through to the other End thereof.

As to their Texture they oftentimes appear to be unwreathed in Form of a very ſmall Plate, which alſo is not only of different Breadths in different Plants, and uſually broader in the Root than in the Trunk; but alſo the ſaid Veſſels are oftentimes unwreathed, not in the Form of a Plate but of a round Thread. The Cauſes of which Diverſity are principally three, the Weftage of the Fibres of which the Air Veſſels conſiſt: The Difference between the ſaid Fibres, or between the Warp and Woof, and the different Kinds of Woof.

By the Weftage of the Fibres it is, that the Veſſels oftentimes untwiſt in the Form of a Plate; as if a fine narrow Ribband be wound ſpirally, and Edge to Edge, about a Stick, and then the Stick being drawn out, will leave the Ribband in the Form of a Tube * and of one of theſe Air Veſſels, for that which upon the unwreathing of the Veſſel ſeems to be a Plate, is as it were a natural Ribband, conſiſting of a certain Number of Threads or round Fibres, ſtanding parallel as the Threads do in a Ribband; and as in a Ribband ſo here, the Fibres which make the Warp and run ſpirally, do not grow together, but are held in that Poſition by other tranſverſe Fibres which embrace them, and are in the Place of the Woof.

And as the ſaid Fibres are tranſverſly continued thereby making a Warp

* *Grew. An. Plan. p.* 117.

and Woof, ſo are they (as in divers Woollen Manufactures) of different Bulk; thoſe of the former being ſtronger and bigger than thoſe of the latter; by which Means, as Cloth and Silk will uſually tear ſooner one Way than another; ſo here while the Warp or thoſe Fibres which run ſpirally are unwreathed, without breaking the ſmaller ones which hold them together, eaſily tear all the Way.

In the following Figures are ſhewn the Poſition of the Veſſels in ſeveral Sorts of Timber cut Length-wiſe and Croſs-wiſe as follows:

Fig. 507. repreſents a ſmall Piece of the Wood of an *Oak-Tree*, cut tranſverſly, and of its natural Size; and Fig. 508. A B C D, ſhews the ſame Piece as it appeared before the *Microſcope* when greatly magnified, whereof the Parts F F ſeemed to be brown dark Streaks, the Wood included between the Spaces H I and K L, is the Breadth of that Circle which the Tree had increaſed in one Year. E E are the Cavities of very large Air Veſſels, which run the Lengthway of the Tree. Theſe large Veſſels are compoſed of ſeveral ſmaller Membranes, as may be ſeen at Fig. 512. which repreſents part of one of the aforeſaid Air Veſſels ſeen length-wiſe, and as it appeared before the Magnifier.

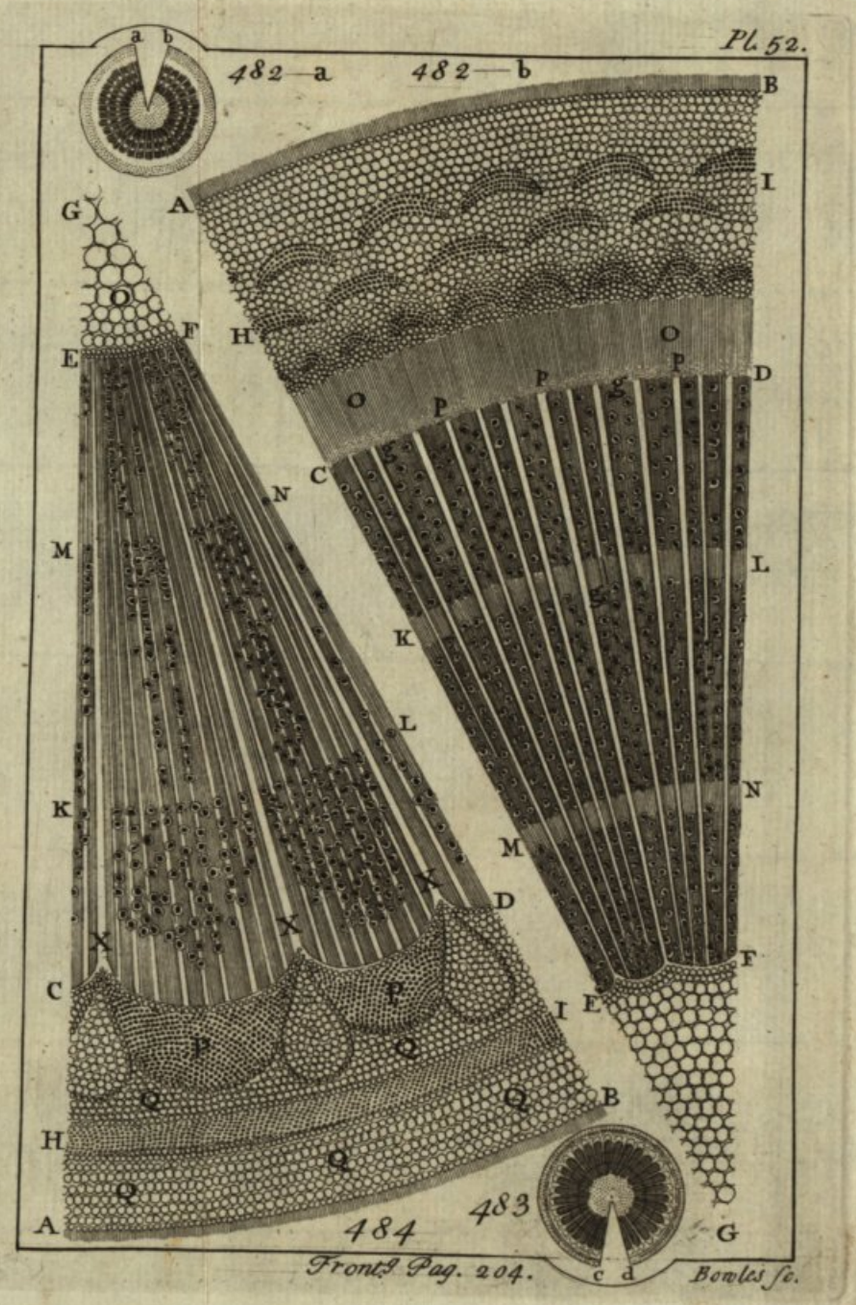
The ſecond Sort of perpendicular Veſſels which tend upwards, are ſeen at e e, Fig. 508. and are alſo compoſed of exceeding fine Skins, * in which are ſeen ſome Spots that in the Microſcope appear like Globules, as at O N, Fig. 511. which ſhews one of theſe ſecond Sort of Veſſels cut lengthwiſe.

The third Sort of theſe Veſſels which run upwards, are extremely ſmall and in great Abundance, as appears throughout the whole Space H I K L, Fig. 508. Theſe alſo are compoſed of extremely fine Skins; they are ſeen length-ways between P Q, Fig. 511.

G G G, Fig. 508. are another Sort of Veſſels, which run horizontally from the Bark to the Pith: Theſe ſeemed to extend themſelves in Furrows, and were crooked or bowed round the Knots. When the *Wood* is cut length-wiſe, theſe horizontal Veſſels are cut acroſs, as at G G G, Fig. 511. The ſecond Sort of horizontal Veſſels are greatly numerous, which when the Oak is cut length-wiſe, are alſo cut acroſs, and appear to the naked Eye as Fig. 513.

Fig. 496. ſhew a Piece of *Elm* cut tranſverſly as it appeared to the naked Eye; and Fig. 497, a *microſcopick* Picture of the ſame. A B, C D is the Breadth of the Ring the Tree had increaſed in one Year. The ſmaller perpendicular Veſſels are ſituate between and joined to the larger, having ſmaller ones between them, as in Oak; the Tubes here alſo are compoſed of ſkinny Membranes. A C and B D, Fig. 497, are horizontal Veſſels ſeen lengthwiſe. Fig. 498, is an upright Section of the Wood of *Elm* magnified, in which G G ſhews the exceeding ſmall Veſſels length-ways,

* *Leeuwen. Anat. & Contemp. Vol.* 1. *p.* 3.


Pl. 52.
482—a
482—b
a b
c d
A
B
C
D
E
F
G
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M
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P
Q
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484
483
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H H is the Cavity of one of the great Veſſels, being full of Turpentine Threads, or little Tubes, with black Spots curiouſly wove together; as at Fig. 499.

Fig. 500. is a ſmall and thin Piece of *Beach*, cut tranſverſly, and Fig. 501. repreſents the ſame as it appear'd in the *Microſcope*. Its Length between A B and D C is the Breadth of a Circle, of one Year's Growth. The perpendicular Veſſels in this Wood are of two, and the horizontal Ones of three Sizes; of which thoſe expreſſed by E E, Fig. 501. are exceeding ſmall; in the upright Section, Fig. 502. theſe horizontal Veſſels are cut tranſverſly, and ſhewn by H H, the ſecond Sort of horizontal Veſſels are ſeen lengthwiſe, from D to A, Fig. 501. and a tranſverſe Section of the ſame Veſſels are ſeen in the upright Section of the Timber, Fig. 502. at I, I, I, and at K K are ſeen the great perpendicular Veſſels.

Fig. 509. repreſents a tranſverſe Section of a ſmall Bit of *Black Ebony*, greatly magnified, of which G, G, G, are the large upright Veſſels. K K, in Fig. 510. ſhews one of theſe large Veſſels cut lengthwiſe, and at Fig. 511. is ſeen another of a larger Sort, in which are many Streaks and Spots. The ſecond Sort of perpendicular Veſſels are ſeen between A B, A B, and the third Sort between C D, C D; a fourth Sort are ſquariſh, and included between the ſecond and third in the upright Section, Fig. 510. L L ſhews the ſmalleſt Veſſels, and I, I, the tranſverſe Sections of the horizontal Ones.

Fig. 503. A B C D is a ſmall Piece of *Box*, cut tranſverſly, and of the ſame Size to the naked Eye as the Piece of *Ebony*. This Wood alſo conſiſts of large and ſmall perpendicular Veſſels intermix'd; the large ones are compos'd of Skins, and are full of extremely minute Particles, as may be ſeen in the upright Section thereof at E E, Fig. 504. the Cavities of the leſſer Veſſels are ſhewn lengthways at F E. A B and C D, Fig. 503. are horizontal Veſſels, running lengthways, and at G G, Fig. 504. is ſeen a tranſverſe Section of the ſame.

A B C D E F, Fig. 505. repreſents a tranſverſe Section of a ſmall Piece of *Straw*. A B E F is the ſhining Bark, compoſed of an incredible Number of exceeding ſmall Veſicles. G G G G are Veſſels, or rather Bladders, having four, five, or ſix Sides, and compoſe the greateſt Part of the Inſide of the *Straw*. H H H are ſome of the before-mentioned Veſſels, intermixed with, or ſurrounded by a great Number of exceeding ſmall Veſſels. At Fig. 506. the ſame Veſſels are ſeen lengthways in a perpendicular Section of the *Straw*.

SECT. V.

Of the Pith.

THE third general Part of a Branch is the *Pith*, being in Subſtance nearly allied to the Parenchyma in the *Bark*, and the *Inſertions* in the Wood.

Its Size is various, not being the ſame in any two Branches here repreſented. In Wormwood, Fig. 490. and Sumach, Fig. 494. it is very large. In Pine, Fig. 488. and Walnut, Fig. 486. not ſo large. In Apple, Fig. 482. and Hazel, Fig. 484. it is ſmaller.

It is alſo remarkable, that the *Bark* and *Wood* in moſt Plants increaſe yearly; and the *Pith*, on the contrary, grows ſmaller.

The *Pith*, for the moſt Part, is furniſhed with a certain Number of Sap Veſſels, which form a Ring round the Margin thereof. They are numerous and conſpicuous in *Walnut*, Fig. 486. and in *Fig*, *Pine*, &c. and are of divers Kinds, being Lymphæducts in *Walnuts*, Lacteals in *Fig*, and Reſiniferous in *Pine*.

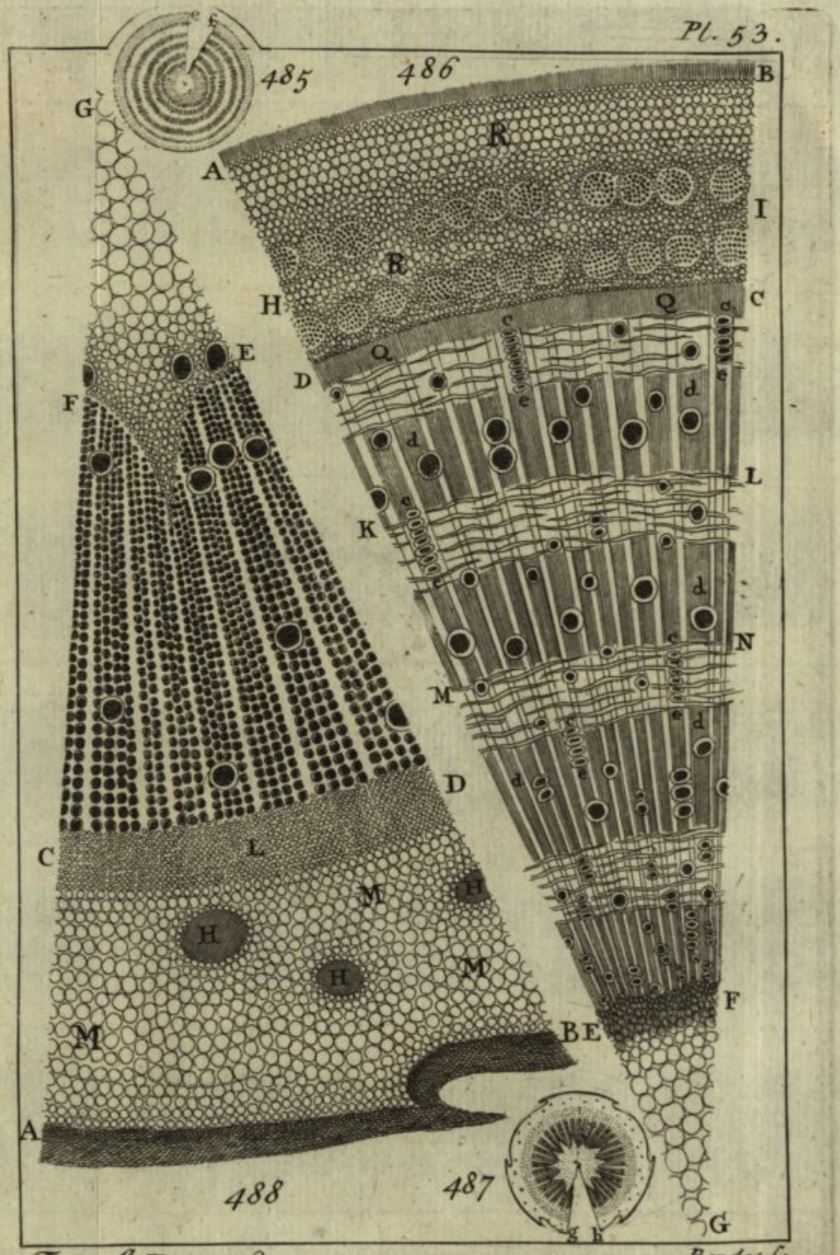
The Parenchyma of the *Pith* is compoſed of Bladders the very ſame with thoſe in the *Bark*, and oftentimes in the Inſertions within the Wood, only theſe of the *Pith* are largeſt, thoſe in the Bark leſs, and theſe in the Inſertions leaſt of all.

The Bladders of the *Pith*, tho' always comparatively great, are of very different Sizes. Thoſe of *Thiſtle*, *Borage*, &c. appear in the *Microſcope* like the Cells of an Honey-Comb; the Bladders in *common Thiſtle* and *Borage*, are ſo large as to contain within their horizontal Area, about twenty Bladders of the *Pith* of *Oak*. Wherefore one Bladder in *Thiſtle* is at leaſt an hundred times bigger than another in *Oak*.

The Shape of the *Pith* Bladders admit of ſome Variety, they are for the moſt Part round, yet oftentimes angular, as in *Reed Graſs*, a Water Plant; where they are alſo cubical; in *Borage*, *Thiſtle*, and many others they are pentangular, ſexangular, and ſeptangular.

As to the Texture of theſe *pithy* Bladders, they are oftentimes compoſed of ſmaller ones, as in *Borage*, *Bulruſh*, and many other Plants.

Whence it appears, that as the Veſſels of Plants, *viz.* the Air Veſſels and Lymphæducts are made up of Fibres, ſo the *Pith*, or the Bladders of which the *Pith* conſiſts, are likewiſe compoſed of Fibres, which is alſo true of the Parenchyma of the Bark, and of the Inſertions in the Wood, and even of the Fruit, and all other parenchymous Parts of a Plant, and that the very Pulp of an *Apple*, *Pear*, *Cucumber*, *Plumb*, or any other Fruit, is nothing elſe but a Ball, of moſt extreamly ſmall tranſparent Threads or Fibres, joined



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together in a different, but curious Manner, even all thoſe Parts of a Plant, which are neither formed into viſible Tubes, nor Bladders, are made up of Fibres; and though it be difficult to diſcover them in thoſe Parts which are the moſt compact and cloſe, yet in the *Pith* which conſiſts of more open Work, they are viſible; and that in the *Pith* of a *Buiruſh*, *common Thiſtle*, &c. not only the Threads of which the *Bladders*, but alſo the ſingle Fibres of which the Threads are compos'd, may be diſtinctly ſeen, when placed before the *Microſcope*.

The Fibroſity of the Parenchyma is alſo viſible in ſome Woods, being interwove with the lignous Parts, and with every Fibre of every Veſſel, as in very white *Aſh* or *Fir* may be diſcover'd.

Whence it follows, that all the Parts of a Plant conſiſt of Fibres, of which thoſe of the Lymphæducts run lengthwiſe, thoſe of the Pith, Inſertions, and Parenchyma of the Bark horizontally, thoſe of the Air Veſſels begin their Circuit horizontally, and continue it in Height or lengthwiſe.

From what has been ſaid, there appears to be a great Similitude between the Mechaniſm of *Plants* and *Animals*, the Parts of the former ſeem to bear a conſtant Analogy to thoſe of the latter; and the *Vegetable* and *Animal* Œconomy ſeem to be both formed on the ſame Model; for from the foregoing Obſervations, and the Aſſiſtance of the *Microſcope*,

Firſt, the *Root* is found to be a ſpongy Body, whoſe Pores are diſpoſed to admit certain humid Particles, prepared in the Ground.

Second, the *Wood* which conſiſts of capillary Tubes running parallel from the Root throughout the Stalk, (the Apertures of thoſe Tubes are too minute to come under the Cognizance of the naked Eye) theſe Mr. *Bradley* calls *arterial Veſſels*; it being through theſe that the Sap riſes from the Root.

Third, beſides theſe there are other larger Veſſels, diſpoſed on the Outſide of the arterial Veſſels between the Wood and the inner Bark, and leading down to the Covering of the Root, which he alſo calls *venal Veſſels*, and ſuppoſes them to contain the liquid Sap found in *Plants* in the Spring.

Fourth, the *Bark* being of a ſpongy Texture, which by many little Strings communicates with the *Pith*.

Fifth, the *Pith*, or Pecten, which conſiſts of little tranſparent Globules, chained together ſomewhat like the Bubbles that compoſe the Froth of Liquor.

Malpighi was the firſt who obſerved, that Vegetables conſiſts of two Sorts of Veſſels. 1. Thoſe abovementioned, which receive and convey the alimental Juices. 2. *Tracheæ*, or *Air Veſſels*, which are long hollow Pipes, wherein Air is continually received and expelled, *i. e.* within which *Tracheæ* he ſhews all the former Series's of Veſſels are contained.

Hence

Hence it follows, that the Heat of a Year, nay of a Day, of a ſingle Hour, or Minute, muſt have an Effect on the Air, included in theſe *Tracheæ*, i. e. it muſt rarify it, and conſequently dilate the *Trachea*; whence alſo muſt ariſe a perpetual Spring or Force of Action to promote the Circulation in *Plants*.

For by the Expanſion of the *Tracheæ*, the Veſſels containing the Juices are preſſed; and by that Means the contained Juice is continually propelled, and ſo accellerated; by which ſame Propulſion the Juice is continually comminuted and rendered more and more ſubtle, and ſo enabled to enter Veſſels ſtill finer and finer; the thickeſt Part of it being at the ſame Time ſecreted and depoſited into the lateral Cells, or Loculi of the *Bark*, to defend the Plant from Cold and other external Injuries.

The *Juice* being thus conveyed from the *Root*, to the remote Branches, and even to the Flower; and having in every Part of its Progreſs depoſited ſomething both for Aliment and Defence; what is redundant paſſes out into the *Bark*, the Veſſels whereof are inoſculated with thoſe wherein the Sap is mounted; and through theſe it deſcends to the Root, and thence to the Earth again, and thus is Circulation effected.

Thus is every Vegetable acted on by Heat during the Day-time, and the Sap Veſſels thus are ſqueezed and preſs'd, and the Sap protruded and raiſed, and at length evacuated, and the Veſſels exhauſted in the Night again; the ſame *Trachea* being contracted by the Coldneſs of the Air, the other Veſſels are eaſed and relaxed, and ſo diſpoſed to receive freſh Food for the next Day's Digeſtion and Excretion.

The Juice being carried on to the *Germs* or *Bud*, is more concreted; and here having unfolded the *Leaves*, which being expoſed to the alternate Action of Heat and Cold, moiſt Nights, and hot ſcorching Days, are alternately expanded and contracted; and the more on account of their reticular Texture.

By ſuch Means the *Juice* is farther altered and digeſted, as it is further yet in the *Petala*, or Leaves of the Flowers, which tranſmit the *Juice*, now brought to a further Subtility to the *Stamina*; theſe communicate it to the *Farina*, or Duſt in the *Apices*, where having undergone a farther Maturation, it is ſhed into the *Piſtil*, and here having acquired its laſt Perfection, gives Riſe to a new Fruit or Plant.

Fig 514, and the four following Figures, repreſent the Structure of the woody Fibres and Lymphæducts both in the Bark and Wood.

Fig. 514, ſhews a ſingle Veſſel in the *Bark* of *Flax*; and Fig. 515. repreſents the ſame Veſſel as ſeen in the *Microſcope*, and greatly magnified; whence it appears to be compoſed of a great Number of other lignous Fibres, with which alſo the Parenchymous are intermixt.

Fig. 516, exhibits a Parcel of the ſame Veſſels in the Wood of Fir, greatly magnified; and at a, is ſeen the ſame Piece of its natural Size.

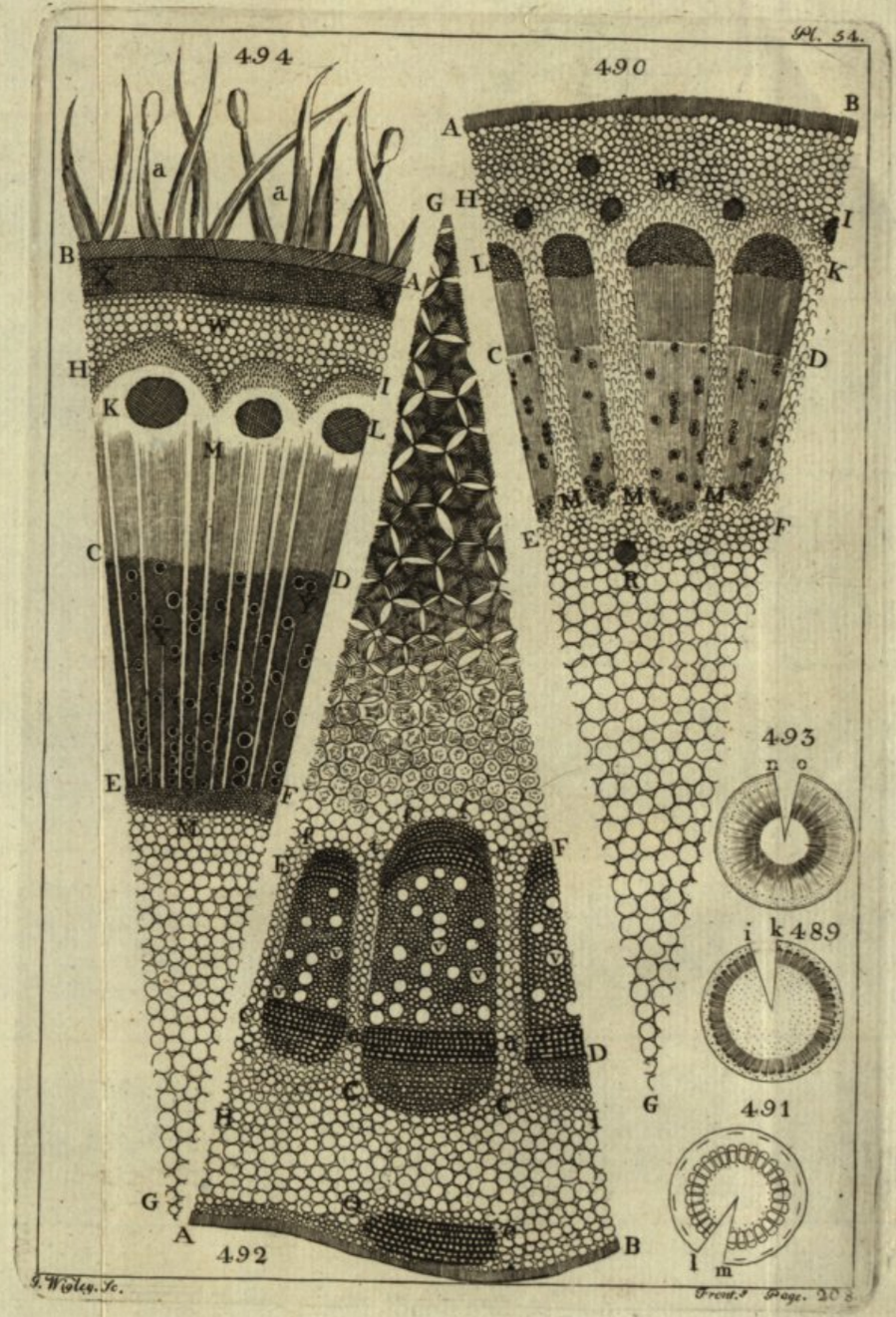

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Fig. 517, AB, ſhews a Lymphæduct, and Fig. 518, C, repreſents a lactiferous Veſſel, both of which are ſurrounded with parenchymous Bladders, and are greatly magnified.

Fig. 519, repreſents part of the Stalk of Sumach, ſomewhat larger (and more magnified) than that of Fig. 494, with ſeveral Breaks in it, to ſhew the Contexture both of the perpendicular and horizontal Fibres; in which, as before,

A B a a ſhews the hairy Skin.

A B C D the Bark in which the Fibres b b, c c, and d d, that hang down therefrom are Lymphæducts, one of which d d d, is compoſed of a great many other ſmaller Fibres.

H W I the Parenchyma.

D M C the common Lymphæducts.

K M L the Milk Veſſels compoſed of Bladders.

H I another Sort of Lymphæducts arched over the Milk Veſſels.

D C E F the Wood, from which the Fibres e f, that hang down, are ſome of them the old Lymphæducts turned into Wood; g h g h are two Air Veſſels in which the wreathing thereof is plainly ſeen, and from h to i is alſo ſeen Part of the ſame Veſſels unwreathed.

O P is part of one of the Inſertions compoſed of Bladders, and thoſe Bladders of Threads.

E F G is part of the Pith compoſed of thready or fibrous Bladders.

CHAP. XXXVIII.

Of Leaves.

SECT. I.

THE *Leaves* of Trees or Plants are full of innumerable Ramifications, that convey the perſpirable Juices to the Pores for their Diſcharge. The Fibres of the Leaf do not ſtand in even Lines from the Stalk, but always in an angular or circular Poſture, and their vaſcular Fibres or Threads are 3, 5 or 7; the Reaſon of their being in this Poſition, is for the more erect Growth and greater Strength of the Leaf, as alſo for the Security of its Sap. Another Obſervable in the Fibres of the *Leaf*, is their orderly Poſition, ſo as to take in an eighth Part of a Circle, as in *Mallows*, in ſome a *Tenth*, but in moſt a *Twelfth*, as in *Holy-Oak*, or a *Sixth*, as in *Syringa*.

The Art of folding up the *Leaves* before their Eruption out of their Gems, *&c.* is incomparable both for its Elegancy and Security, *viz.* in taking up (ſo as their Forms will bear) the leaſt Room; and in being ſo conveniently couched, as to be capable of receiving Protection from the other Parts, or of giving it to one another, *e. gr.* firſt there is the *Bow-lap*, where the Leaves are all laid ſomewhat convexly, one over another, but not plaited, but where the Leaves are not ſo thick ſet as to ſtand in the *Bow-*

lap; there we have the *Plicature*, or the *flat Lap*, as in *Roſe-tree*, &c. To theſe Dr. *Grew* adds their various Foldings, which he calls by the Names of the *Duplicature*, *Multiplicature*, the *fore Rowl*, *back Rowl*, and *tre Rowl* or *treble Rowl*.

To theſe curious Foldings may be added another noble Guard by the Interpoſition of Films, *&c.* of which Dr. *Grew* ſaith there are about ſix Ways, viz. *Leaves*, *Surfoyls*, *Interfoyls*, *Staks*, *Heads*, and *Mantlings*.

The various Methods which Nature takes to preſerve the Leaves from the Injuries both of the Ground and Weather are, *viz.* the young Buds of *Ammi*, at their firſt Eruption from the Ground, are couched, as *Fern* is rowled inward; each Bud, againſt the Brace of the Stalk of the foregoing Leaves, and moſt exactly incloſed in the Membranes thence produced. Nature hath generally provided them with another Protection, where the Stalks of the Leaves are ſo long that they cannot lap over each other, the Bottoms of the Stalks are expanded into broad Membranes, as in *Crows-foot*, *Doves-foot*, *Clover*, *Cranſhill*, *Strawberry*, *Harrow*, &c. and ſometimes inſtead of two Skins lapped over each other, one entire Skin is produced from the Stalk, in which, as within a Secundine, the Bud is ſafely lodged, which it gradually breaks open in its Growth.

It is alſo obſervable in *Dock*, *Sorrel*, *Biſtort*, and all other Plants of this Sort, with this Difference, that every Veil or Secundine is not here produced from the Stalk of the *Leaf*; whereas in the former every Bud hath one to itſelf in theſe Plants, every leſſer *Leaf*, together with its own proper Veil, is always incloſed with the next greater *Leaf* in another common to them both, and both theſe with the next in another, and ſo on to the greateſt. The *Orchis*, and other Plants of this Sort, have a double Sheath over all. The Buds of ſome Herbs as *Plantain*, having no Hairs growing over them, are covered with hairy Thrums, and the *Nettle* hath Baſtard-leaves or Interfoyls between *Leaf* and *Leaf*, for the Preſervation of its Stings.

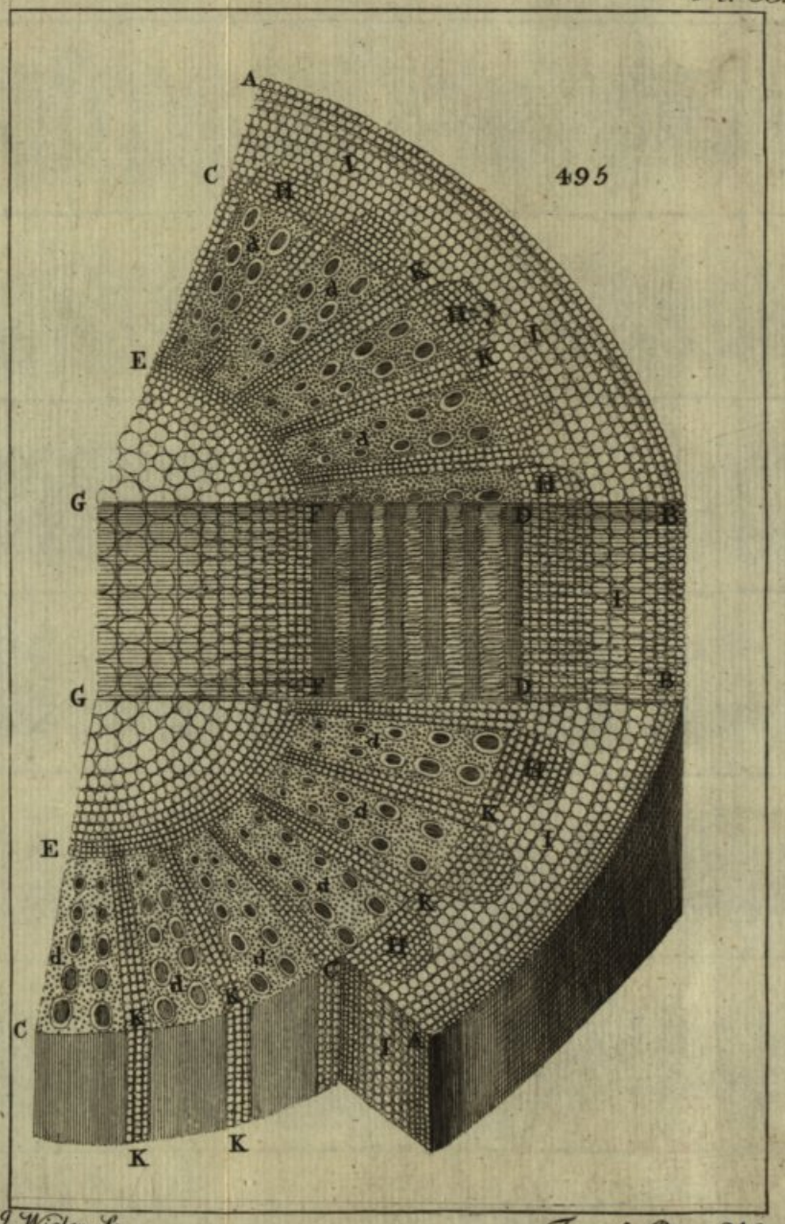
Another Sort of Protection is ſeen, in white *Archangel*, and other Plants of a like Shape. In which the greater *Leaves* do alſo incloſe the leſſer, by a double fore Curl at the Bottom of every two great *Leaves*, which embraces the little under Bud, and ſo keeps it clean and warm.

The *Leaves* of *Onions* are all Pipes one within another, having a ſmall Aperture about the Middle common to all of them, even the moſt minute ones in the Center.

As the Buds of *common Sumach* are exceeding tender, Nature appears in a peculiar Manner ſolicitous for their Preſervation, being lodged within the Body of the Stalk, as entirely as a Kernel is within an Apple; from whence it is that the Baſis of every Stalk is extremely ſwelled.

There are alſo *globular Excreſcencies*, *Spots*, *Hairs*, *Thorns*, and *Prickles*. Globulets are ſeen upon *Orach*, but more plainly upon *Bonus Henricus*, in

Pl. 55.



J. Wigley. Sc.

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in these growing almost upon the whole Plant, and being very large, are by most People taken Notice of; but the *Microscope* hath discovered to us that they are the natural and constant Offspring of very many other Plants, they are of two Kinds transparent as upon the Leaves of *Hyssop*, *Mint*, *Baume*, &c. white on *Germander*, *Sage*, &c. Sometimes they appear like a fine Powder upon the Leaf, these were first white and transparent as in *Bears Ear*. If this be licked of, it will afford the Taste of the essential Content of the Plant. They frequently grow on both Sides the *Leaf*, yet sometimes, as in *Ground Ivy*, chiefly on the Back side thereof, and in many Plants where the Elder-leaves have none, on the young Buds they are very numerous, as in *Corin tree*, *Sorrel*, and others.

Spots are observable in *St. Johns-wort*, *Rue*, *Ground-Ivy*, *Pimpernel* or *Anagallis*, &c. when held up against the Light.

Thorns are lignous and cortical, the first are such as those of *Hawthorn*, somewhat like these are the Spines or thorny Prickles, upon the Edges and Tops of divers *Leaves*, as *Barberry*, *Holly*, *Thistle*, *Furz*, &c.

Cortical Thorns are such as those of the *Rasberry-Bush*, being not, unless in an invisible Proportion propagated from the lignous Body. They are of Use not only for the Protection of the Bud, but also for the Support of the Plant.

The Use of Hairs on Leaves are to preserve young Buds, not only from the cold Air, but also from too much wet, which if it were contiguous would often rot and dry them. But being made to stand off in Drops, at the Ends of the Hair, does not hurt but refresh them. Thus we see by the Assistance of the *Microscope*, that Nature oftentimes makes the meanest Things subservient to the best Ends.

Sect. II.

Of the Parts and Texture of the Leaf.

THE first Part which here presents itself is the Skin, a small Bit of which being stripped off the *Leaf*, and laid upon the Object carrying Glass R, of Fig. 2. or held between the Nippers, and then placed before the Microscope, will appear to consist of parenchymous and lignous Fibres, all very curiously and admirably interwoven, as in Flag, Tulip, *&c.*

From hence it is easy to conceive, that the Skins of all Plants (as well as those of Animals) are perspirable between the several Fibres of which they consist, formed into several Orifices, either for the better Avolation of superfluous Sap, or the Admission of Air, these Orifices are not in all Leaves alike, but varied in Bigness, Number, Shape and Position, and are the Cause of the Gloss on the Upper-side of the Leaves, the Backside having none of them.

Next the Skin lies the pulpy Part of the *Leaf*, called the Parenchyma, being compoſed of an incomparable Number of little cylindrical Fibres, which are in moſt Leaves wound up into minute Bladders, but generally more viſible in the Stalk than in the Body of the Leaf. In ſome Leaves, as in Borage, Fig. 520 the greater Bladders are made up of leſſer ones, and in ſome others theſe parenchymous Fibres are all drawn up cloſe together.

The pithy Part in the Stalk, and almoſt up to the Top of the chief Fibre, in many *Leaves* is tubular, even whilſt they are yet young and ſappy, as in *Sweet Cervil*, *Hemlock*, *Endive*, *Cichory*, *Lampſana*, *Dandelion*, *Burdock*, *Daize*, *Scorzonera* and others, and ſometimes the ſaid pithy Part is opened into ſeveral pithy Pipes; the Fibres alſo of the Leaf, which is viſible to the naked Eye, are compoſed of Sap and Air Veſſels. Their Poſition is various and regular, not only in the Body of the Leaf, but likewiſe in the Stalk, as in the Stalk of a Mallow-leaf, Fig. 521. they ſtand in ſix oblong Parcels of equal Size, and in a Circle near the Circumference. In *Dandelion*, *wild Clary*, and in *Borage*, Fig. 522. they ſtand in five Parcels.

In the Body of the Leaf, beſides the Poſitions of the fibrous Strings, there is one in particular which runs round the Edge of the Leaf in all Plants; but can hardly be well diſcover'd without ſtripping off the Skin of the Leaf. The Continuation of the Veſſels ſeem to be ramified, and ſeems alſo to be inoſculated.

Theſe *Trachea* or Air Veſſels are viſible, and appear very pretty in the Leaf of Scabious, or the Vine, by pulling aſunder ſome of its principal Ribs or great Fibres; between which may be ſeen the ſpiral Air Veſſels (like Threads of a Cob-web) a little uncoyled, as repreſented by Fig. 523. which ſhews a Piece of a *Vine-leaf*, wherein theſe Veſſels were drawn out and a little magnified, and at a, the ſpiral Circumvolutions are repreſented as they appear'd in the *Microſcope* when greatly magnified, and as they ſtand intire within the Wood; and at b, is ſeen one a little ſtretched.

Mr. *Leeuwenhoek* tore a Leaf of *Box* to Pieces, called *Palma Cereris*, that he might the better examine it, and computed one Side thereof to contain 172090 Pores, and as the other Side muſt conſequently have the ſame Number, the whole Pores in a Box-leaf will be 344180.

SECT. III.

Of Roſemary-Leaves.

FIG. 524. repreſents a ſmall Part of the Underſide of a *Roſemary-leaf*,* whereof A B ſhews Part of the Upper-ſide which was doubled over, and conſiſted of a ſmooth ſhining Subſtance, but its Under-ſide appeared

* *Ho. Mi. p.* 142.

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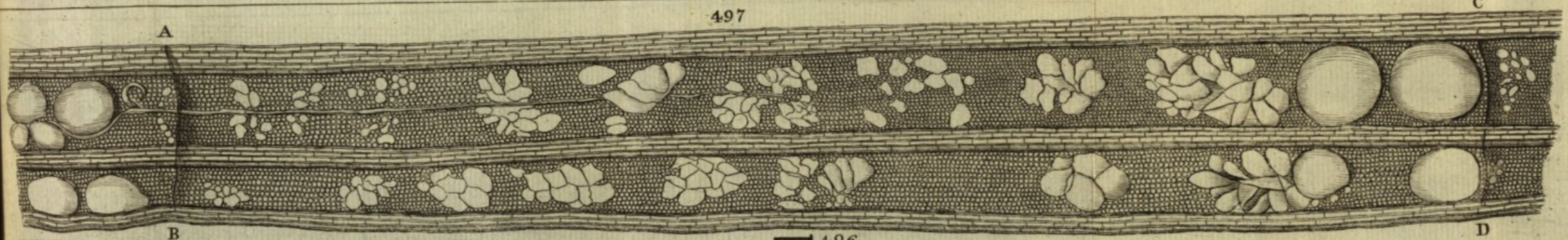

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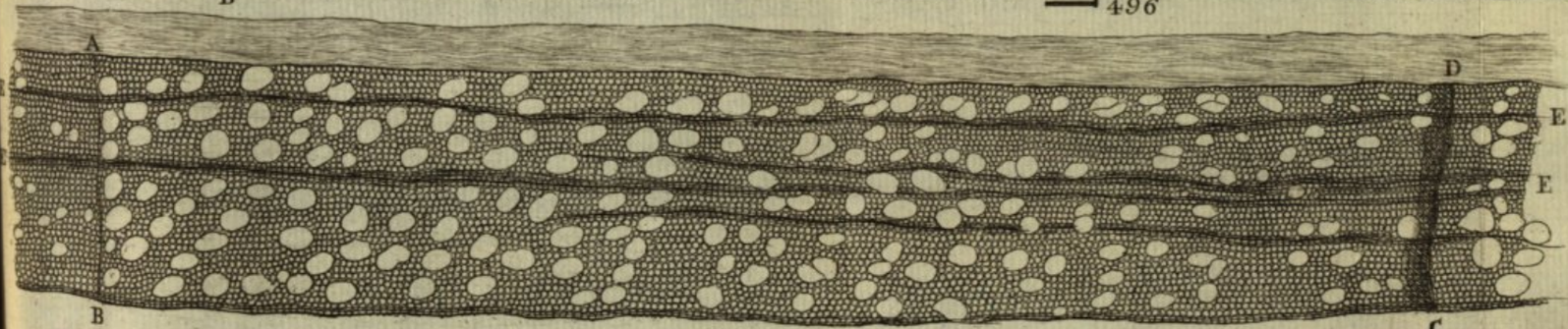

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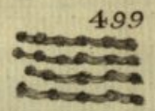

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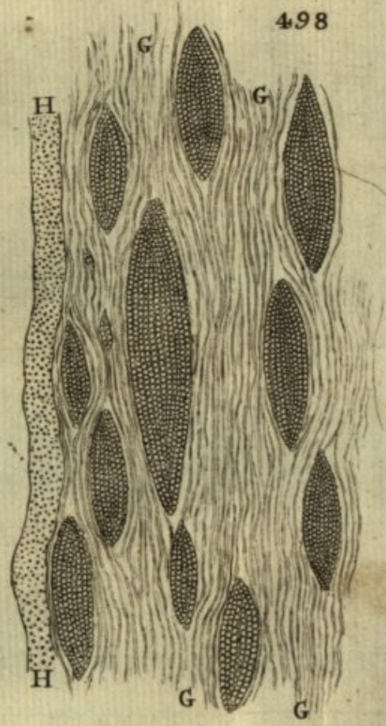

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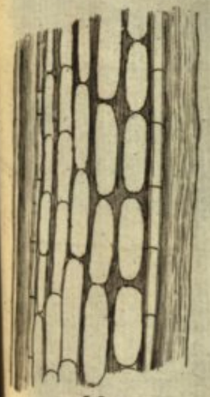

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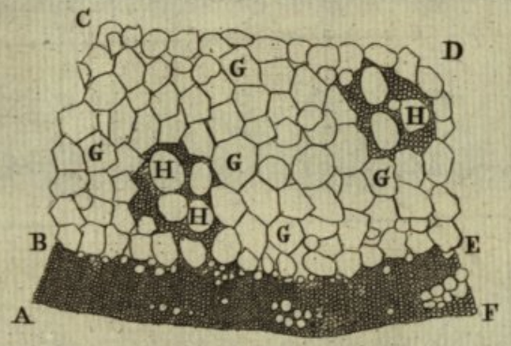

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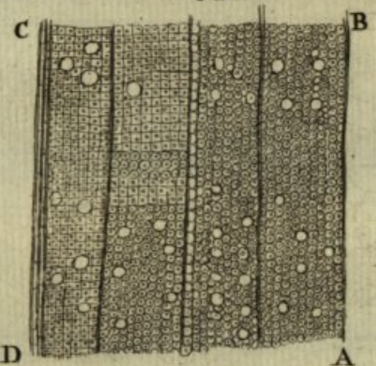

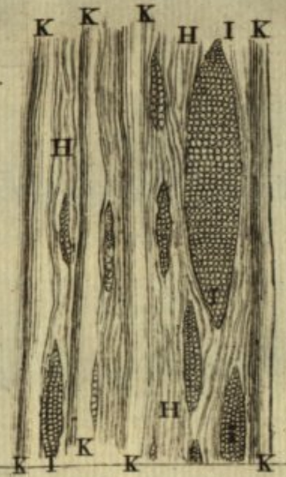

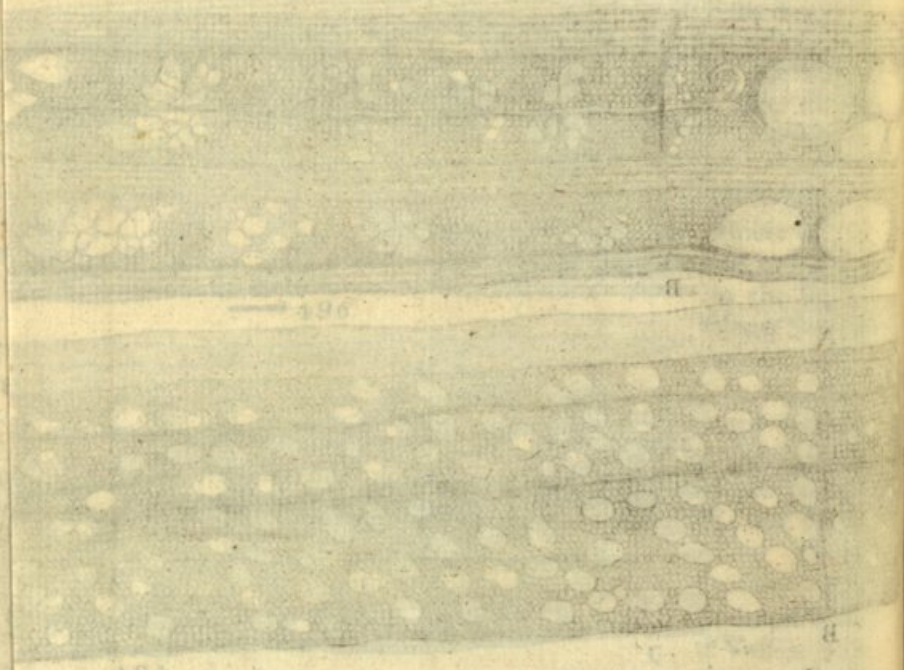
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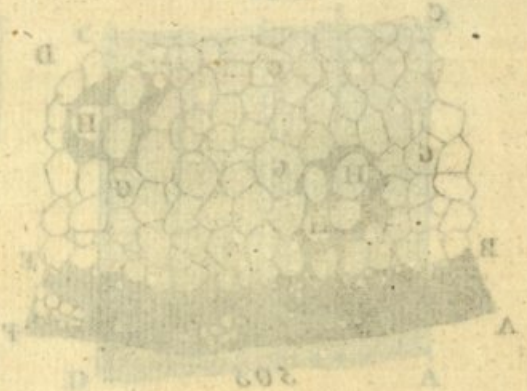
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in the *Microſcope* like a Thicket of Buſhes, amongſt which were a great Number of round Balls, exactly globular, and afford a very agreeable Proſpect.

The Back-ſide of a Roſe-tree Leaf, but eſpecially of a Sweet Briar-leaf, looks diapered with Silver.

The Back of the Leaf of *Engliſh* Mercury * looks as if rough caſt with Silver, and all the Ribs ſet round with white tranſparent Balls.

A Leaf of Rue looks full of Holes like an Honey-Comb.

A Sage-leaf is taſſeled with white Silver Thrums, and one or two Cryſtal Beads, or Pendants, faſtned to every Knot.

SECT. IV.
Of Stinging-Nettles.

A Nettle is a Plant known almoſt to every body, there being very few but what have felt as well as ſeen it; but how the Pain is ſo ſuddenly created, and by what Means continued, we muſt have recourſe to the Microſcope for our Information, and that will if almoſt any Part of the Plant be looked on, ſhew us the whole Surface thereof to be very thick ſet with ſharp Points, that penetrate the Skin when touched, and occaſion Pain, Heat, and Swelling; they are repreſented in a ſmall Part of the Leaf as they appear in the Microſcope, by Fig. 525. at A B, conſiſting of a rigid hollow Body tapering from B, till it terminate in the moſt acute Point imaginable, being exceedingly clear and tranſparent. At the Bottom of this Cavity lies a minute Bag B, containing a limpid Liquor, † which, upon the leaſt Touch of the Prickle, is ſquirted through the little Orifice, and if it enters the Skin, produces the before-mentioned Miſchiefs by the Pungency of its Salts. C D ſhews one of the chief Fibres of the Leaf, from whence the Stings proceed.

The other Parts of the Leaf or Surface of the Nettle have very little conſiderable, but what is common to moſt Plants, as the Ruggedneſs, Indenting, and Hairineſs, and other Roughneſſes of the Surface, on the Outſide of the Plant.

SECT. V.
Of Cowage, or Cowitch.

THERE is a certain Down of a Plant, brought from the *Eaſt-Indies*, which grows on a Kind of hairy Kidney Bean §. The Pods about three Inches long, reſemble a *French* Bean, and are cover'd with this Down

* *Pow. Mi. Ob. p.* 50. † *Hook's Mi. p.* 143. § *Ibid. p.* 146.

or Hair, which is very ſtiff for its Bigneſs, and cauſes Pain, and Inflammations, if rubbed on any Part; and when viewed by the Microſcope, this Down appears to be a Multitude of pointed Thorns exquiſitely ſharp.

SECT. VI.

Of the Texture of the Leaves of Sea-Weeds.

IT is a Plant which grows upon the Rocks under Water, increaſing and ſpreading itſelf into a great Tuft, which is not only handſomely branched into ſeveral Leaves; but its whole Surface is cover'd over with a curious Kind of carved Work, * conſiſting of a Multitude of very ſmall Holes, ranged in the neateſt and moſt delicate Order; a ſmall Piece thereof is repreſented as it appear'd in the Microſcope, at Fig. 526.

CHAP. XXXIX.

Of Flowers.

A *Flower* is that Part of a Plant which contains the Organs of Generation, or the Parts neceſſary for the Propagation of the Kind.

It is a natural Production, which precedes the Fruit, and yields the Grain or Seed.

Their Structure is ſomewhat various, though the Generality, according to Dr. *Grew*, have theſe three Parts entire, the *Empalement*, the *Foliation*, and the *Attire*.

Mr. *Ray* reckons, that every perfect *Flower* has the *Petala*, *Stamina*, *Apices*, and *Stylus*, or *Piſtil*; ſuch as want any of theſe he deems imperfect Flowers.

In moſt Plants there is a Perianthium, Calyx, or Flower Cup, of a ſtronger Conſiſtence than the Flower itſelf, and deſigned to ſtrengthen and preſerve it.

Flowers, whoſe *Petala* are ſtrong (as *Tulips*) have no *Calyx*; Carnations, whoſe *Petala* are long and ſlender, have an *Empalement* of one Piece; and others as *Knap-Weeds*, have it conſiſting in ſeveral Pieces, and in divers Rounds, and all with a counterchangeable Reſpect to each other, for the greater Strength and Security of themſelves and the *Petala*, &c. they include.

The next is the Foliation, as Dr. *Grew*, the Petala, or Folia, as Mr. *Ray*, and others; in theſe, not only the admirable Beauty, and luxuriant Colours are obſervable, but alſo their curious Foldings, in the Calx before their Ex-

* *Hook's Mi. p.* 140.

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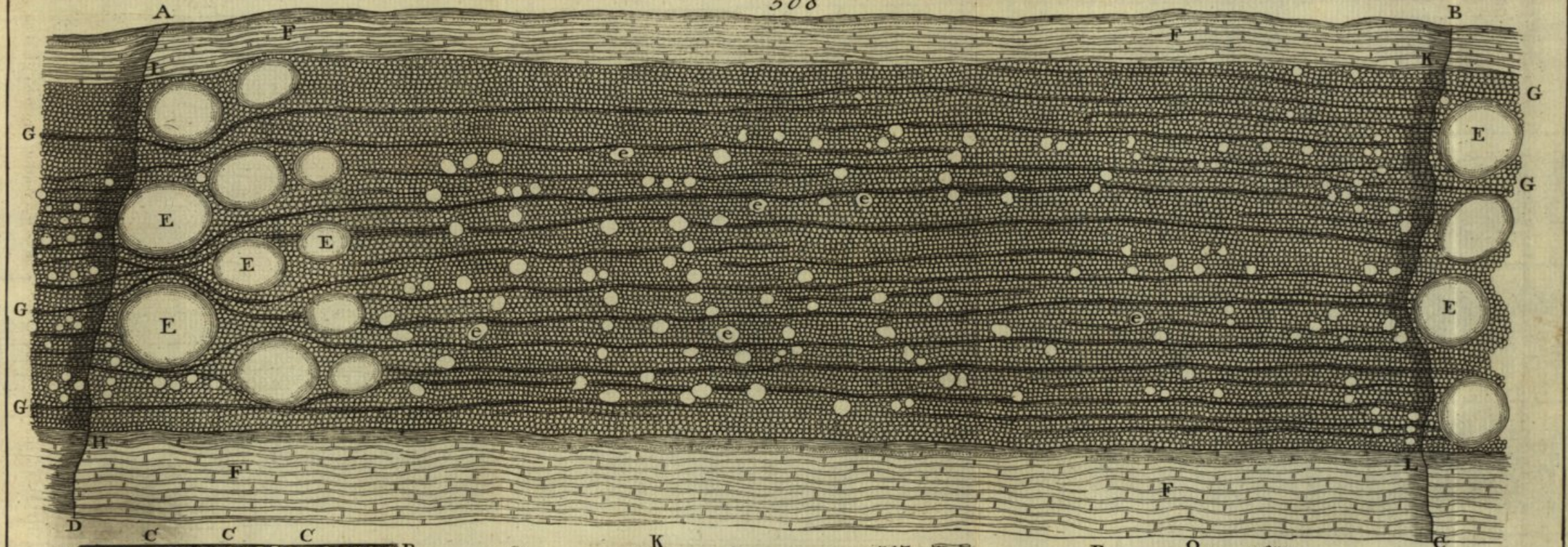

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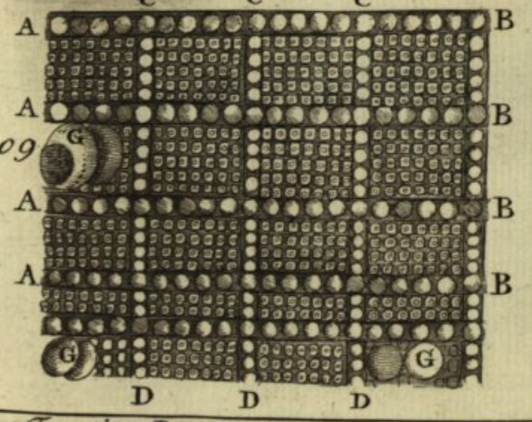

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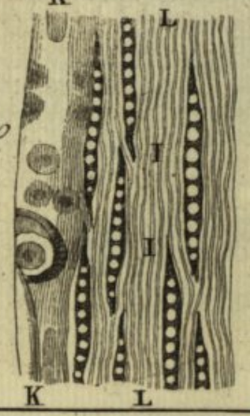

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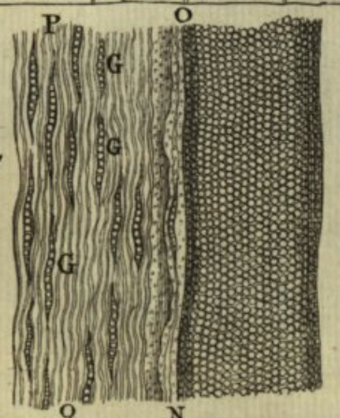

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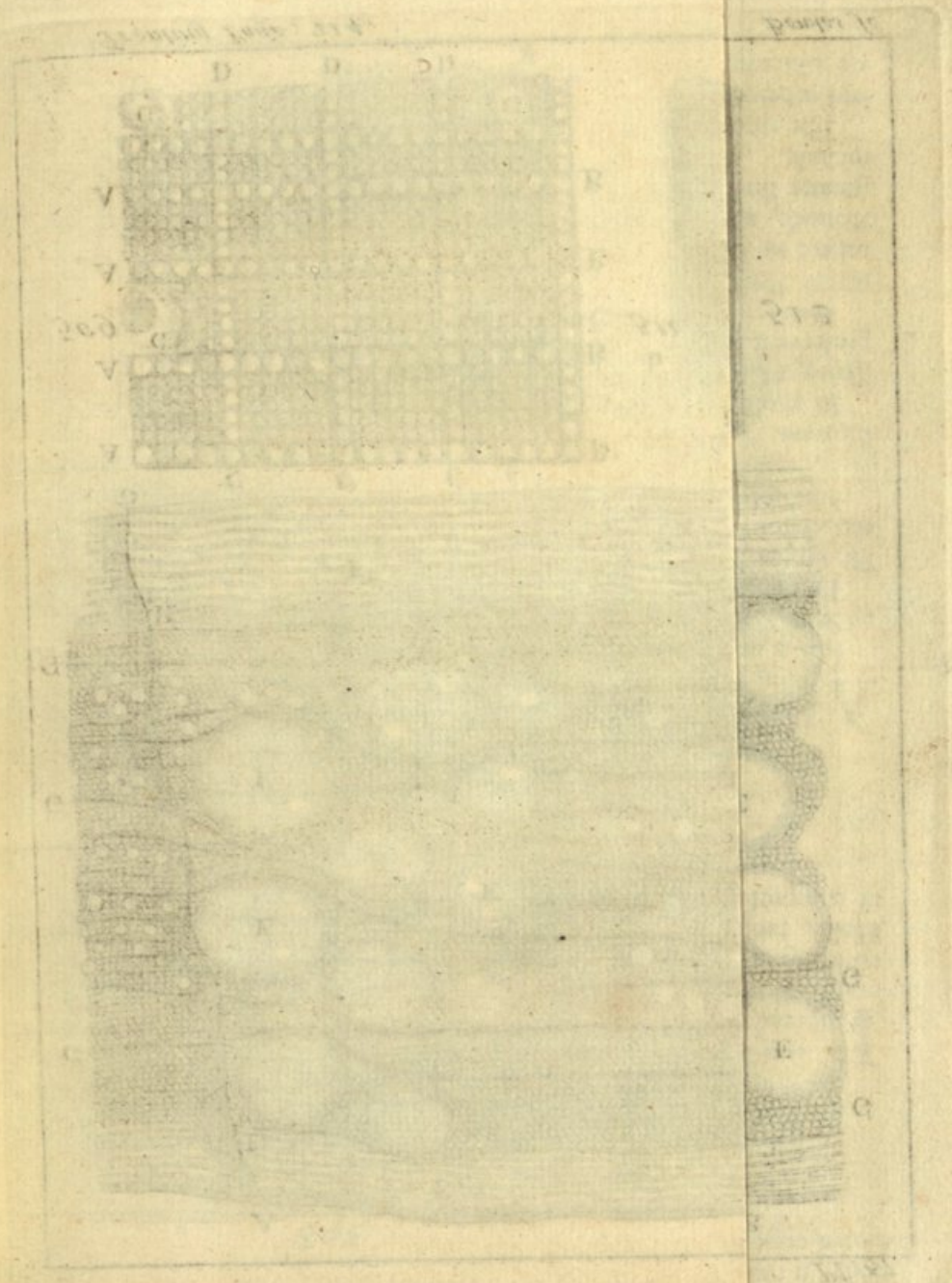

panſion, of which Dr. *Grew* hath theſe Varieties, *viz.* the Cloſe Couch, as in *Roſes*, and ſeveral other double Flowers; the Concave-Couch, as in *Blataria*; *Flora albo*, the ſingle Plait, as in Peaſe-Bloſſoms; the double Plait, as in Blew-bottles, *&c.* the Couch and Plait together, as in *Marigolds*, *Daizes*, &c. The Rowl, as in *Lady Bower*; the Spire, as in *Mallows*; and laſtly, the Plait and Spire together, as in *Convolvulus Doronici Folio*.

As to the Stamina with their Apices and Stylus (called the Attire by Dr. *Grew*) they are admirable, whether we conſider their Colours, or their Make, but eſpecially their Uſe, if it be as Dr. *Grew*, Mr. *Ray*, and others imagine, namely, as a *Male Sperm*, to impregnate and fructify the Seed; which Opinion is corroborated by the ingenious Obſervations of Mr. *Samuel Moreland*, viz.

All *Flowers*, in general, or at leaſt the greateſt Part of them, are furniſhed with Chives, Tops, and Piſtils.

The Farina, or fine mealy Powder, which is at its proper Seaſon, ſhed out of thoſe Thecæ or Apices; Seminiformes, which grow at the Top of the Stamina, does in ſome Meaſure perform the Office of a *Semen Maſculinum*, by dropping upon the Outſide of the *Uterus* or *Vaſculum Seminale*, and impregnate the included Seed, &c. But Dr. *Moreland* was of Opinion, that the Seeds which come up in their proper Involucra, are at firſt, like the unimpregnated Ova of Animals; * that this Farina is a Congeries of ſeminal Plants *, one of which muſt be conveyed into every Ovum, before it can become prolifick. That the Stylus, as Mr. *Ray*, or the upper Part of the Piſtulum, as Mr. *Tournefort* calls it, is a Tube deſigned to convey theſe ſeminal Plants into their Neſt in the Ova; and that there is ſuch a vaſt Proviſion made thereof, becauſe of the Odds there are, whether one of ſo many ſhall ever find its Way into, and thro' ſo narrow a Conveyance.

For in the *Corona imperialis*, where the *Uterus* or *Vaſculum Seminale* of the Plant ſtands upon the Centre of the Flower, from the Top of which ſtands the *Stylus*; the *Vaſculum Seminale*, and *Stylus* together, repreſenting a Piſtillum; round this are planted ſix Stamina; upon the Extremities of each of theſe are Apices, ſo artfully fixed, that they turn every Way with the leaſt Blaſt of Wind, being in Height almoſt exactly equal to the *Stylus*, about which they play, and which in this Plant is manifeſtly open at Top; it is hollow all the Way, and upon the Top of the Stylus there is a Sort of Tuft, conſiſting of pinguid *Villi*, ſuppoſed to be placed there to catch and detain the Farina, as it flies out of its Theæ; and that the Rain either waſhes it, or the Wind ſhakes it down the Tube, till it reaches the *Vaſculum Seminale*.

In the *Caprifolium* or Honey Suckle, there riſes a *Stylus*, from the Rudiments of a Berry, into which it is inſerted, to the Top of the monopetalous Flower; from the Middle of which Flower are ſent forth ſeveral Sta-

* *Phi. Tranſ. No.* 287.

mina,

mina, that ſhed their Farina off the Caſes, upon the Orifice of the Stylus, which in this Plant is villous or tufted, upon the ſame Account as the former is.

In *Allium* or *common Garlick*, there ariſes a tri-coccous Uterus, or Seed-Veſſel, in the Center of which is inſerted a ſhort *Stylus*, not reaching ſo high as the Apices, which thus overtopping it, have the Opportunity of ſhedding their Globules the more eaſily into its Orifice; for which Reaſon there is no Tuft on this as on the former, to inſure its Entrance, that being provided for by its Situation juſt under them.

From whence we conclude, that where a fine Powder is curiouſly prepared, carefully repoſited, and ſhed abroad at a peculiar Seaſon, where there is a Tube planted in ſuch a Manner, as to be fit to receive it, and ſuch Care in diſpoſing this Tube, that where it does not lie directly under the Caſes that ſhed the Powder, it hath a peculiar Apparatus at the Extremity to inſure its Entrance, ſo that nothing can be more genuinely deduced from any Premiſes; than it may from theſe, that this Powder, or ſome of it, was deſigned to enter this Tube; if theſe *Stamina* had been only excretory Ducts, to ſeparate the groſſer Parts, and leave the Juice deſigned for the Nouriſhment of the Seed the more reſerved, what Need was there to lodge theſe *Fæces* in ſuch curious Repoſitories? They would have been convey'd any where, rather than where there was ſo much Danger of their dropping into the Seed-Veſſel again, as they are here. Again the Tube over the Mouth of which they are ſhed, and into which they enter, leads always directly into the Seed-Veſſel; to which may be added, that the Tube always begins to die, when theſe *Thecæ* are emptied of their Contents; if they laſt any longer, it is only whilſt the Globules which enter at their Orifice, may be ſuppoſed to have finiſhed their Paſſage; nor can we expect a more convincing Proof of theſe Tubes being deſigned to convey theſe Globules, than that they wither when there are no more Globules to be conveyed.

In leguminous Plants, if the Petala of the Flower be carefully taken off, the Pod or Siliqua may be diſcovered, cloſely cover'd with an involving Membrane, which about the Top, ſeparates into ſeveral *Stamina*, each being fraught with its Quantity of *Farina*; and theſe *Stamina* bound cloſe upon the Bruſh, which is obſervable at the Extremity of that Tube, which here alſo leads to the Pod; it does not indeed ſtand upright, but bent ſo as to make almoſt a right Angle with it: In *Roſes* there ſtands a Column conſiſting of ſeveral Tubes, clung cloſely together, tho' eaſily ſeparable, each leading to its peculiar Cell, having the Stamina in great Numbers planted all round. In *Tithymalus* or *Spurge*, there ariſes a tricoccous Veſſel, that, whilſt it is ſmall and ſo not eaſily diſcernable, lies at the Bottom, till it is impregnated; but afterwards it grows up and ſtands ſo high upon a tall Pedicle of its own, as would incline one to think, that there was to be no

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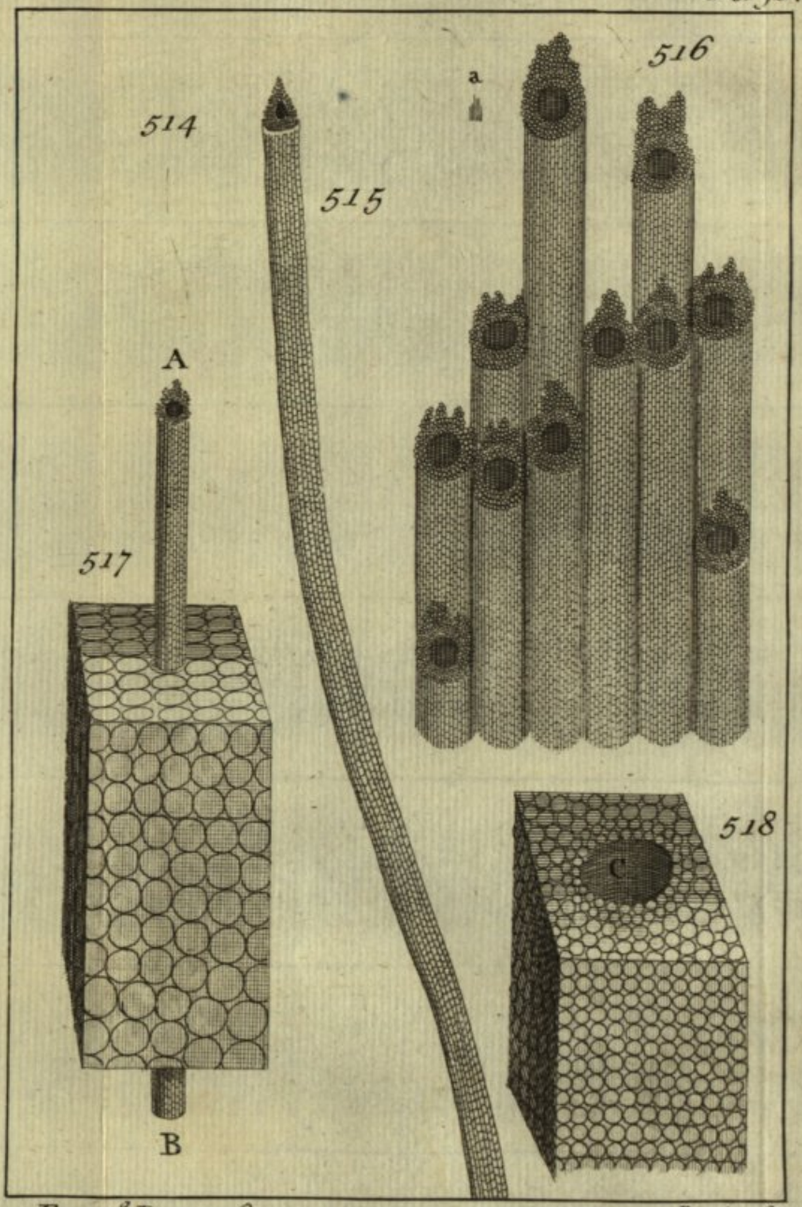
Pl. 58.



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Communication between this and the *Apices*, which he ſees dying below. In *Strawberries* and *Raſberries*, the Hairs which grow upon the ripe Fruit are ſo many Tubes, each leading to its particular Seed; and therefore we may obſerve, that in the firſt opening of the Flower there ſtands a Ring of *Stamina* within the *Petala*, and the whole inward Area appears like a little Wood of theſe Hairs or Pulp, which when they have received and conveyed their Globules, the Seed ſwells and riſes in a carnous Pulp.

Fig. 527. repreſents a yellow Lilly. A, the Top of the Piſtil or Tube, at which the ſeminal Plants are ſuppoſed to enter, and through which they are conveyed to the unimpregnated Seeds in the Seed-Veſſels; b b the Apices Semini-formes, which when open, ſhed that Powder which enters the Tube at A; C the Place of the Seed-Veſſel at the Bottom of the Tube, the Tube and Veſſel itſelf being concealed under the Leaf in this Figure.

Fig. 528. repreſents the *Siliqua* in a Flower of a Pea kind, E the Tube which ariſes from the *Siliqua*, and conveys the Plants thereto; F the membraneous Coat which involves the Siliqua laid open; g g g g the Apices, which before the membraneous Tegument is laid open, appear to riſe from its Edges, and by the Petala of the Flower are kept cloſe upon the Orifice of the Tube, that they may conveniently ſhed their Farina into it.

Hence we learn from the general Structure of the Flowers of Plants, though diverſified infinite Ways, that ſome have no ſenſible Piſtil, others no Stamina, others have Stamina without any Apices; and what exceeds all the reſt, ſome Plants have no Flowers.

Mr. *Bradley* obſerves, that at the Bottom of the Piſtil of the Lilly, there is a Veſſel which he calls the *Uterus*, or Womb, wherein are three Ovaries filled with little Eggs, or Rudiments of Seed, which, ſays he, always decay and come to nothing, unleſs impregnated by the Farina of the ſame Plant, or ſome other of the ſame Kind.

It is this Farina or Duſt falling out of the Apices on the Piſtil, fœcundifies the Grain or Fruit incloſed therein; and hence they call it the *Farina fecundans*. Thus the Farina ſhould be the male Part of the Plant, and the Piſtil the female.

The Fruit is uſually at the Baſis of the Piſtil, ſo that when the Piſtil falls with the reſt of the Flower, the Fruit appears in its Stead. The Piſtil is frequently the Fruit itſelf, but ſtill they have both the ſame Situation in the Center of the Flower, whoſe Leaves diſpoſed around the little Embrio, only ſeem deſtined to prepare a fine Juice in their little Veſſels for its Support. Mr. *Bradley* imagines their Uſe to be only to defend the Flower.

The Diſpoſition of the Piſtil, and the Apices about it is always ſuch, as that the Farina may fall on its Orifice; it is uſually lower than the Apices; and when we obſerve it to be grown higher, we may conjecture the Fruit has begun to form itſelf, and has no further Occaſion for the male Duſt. Alſo, as ſoon as the Work of Generation is over, the male Parts, together

with the Leaves, fall off, and the Tube leading to the Uterus begins to ſhrink. Nor muſt it be omitted, that the Top of the Piſtil is always either covered with a Sort of Velvet Tunicle, or emits a gummy Liquor, the better to catch the Duſt of the Apices. In Flowers that turn down, as in the *Acanthus*, *Cyclamen*, and the *Imperial Crown*, the Piſtil is much longer than the Stamina; that the Duſt may fall from their Apices in ſufficient Quantity thereon.

This Syſtem favours much of that admirable Uniformity found in the Works of Nature, and carries with it all the ſeeming Characteriſticks of Truth. Mr. *Geoffroy* ſays, that the Plant is rendered barren, and the Fruits become abortive, by cutting off the Piſtils before the Duſt could impregnate them, which is ſince confirmed by other Experiments of Mr. *Bradley*.

In many Kinds of Plants, as *Willow*, *Oak*, *Pine*, *Cypreſs*, *Mulberry Tree*, &c. the Flowers are ſterile, and ſeparate from the Fruit; but then they have their Stamina and Apices, which may eaſily impregnate the Fruits, which are not far off.

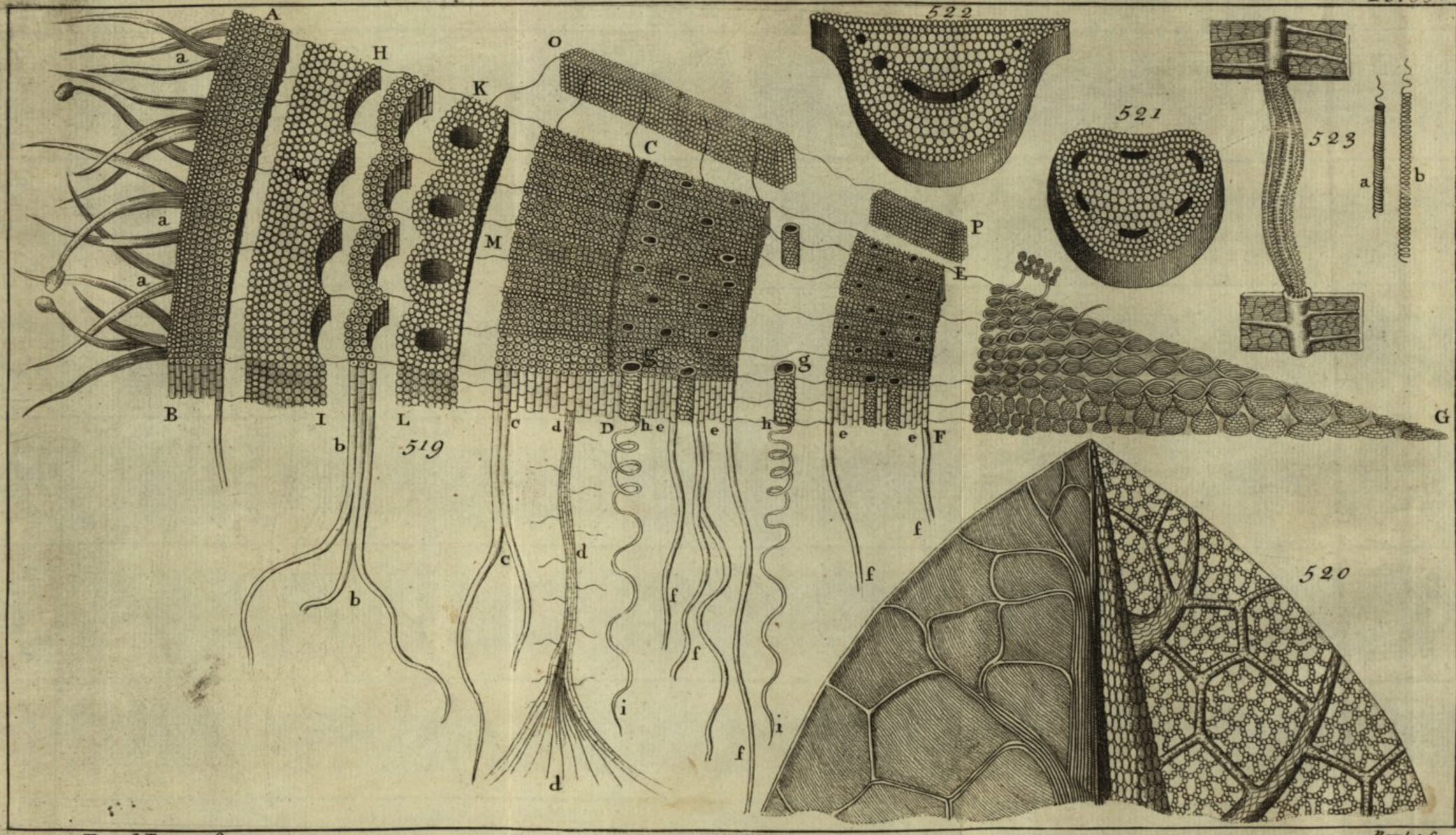
There is ſome Difficulty in reconciling this Syſtem to a Species of Plants, which bear *Flowers* without *Fruits*, and another Species of the ſame Kind and Name, which bear *Fruits* without *Flowers*; hence diſtinguiſhed into Male and Female; of which Kind are the *Palm-Tree*, *Poplar*, *Hemp*, *Hops*, &c. for how ſhould the Farina of the Male here come to impregnate the Seed of the Female. Mr. *Tournefort* imagines, that the fine Down always found on the Fruit of theſe Plants, may ſerve inſtead of Flowers, and do the Office of Impregnation; but Mr. *Geoffroy* rather takes it, that the Wind doing the Office of a Vehicle, brings the Farina of the Males to the Females.

For the Manner wherein the Farina fecundifies, Mr. *Geoffroy* advances two Opinions, 1. That the Farina being always found of a ſulphurous Compoſition, and full of ſubtile penetrating Parts, falling on the Piſtils of the Flowers, there reſolves, and the ſubtileſt of its Parts penetrating the Subſtance of the Piſtil and young Fruit, excite a Fermentation ſufficient to open and unfold the young *Plant*, contained in the Embrio of the Seed; in this Hypotheſis the Seed is ſuppoſed to contain the Plant in Miniature, only wanting a proper Juice to unfold its Parts and make them grow.

The ſecond Opinion is, that the Farina of the *Flower* is the firſt Germ, or Bud of the new Plant, and needs nothing to unfold it, and enable it to grow, but the Juice it finds prepared in the Embrio's of the Seed.

The Reader will here obſerve, that theſe two Theories of *vegetable Generation*, bear a ſtrict Analogy to thoſe of *Animal Generation*, viz. either that the young Animal is in the *Semen Maſculinum*, and only needs the Juice of the Matrix to cheriſh and bring it forth, or that the Animal is contained in the *Female Ovum*, and needs only the Male Seed to excite a Fermentation.

Mr.



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Mr. *Geoffroy* takes the proper Seed to be in the Farina, becauſe the beſt *Microſcopes* do not diſcover the leaſt Appearance of any Bud in the little Embrio's of the Grains, when examined before the Apices have ſhed their Duſt.

In leguminous *Plants*, if the Leaves and Stamina be removed, and the Piſtil, or that Part which becomes the Pod, be viewed with the *Microſcope*, ere yet the Flower be opened, the little green tranſparent Veſiculæ, which are to become the Grains, will appear in their natural Order, but ſtill ſhewing nothing elſe but the mere Coat or Skin of the Grain.

If the Obſervation with the *Microſcope* be continued for ſeveral Days ſucceſſively, in other Flowers as they advance, the Veſicula will be found to ſwell, and by Degrees to become replete with a limpid Liquor; wherein when the Farina comes to be ſhed, and the Leaves of the Flower to fall, we obſerve a little *greeniſh Speck*, or *Globule*, floating about at large. At firſt there is no Appearance of Organization in this little Body; but in Time, as it grows, we begin to diſtinguiſh two little Leaves like two Horns. The Liquor inſenſibly diminiſhes as the little Body grows, till at length the Grain becomes quite opake; when upon opening it, we find its Cavity filled with a young Plant in Miniature, conſiſting of a *Plumula*, *Radicle*, and *Lobes*.

The Tops or Apices ſometimes ſtand erect above their Chives or Stamina, as thoſe in *Lark-heel*, but generally hang a little down by the Middle like a *Kidney Bean*, as in *Mallows*, they have for the moſt Part a double Cleft, tho' it is in ſome ſingle, from which they diſburſe their Powders, which ſtart out, and ſtands upon the Lips of the Cleft, as at Fig. 529. which repreſents one of the Apices of the Flower of St. *John's Wort* magnified.

The Particles of theſe Powders altho' like Meal or Duſt, yet if viewed thro' a Microſcope, they have all of them very curious and regular Forms. In *Dog's-Mercury* and *Borage* they are extreamly ſmall, but in *Mallows* fairly viſible to the naked Eye. In ſome Flowers theſe Powders are yellow, as in *Dogs-Mercury*, *Goats Rue*, &c. And in ſome of other Colours, but in moſt they are white; thoſe of *yellow Henbane* are very elegant, being to the naked Eye as white as Snow, and in the *Microſcope* as tranſparent as Cryſtal.

The *Tops* or *Apices* which contain the Farina, are for the moſt Part either white or yellow, ſometimes blue, but never red, whatever Colour the Flowers be of. They differ in Poſition, ſometimes ſtanding double upon one Chive, as in *Toad-Flax*, *Snap-Dragon*, &c. In ſome they are faſtned to their Stamina at their Middle, as in *Spaniſh Broom*, *Hyſſop*, *Scabeous*, *Behen*, &c. in ſome erect, as in *Clematis*, *Auſtriaca*, *Ladies Looking-Glaſs*, *Rape Crow-foot*, &c. *Coded Arſmat* hath no Chives, but ſtand upon a large Baſe.

Their Number are alſo different, in great *Celandine*, *Roſe*, *Rape-Crow-foot* they are numerous; in great *Plantain*, and ſome other Herbs, much

more conſpicuous than the Foliature itſelf. In *Germander Chickweed*, they are always two, and no more; in ſome they follow the Number of the Leaves, eſpecially in the Number five; as in *Blattaria*, *black Henbane*, &c. In *Stichwort* and *Lychnis ſylveſtris* they are ten, juſt double to the Number of Leaves.

Their Shape is different, and always very elegant, with great Variety. In *Borage*, like the Point of a Spear; in *Blataria*, like an Horſe-ſhoe; in *Clematis* like a Spatula, wherewith Apothecaries make their Mixtures: In *Mallow* like a Head-roll; in *Hyſop* they have one Cleft before, in *Blattaria* one round about; in *Water Betony* one at the Top; in *Scabious* they have a double Cleft, one on each Side.

In *Colocynthis* the Farina is not contained in ſeveral Thæcæ or Apices ſtanding upon Chives, but is all of one entire Part, like a thick Column in the midſt of the Flower, having ſeveral little Ridges or Furrows winding from the Top to the Bottom round about, in the Middle of each of which runs a Line, where the Skin, after ſome Time, opens into two Lips, and preſents the globular Particles contained in the Hollow of every Ridge.

But where the Seeds are contained in the Apices, a Stilus or little Column ſtands upon the Top of the true *Seed-Caſe*, which is alſo regularly and variouſly figured. In *Bind-weed* it hath a round Head like that of a great Pin. In the *common Bell*, *St. Johnwort*, &c. it is divided into three Parts. In *Gerarium* into five; in *Aſarum* into ſix, ſometimes the Head is ſmooth, and in others it is beſet with little Thorns, as in *Hyoſcyamus*.

The Piſtil is a little upright Part in the Middle of the Calx, or the Leaves of *Flowers*, called alſo the Style.

It is an eſſential Part of a Flower, and the principal female Organ of Generation, it being in this that the Seeds or young Plants are formed. It ariſes from the Pedicle of the Flower, or the Center of the Calx, and at length becomes the young Fruit, which is ſometimes hid in the Calx, and ſometimes quite out.

Its Figure is very different in different Flowers; in ſome it is a little Stalk, which enlarges at the two Ends, in others a mere Stamen or Thread, ſometimes it is round, ſometimes ſquare, triangular, oval, *&c.*

Almoſt all Piſtils are furniſhed at Top, either with fine Hairs, or little Filaments diſpoſed in Plumes, or are beſet with little Veſicles full of a glutinous Juice.

Some Flowers have ſeveral Piſtils, or rather the Piſtils terminate in ſeveral Branches, which have their Riſe from as many young Fruits, or as many Capſulæ containing Seeds.

Whatever Form the Piſtils are in, they have certain Apertures at their Tops, or Clefts, continued their whole Length, to the Baſe or Embrio of the Fruit.

The Seed Veſſels conſiſts ſometimes of two, and for the moſt part of three

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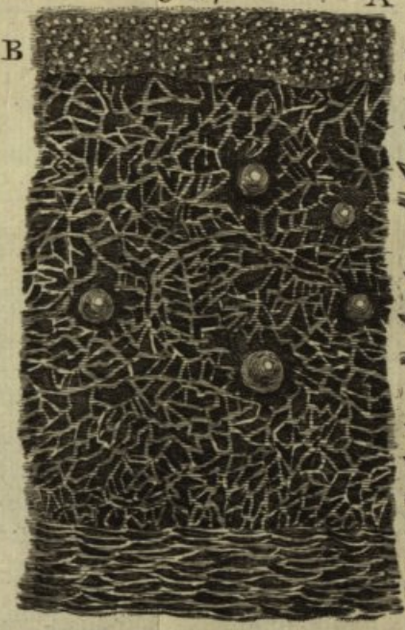

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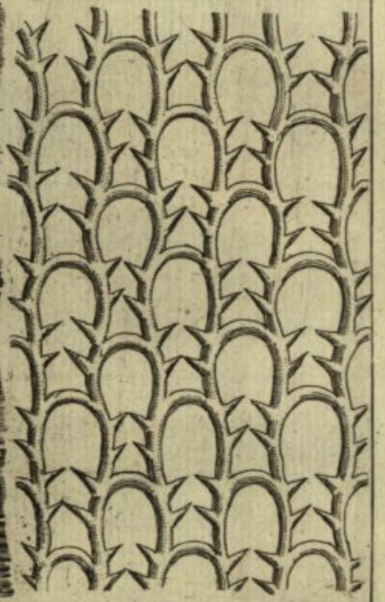

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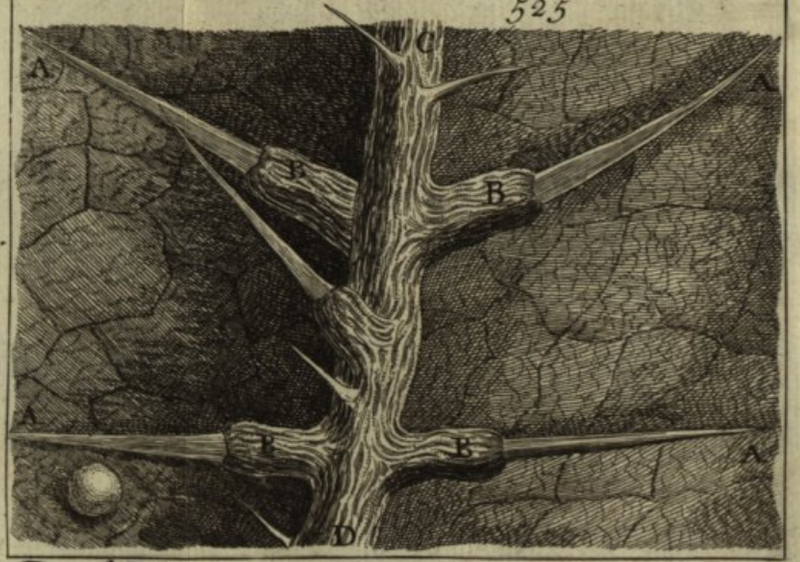

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three Pieces; for which Reaſon they are called Suits, as at a b c d, Fig. 527.

The outer Part of each Suit, according to *Grew*, is its Floret, whoſe Body or Tube is divided at the Top (like that of a Cowſlip) into five Leaves as at b, which forms a Flower in Miniature, and is all the Flower in many Plants, as *Mugwort*, *Tanſie*, &c. Upon the Expanſion of the Floret, the next Part c, of the Suit begins to appear from within its Tube, which may be called the Sheath (with reſpect to that within it). This Sheath in a ſhort Time divides at Top, through which Aperture the Blade d diſplays itſelf. This is the third Part of the Suit, and terminates in a forked Point, about which appears little Globules.

In ſome Flowers every one of the before-mention'd Florets is encompaſſed with an Hedge of Hairs, and every Hair branched on both Sides, almoſt like a Sprig of Fir, as at c d in golden Rod, Fig. 530. which ſhews one of the Suits thereof as it appeared in the *Microſcope*, in which at e is the little Column or Blade that contains the Farina, which is alſo ſeen by itſelf at F.

The Baſe of the Floret is generally cylindrical, but ſometimes ſquare, as in *French Marigold*, at a, Fig. 531. and the Leaves thereof, which for the moſt part are ſmooth, in the ſame Flower are all over hairy. The middlemoſt of the three Parts or Sheath b, is uſually faſtned to the Top, or elſe at the Bottom of the Floret, and is rather indented than parted into Leaves: The Surface ſeldom plain or even, but wrought into five Ridges and as many Gutters, running almoſt parallel from Top to Bottom.

The inmoſt Part or Blade runs through the Hollow of the two former as at a, Fig. 531. and is faſtned with the Floret to the Convex of the Seed Caſe; the Head and Sides of this Part is always beſet round about with Globulets. In ſome growing cloſe to the Blade, as in common Marigold; and in the *French* Marigold, as at Fig. 532. and others, upon little ſlender Stalks. Theſe, as the Blade ſprings up from within the *Sheath*, are rubbed off and ſtands like a Powder upon them both. In ſome, as in *Chicory*, they ſeem to grow within-ſide the Sheath, as will appear if it be ſplit * with a ſmall Pin, as alſo in *Knapweed* they are very numerous.

The Head of the Blade is always divided into two, and ſometimes into three Parts, as in *Chicory*, Fig. 533. which gradually curl outwards after the Manner of Scorpion Graſs.

This Deſcription agrees principally to the corimbiferous Kind, as Tanſy, Camomile, *&c.* but in *Scorzonera*, *Chicory*, Fig. 533. *Hawk-weed*, *Mouſe-ear*, and all the intibous Kind, with many more. The Piſtil is ſeparated from the Foliature, ſo as to ſtand alone therein, every Leaf a b c of the Flower having a Piſtil of its own; for which Reaſon the Baſe of each Leaf is formed into a little Tube a, Fig. 533. that incloſes the Piſtil, which commonly conſiſts of

* *Grew An. Plants, p.* 170.

a Sheath and Blade e; the Leaf itſelf anſwering to the Floret in other Flowers. The Blade (or rather Stamina) is ſeen drawn out of its Sheath at f g of the ſame Figure, and at g the Head of the Blade is open'd into three Parts, which are full of thoſe globular Particles before-mention'd.

The Time in which the *Flower* is generated, is hardly any where, if at all taken Notice of among ſo many Obſervers of Plants. It is therefore to be remarked, that all the Parts of the Flower in all Flowers, are perfectly finiſhed long before they appear in Sight, uſually three or four Months, and in ſome ſix. And that in Perenial Plants, thoſe Flowers which appear in any one Year are not formed in that, but were actually in Being and intire in all their Parts the Year before. The Flower of *Mezeron*, which opens in *January*, is intirely formed about the Middle of *Auguſt* in the foregoing Year; at which Time, if the green Leaves of the Bud be carefully removed, the Leaves of the Flower and Seed-like Attire, encompaſſing the Seed-Caſe, may be diſtinctly ſeen when placed before the *Microſcope*.

In order to obſerve the mealy *Powder* or *Farina*, let it be gathered in the midſt of a Sun-ſhiny Day when all the Dew is off, ſhake, or elſe gently bruſh it off with a ſoft Hair-Pencil upon a clean Piece of white Paper; then breathe upon a ſingle Talc, and inſtantly apply it to the Farina, which will adhere to it. If too great a Quantity of Powder ſticks to the Talc, blow a little of it gently off, if not enough breathe on it again, and touch the Farina with it as before, then fix it in a Slider as before directed.

But I would here adviſe the Curious not to neglect an Examination of the little Cells that contain the Farina, and alſo of the Piſtils and Uteri, and other Parts of Generation of the *Flowers*.

Fig. 534, repreſents the Flower of St. Johnwort a little magnified, in which may be ſeen the Stamina and their Apices ſurrounding the Seed-Caſe. Fig. 529, is one of the Apices more magnified.

Fig. 530, repreſents one Suit of golden Rod Flower, conſiſting of a Seed-Caſe A, and a Stamina e, one of which is ſeen by itſelf at F.

Fig. 531, ſhews one of the Suits of *French Marigold*, or *Flos Africanus* magnified, of which there are about 12 in one Flower, each conſiſting of three Pieces, the middlemoſt of which is ſeen alone at Fig. 532.

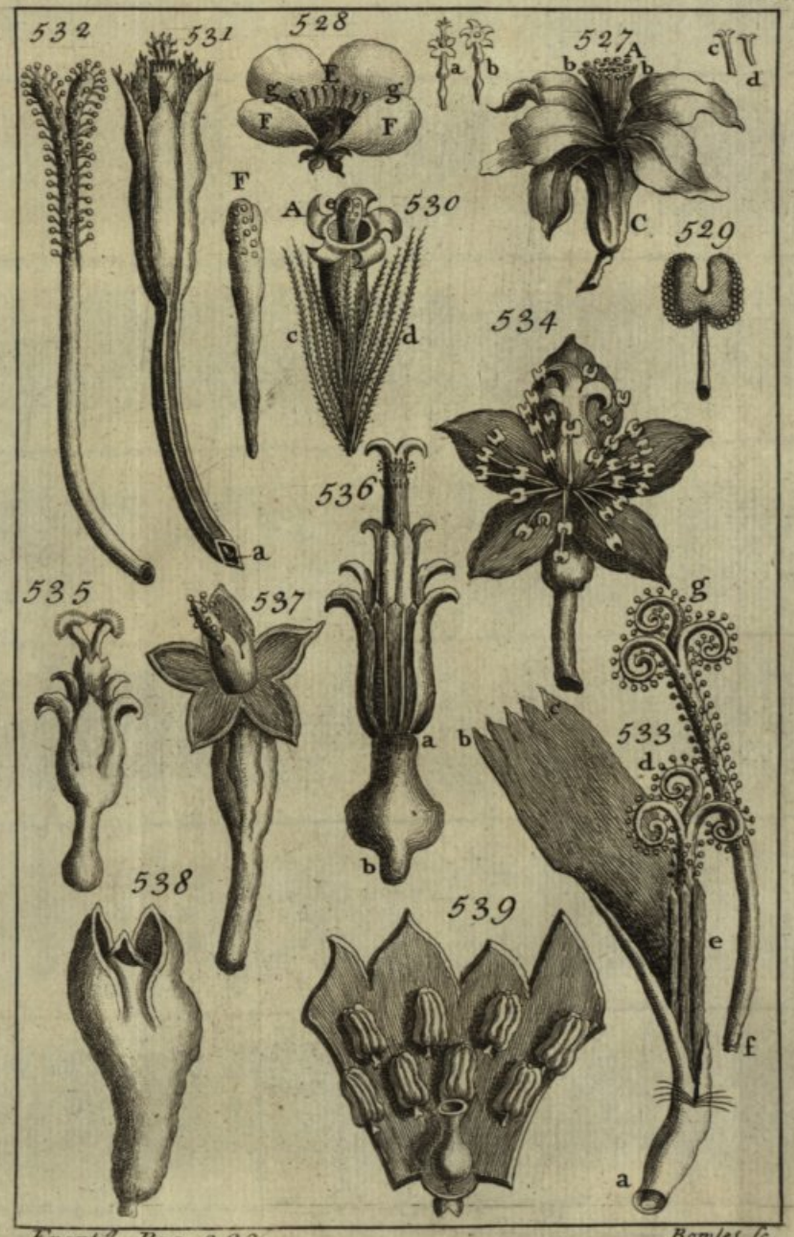
Fig. 535, repreſents one Suit of *Chryſanthemum-Creet*, conſiſting alſo of three Pieces, of which there are about 80 in one Flower.

Fig. 536, exhibits one Suit of *Knapweed* magnified, conſiſting of three Pieces, a b is the Seed-Caſe, at the Bottom of every Suit.

Fig. 537, is a microſcopick Repreſentation of one of the Suits of a *Marigold*, of which there are about 40 in one Flower.

Fig. 533, repreſents the Piſtil and Blade, proper to each Leaf in the Flower of *Chicory*.

Fig. 538, repreſents one of the Flowers in the Bud of *Mezeron* perfectly formed



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formed in all its Parts the Year before it appears, but differs in Shape as a Fœtus doth when newly formed.

Fig. 539, ſhews the ſame Flower cut open, wherein may be ſeen the ſpermatick Thæcæ and the Uterus.

CHAP. XL.

Of the Fruit of an Apple, Lemon, Cucumber, and Pear.

SECT. I.

THE general Compoſition of all *Fruit* is one, that is, their eſſential Parts are in all the ſame, and but a Continuation of thoſe which have been already obſerved in the other Parts of a Plant. Yet from the different Conſtitutions and Tinctures of thoſe Parts, the ſeveral Varieties in Fruits proceed.

An *Apple* conſiſts of a Skin, Parenchyma, Veſſels and Core, the Parenchyma or Pulp is the ſame with that of the Bark of the Tree, as is apparent not only from the viſible Continuation thereof, from the one through the *Stalk* into the other, but alſo from their Structure, being both compoſed of Bladders, with this Difference, that whereas in the Bark they are very ſmall and ſpherical (as may be plainly ſeen when viewed through the *Microſcope*,) here they are oblong and very large, in Proportion to the Size and Tenderneſs of the *Fruit*, being all uniformly ſtretched out by the arching of the Veſſels, from the Core towards the Circumference of the Apple.

The Veſſels, as in the other Parts of a Plant, are ſucciforous, and for Air, both the Branches of the former and the ſingle Veſſels of the latter are extremely ſmall, running every where together; not collateral, as Veins and Arteries do in Animals, but the latter ſheathed in the former.

They are diſtributed into twenty principal Branches, the ten outermoſt a little within the Apple, are diverted from a ſtreight Line into ſo many Arches; from which a few ſmall Branches are without any Order diſperſed through the Apple; the five middlemoſt and the five inmoſt run in a ſtrait Line as far as the Core, and are there diſtributed into as many leſſer Arches, the former at the outer and the latter at the inner Angles of the Core, upon which laſt the Seeds hang.

All theſe main Branches meet together at the Top of the *Apple*, where originally they all ran into the Flower.

A *Lemon* hath a three-fold Parenchyma, ſeemingly derived from each other; the Texture upon every Derivation being ſomewhat altered, by being made more cloſe and elaborate. The outmoſt called the Rind, hath the moſt open and coarſeſt Texture, being compoſed of the largeſt Threads,

and

and theſe wove up into larger Bladders. Thoſe little Cells which contain the eſſential Oil of the Fruit, and ſtand near the Surface of the Rind, are ſome of the ſame Bladders, but more dilated.

From this outmoſt Parenchyma, nine or ten Inſertions are produced, betwixt as many Portions of the pulpy Part towards the Center, where they all unite into one Body, anſwerable to the *Pith* in the *Trunk* or *Root* of the *Tree*; and are a conſpicuous Demonſtration of the Communication between the *Bark* and *Pith*.

Throughout this Parenchyma the Veſſels are diſperſed, but the chief Branches ſtand on the inner Edge of the Rind, and the outer Edge of the Pith, juſt at the Extremities of every Lamellæ from thoſe Branches at the Edge of the Pith; other little and very ſhort ones ſhoot into the Pulp of the *Fruit*, upon which the Seeds are appendant. In the Center of the Pith are eight or nine in a Ring, which run through the Fruit up to the Flower.

Between the Rind and Pith, and thoſe ſeveral lamelated Inſertions which join them together, ſtands the ſecond Sort of Parenchyma, being cloſer and finer, and divided by the Lamels into ſeveral diſtinct Bodies, every one of them being an entire Bag; in every one of which the third Parenchyma is contained; which is alſo a Cluſter of other leſſer Bags, all disjoined from one another, each having their diſtinct Stalks of ſeveral Lengths, by which they are all faſtned to the utmoſt Side of the great Bag wherein they are contained. Within theſe leſſer Bags alſo the *Microſcope* can ſhew many Hundreds of Bladders, conſiſting of extremely fine Threads, as it were wove together into that Figure; and within theſe Bladders lies the acid Juice of the Lemon.

A *Cucumber* hath alſo a three-fold Parenchyma, the outermoſt is derived from the Bark, which being expoſed for ſome Time to dry, and then tranſverſly cut with a Razor; not only the Bladders but alſo the Threads whereof the Bladders conſiſt, are plainly viſible when viewed through the Microſcope.

Throughout this Parenchyma are diſperſed the Sap Veſſels, in ten or twelve very large Branches, each of which emboſoms another of Air Veſſels.

The middle Parenchyma is derived from the Pith, and divided into three triangular Columns, within which are a diſtinct Sort of Sap Veſſels, whence ſeveral ſmall and ſhort Fibres ſhoot into the inmoſt Parenchyma, whereupon the Seeds do hang.

The inmoſt Parenchyma wherein the Seeds do lie (and which anſwers to the Pulp of a *Lemon*) ſeems to be produced from the Seed-fibres, by three Inſertions from the Columns, and as many from the outmoſt Parenchyma, and theſe reinſerted; it is divided into ſix triangular Bodies, and every Triangle into three Ovals.

A *Pear*, beſides the Skin, conſiſts of a two-fold Parenchyma of Veſſels,

tartareous Knots, or *Grains*, and a *Core*; the Skin when viewed in the *Microſcope*, appears to be lined with a great Number of theſe tartareous Grains, which are alſo diſperſed round about the Fruit, for about the Thickneſs of the Third of an Inch, as will appear on applying a tranſverſe Slice of a Pear to the *Microſcope*.

The outer Parenchyma is of the ſame Original and general Structure as in an Apple, but the Bladders not altogether ſo long with reſpect to their Breadth.

The Bladders here have alſo a different Poſition from that they have in an Apple, being in that all ſtretched out towards one common Center, which is that of the Apple itſelf. But here they every where bear a Reſpect to the ſaid tartareous Grains, every Grain being the Center of a certain Number of Bladders.

Throughout this Parenchyma, the *Veſſels* for Sap and Air are likewiſe diſperſed into fifteen principal Branches. The five utmoſt make as many Arches, but commonly not ſo deep as in an *Apple*; from theſe ſome ſmall Fibres are diſperſed throughout the Parenchyma. The ten inner Branches proceeding to the Seed, and from thence with the other five to the Flower.

Next the Core ſtands the inner Parenchyma, conſiſting of ſmall roundiſh Bladders, anſwerable to that of the Pith, from which it ſeems to be derived.

Between this and the outer Parenchyma, the ſaid tartareous Grains begin (firſt) to ſtand nearer together, to grow bigger, and of a more unequal Surface; and by Degrees to unite into a Body, in ſome *Pears*, and eſpecially towards the Cork, they are almoſt as hard as a Plumb-Stone.

On cutting a Pear lengthwiſe, through its Center, theſe tartareous Grains will be apparent.

At the Bottom of the Core in moſt Pears, and a little below the Center of the Fruit, is a Kind of umbelical Knot; from whence extends a ſtreight Channel, which opens at the Middle of the Cork or Stool of the Flower, ſcarce wide enough to admit the ſmalleſt Pin.

SECT. II.

Of a Plumb, *and ſome other* Fruits *of the ſame Kind.*

A *Plumb* conſiſts of a Parenchyma, the two general Kind of Veſſels, and a Stone; and in Proportion to the Bulk of the Fruit, hath more Veſſels than an *Apple* or *Pear*. Alſo in *Plumbs*, all theſe Veſſels are braced together into one uniform Piece of *Net-Work*, every where terminating at an equal Diſtance from the Circumference, the Skin is fibrous and tough.

The Stone is compoſed of two, or rather three diſtinct Parts, one of them the Lining, taking its Riſe from the Parenchyma, which the Seed Branch

brings along with it, through the Channel in the Side, and at laſt into the Hollow of the Stone, and is there ſpread all over it.

The Foundation or Ground of the outer and more bulky Part of the Stone, is the inner Part of the Parenchyma, upon which the tartareous Parts of the Sap are continually precipitated, and thereby petrified, as appears on comparing the ſeveral Ages of the ſame Fruit together; on the Surface of many Stones, ſome of the ſaid tartareous Parts appear in diſtinct *Grains*.

An *Apricock* is of the *Plumb* Kind, but ſome Things are herein better obſerved, as firſt the Poſition of the Bladders of the Parenchyma; for the tartareous Parts of the Sap, not being here diſperſed in little Grains, throughout the Fruit as in a *Pear*, but are all thrown off into the Stone; therefore the Bladders all radiate exactly to the Center of the Stone, conveying thereto the feculent Sap, in ſo many little Streams. This is beſt ſeen when the Fruit is full ripe.

The gradual Tranſmutation of the inner Part of the Parenchyma into a Stone, is alſo more apparent in this Fruit, and ſo are the three Coats which ſerve for the Generation of the Seed; being now all very diſtinct and remarkable.

A Peach hath a much bigger Stone, and therefore when full ripe, it hath a more defecated or better refin'd *Juice*; the Reaſon why the Stone is ſo great, is becauſe the Veſſels run ſo numerouſly through the Body of it; and ſo cauſe a more copious Perſpiration of the Lees therein.

A *Cherry* is likewiſe nearly related to a *Plumb*, but the Bracement or Reticulation of the Veſſels, is here carried on farther, ſo as to be all round about contiguous to the Skin.

A *Walnut* is a *Nuciprune*, or between a *Plumb* and a *Nut*, for the Rind anſwers to the Pulp, and the Shell, as the Stone, is alſo lined; but the *Seed-Veſſels*, which in a *Plumb* run thro' a Channel, made on Purpoſe in the Stone, do here enter as in a *Nut*, at the *Center* of the Shell; by which Means they are inveſted with a more fair Parenchyma.

SECT. III.

Of the Grape.

A *Grape* is as it were a *Plumb* with two Stones, for their Thickneſs are as hard as any other. The principal Fibres run directly between the Stones; and the ſmaller Fibres, and make only one ſingle *Net*; near the Circumference they all meet together at the Top of the *Grape*. Many lignous Fibres are alſo mixed with the Skin itſelf, whereby it becomes very thick and tough.

The Parenchyma, or Pulp of a *Grape* ſeems to be derived from the Pith, at leaſt as far as the Reticulation of the Fibres.

CHAP.

CHAP. XLI.

The Anatomical Preparation of Vegetables.

THoſe *Leaves* of *Plants* are only fit for this Purpoſe, whoſe internal Structure is compoſed of woody Fibres, and are of a pretty good Thickneſs, as the Leaves of *Oranges*, *Lemons*, *Jeſſamin*, *Bays*, *Roſes*, *Cherries*, *Apricocks*, *Peaches*, *Plumbs*, *Apples*, *Pears*, *Poplars*, *Pines*, *Oaks*, *Ivy*, &c.

There are ſeveral other that have no woody Fibres or Veins, but theſe diſſolve without ſeparating, as thoſe of *Vines*, and *Lime-Trees*.

The *Leaves* are to be gather'd * in *June*, or *July*, when they are full grown, and have not been damaged by *Worms*, or *Caterpillars*; put them into an earthen Pot or large Glaſs, with a good deal of *Rain-Water*. The Pot or Glaſs being kept uncover'd; and ſo expos'd to the Sun, or open Air. The Leaves muſt be quite cover'd with Water, and as it evaporates a freſh Quantity muſt be pour'd in. In about a Month's Time, ſome of the Leaves will begin to putrify, but the others muſt be kept two Months longer. When the two external Membranes begin to ſeparate, and the green Subſtance of the Leaf to grow liquid, then it is Time to perform the Operation. The *Leaf* is to be put into a white and flat earthen Plate or Diſh, filled with clear Water; then upon gently ſqueezing it with the Finger, it will open on one Side, and the green Subſtance will run out; immediately on that the two outer Membranes muſt be ſtripp'd off, chiefly in the Middle, and along the Nerves, where they adhere cloſely. If there be once an Opening, they will go off very eaſily; the Skeleton that remains between, is afterwards waſhed in clean Water, and kept between the Leaves of a Book.

The Method of preparing Fruits, as *Apples*, *Plumbs*, *Cherries*, *Peaches*, and the like, is as follows:

The fineſt and largeſt *Pears*, that are ſoft and not ſtony, are fitteſt for this Purpoſe; firſt pare them nicely, without ſqueezing them, taking Care not to hurt the Stalk or Crown; then put them into a Pot of Rain or freſh ſpring Water, cover it and let them boil gently, till they become throughly ſoft; then take them out, and put them into a Baſon of cold Water, then take out one of them, and holding it by the Stalk with one Hand, and with one Finger and the Thumb of the other Hand, rub the Pulp gently off, beginning near the Stalk, and rubbing equally towards the Apex; and you will eaſily ſee in the Water how the Pulp ſeparates from the Fibres, which being tendereſt near the Extremities, there the greateſt Care muſt be

* *Phil. Tranſ.* No. 416.

taken. No Inſtrument is of Uſe in this Operation, except laſt of all a Penknife, to ſeparate the Pulp ſticking to the Core. In order to ſee how the Operation advances, fling away the muddy Water from Time to Time, and pour on clean. All being ſeparated, the Skeleton is to be preſerved in Spirits of Wine, the ſame is to be obſerved with *Apples*, *Plumbs*, *Peaches*, and the like.

Carrots, and other Roots, that have woody Fibres, muſt be boiled without paring, till they grow ſoft, and the Pulp comes off; not only ſeveral Sorts of Roots, but likewiſe the Barks of ſeveral Trees, may be reduced into Skeletons, preſenting rare and curious Views of Vegetables.

CHAP. XLII.

To preſerve the Specimens of Plants.

PRepare two Iron Plates as large as the *Specimens* you intend to preſerve, let them be pretty thick, and very ſmooth on one Side, with Holes for Screws at each Corner; then take your *Flowers*, *Leaves*, &c. when full ripe, and of their true Colour, ſpread them on a brown Paper, with the Leaves as diſtinct as you can; if the Flowers are large, more Paper muſt be laid under them; and if thick you may pare away half thereof, as alſo of the Stalk ſo as to lie flat; then put theſe between the Iron Plates, ſcrew them faſt, and ſet them in an Oven for two Hours; after which take out the Flowers, and with a Bruſh dipp'd in equal Quantities of *Aqua fortis*, and *Aqua vitæ*, or Brandy, paſs over the *Leaves* and *Flowers*; then lay them to dry on freſh brown Paper, and take the Quantity of a Walnut of *Gum Dragon*, which in leſs than 24 Hours will be diſſolved in a Pint of Water, and with a Bruſh rub the Back-ſides of the *Leaves* and *Flowers* to make them ſtick; then lay them in your Paper-Book, and they will always look freſh. *

CHAP. XLIII.

Of Charcoal, or burnt Vegetables.

CHarcoal, or a *Vegetable* burnt black, affords an Object no leſs pleaſant than inſtructive; for if a ſmall Piece of *Charcoal* be ſuddenly broke, it will appear to have a very ſmooth Surface, but if examined by the *Microſcope*, Abundance of Pores are diſcoverable in many Kinds of Wood, ranged round the Pith both in a circular and a radiant Order; and moſt of theſe ſo exceeding ſmall, and ſo cloſe to each other, that but a very little Space is

* *Phil. Tranſ.* No. 227.

left

left between them to be filled with a ſolid Body. Theſe Pores, or rather Tubes, are ſo extreamly ſmall, that in a Line of them $\frac{1}{100}$th Part of an Inch long, Mr. *Hook* reckoned no leſs than 150, therefore in a Line an Inch long were no leſs than 2700 Pores, and in a circular Area, or of a Stick of an Inch Diameter, are contained 5,725,350 Pores or minute Tubes, * a Number that to ſome perhaps may ſeem incredible, were they not left to the Judgment of their own Eyes to the Truth thereof. In *Cocus*, *black* and *green Ebony*, *Lignum Vitæ*, &c. theſe Perforations are abundantly ſmaller than thoſe of ſoft light Wood; ſo prodigiouſly curious are the Contrivances, Pipes or Sluices, thro' which the Juice of *Vegetables* are conveyed.

To prepare or make Charcoal of any Kind of Wood, in order to examine it with the Microſcope.

The Body to be charred or coaled may be put into a Crucible, a Piece of a Muſket Barrel, a Pot, or any other Veſſel that will endure to be made red-hot in the Fire without breaking; cover it over with Sand, ſo that no Part of it be expoſed to the open Air. Then ſet it into a good Fire, and keep it there till the Sand has continued hot, for a Quarter, Half, an Hour, or two, more or leſs, according to the Nature and Bigneſs of the Body. Then take it out of the Fire, and let it lie till the Sand be very near cold. The Wood may be taken out of the Sand well charr'd, and clear'd of all its watery Parts.

CHAP. XLIV.

Of the Texture of Cork.

IF an exceeding thin Slice of *Cork* be cut off with a very ſharp Penknife, or Razor, and applied to the *Microſcope*, in an Ivory Slider, or held between the Nippers, it will appear to be all perforated and porous; having but a little ſolid Subſtance in Proportion to the empty Cavity, as is manifeſt on a Sight of Fig. 540. Theſe Pores are not very deep, but conſiſt of many little Cells, ſeparated out of one continued long Pore, by certain Diaphragms, † viſible in Fig. B, which repreſents them ſplit the long ways: Hence the *Microſcope* informs us, that the Lightneſs of Cork proceeds from its being a very ſmall Quantity of a ſolid Body, extended into exceeding large Dimenſions, and alſo why it is a Body ſo very unapt to ſuck in Water, and conſequently to preſerve itſelf floating on the Top thereof, tho' left on it never ſo long; and why it is able to confine Air in a Bottle, tho' conſi-

* *Hook's Myc. p.* 101. † *Ibid. p.* 113.

ſiderably

derably condenſed, and preſſing very ſtrongly to procure a Paſſage without admitting the leaſt Bubble to paſs through its Subſtance. As to the firſt, the Microſcope hath informed us that the Subſtance of Cork is filled with Air, and that this Air is perfectly incloſed in little Boxes or Cells diſtinct from each other: This therefore makes it very plain, that neither Water nor any other Air can eaſily inſinuate itſelf into them, their being already within them an *intus exiſtens*; * for this Reaſon Pieces of Cork are good Floats for *Nets* and *Stopples* for *Vials*, &c. and is capable of being compreſſed into a twentieth Part of its uſual Dimenſions, and to reſtore itſelf to its former State by means of the included Air in the before-obſerved conſtituent *Cells* or *Bladders*. Mr. *Hook* told ſeveral Lines of theſe Pores, and found that there were generally about 60 placed Endwiſe in a Line of the $\frac{1}{18}$ Part of an Inch long: Whence there muſt be 1160 in the Length of an Inch, and in a ſquare Inch 1166400; therefore a cubick Inch muſt contain 1259712000, a Thing almoſt incredible, did not the *Microſcope* aſſure us of it by ocular Demonſtration. If you cut off a Piece from a Board of Cork tranſverſly to the Flat of it, you will as it were ſplit the Pores, which will appear juſt as they are repreſented at Fig. B, but if a very thin Piece be cut off parallel to the Plane of it, the Pores of it will be tranſverſly divided, and will appear as expreſſed in Fig. A.

CHAP. XLV.

SECT. I.

Of a Plant growing on the blighted, or yellow Specks of Damask-roſe Leaves, Bramble Leaves, &c.

IT is obſervable that in the Months of *June*, *July*, *Auguſt*, and *September*, that many of the green Leaves of *Roſes* begin to dry and grow yellow, but eſpecially the Leaves of the old Shrubs of *Damaſk-Roſes*, are all ſpotted with yellow Stains, and the Under-ſides juſt againſt them have little yellow Hillocks of a gummy Subſtance, and ſeveral of them have ſmall black Spots in the midſt of thoſe yellow ones. Upon examining theſe with the *Microſcope*, Multitudes of little black Bodies like Seed-cods were perceived to ſpring out of ſeveral ſmall yellow Knobs, and to be faſtned to theſe Knobs by a ſmall Straw-coloured and tranſparent Stem, many of thoſe Hillocks were bare as if thoſe Bodies lay yet concealed, as at G, Fig. 541. In others they were juſt ſpringing out, as at A; in others, as at B, they were juſt out, with very little or no Stalk; in others, as at C, the Stalks

* *Hook. Mi. p.* 113.

plainly appear; in others, and at D, thoſe Stems were grown bigger and larger; and in others, as E F, *&c.* thoſe Stems and Cods were grown a great deal bigger, and the Stalks more bulky about the Root, and very much tapered towards the Top: As they increaſed in Bulk they began to turn their Tops towards their Roots, in the ſame Manner as that of Moſs is obſerved to do. The whole Square of this Figure repreſents a ſmall Part of a *Roſe-Leaf* no bigger than the Letter H.

Theſe kind of vegetable Sprouts are to be found on ſeveral Kinds of Roſe-Leaves, and on the Leaves of divers Sorts of Briars, and on Bramble Leaves in ſuch Cluſters, that 3 or 400 of them make a conſpicuous black Spot or Scab on the Backſide of the *Leaf*.

SECT. II.

Of Mouldineſs, or the Principals of Vegetation ariſing from Putrifaction.

MR. *Leeuwenhoek* obſerved, that *Mouldineſs* on Skin, Fleſh, or other Things, ſhoots up firſt with a ſtreight tranſparent Stalk, in which a globular Subſtancé riſes that commonly ſettles at the Top of the Stalk, and is followed by another Globule driving out the firſt either on the Side or at the Top, and that again is ſucceeded by a third, *&c.* all which form on the Stalk one great Knob, much thicker than the Stalk itſelf; and this large Knob burſting aſunder repreſents a kind of Bloſſoms with Leaves. *

The blue, white, and ſeveral Kinds of hairy mouldy Spots that are obſervable on divers Kinds of putrify'd Bodies, whether *animal* or *vegetable* Subſtances, ſuch as the *Skin*, *raw* or *dreſs'd Fleſh*, *Blood*, *Humours*, *Milk*, *Cheeſe*, &c. or rotten ſappy *Wood*, *Herbs*, *Leaves*, *Barks*, *Roots*, &c. are a kind of ſmall but variouſly figured *Muſhrooms*; a Specimen of which is repreſented at Fig. 542. which is nothing elſe but the microſcopick Appearance of a ſmall white Spot of hairy Mould found upon the Covers of a Book that was bound in Sheep's Skin. Theſe Spots appeared through the *Microſcope* to be a very pretty ſhaped vegetative Body, which ſhot out Multitudes of long and ſlender cylindrical Stalks, not exactly ſtreight, but bent with the Weight of a round white Knob growing upon the Top of each as at A A A; others a little oblong as at B, others a little broken as at C, and others that were burſt aſunder forming a kind of Bloſſoms with Leaves as at D.

* *Phi. Tranſ. No.* 94.

SECT.

SECT. III.
Of Moſs, &c.

MOSS is a Plant no leſs worthy a microſcopick Conſideration than the moſt elegant Plant that grows, and for its Shape and Beauty may be compared with any other. It has a Root almoſt like a feedy *Parſnip*, Fig. 543. furniſhed with ſmall Strings and Suckers, all of them being as curiouſly branched as the Roots of much bigger Vegetables; from this ſprings the Stem or Body of the Plant, which is finely creaſed or fluted; on the Sides of this are cloſe and thickly ſet a Multitude of well ſhaped Leaves, ſome of them of a roundiſh, others of a longer Shape; all the Surface on each Side the Leaf is curiouſly cover'd with a Multitude of little oblong tranſparent Bodies, as at D, Fig. 546. From the Tops of the Leaves proceeds a tranſparent Hair or Thorn: The Stem ſhoots out into a long round Stalk, which on cutting is found to be hollow without any Knot or Stop, from its Bottom where the Leaves encompaſs it, to the Top on which grows a large Seed-Caſe A, covered with a thin and more whitiſh Skin B, Fig. 544. terminated in a long thorny Top, which at firſt covers all the Caſe, and by degrees, as that ſwells, the Skin cleaves, and at laſt falls off together with its thorny Top, leaving the Seed-Caſe to ripen, and ſcatter its Seed, at a Place underneath this Cap B, which before the Seed is ripe appears like a fluted Metal Button, without any Hole in the Middle; but, as it ripens, the Button grows bigger, and a Hole appears in the Middle of it E, Fig. 545. out of which, in all Probability, the Seed falls; for as it ripens by the Proviſion of Nature that End of this Caſe turns downwards. On opening ſeveral of theſe dry red Caſes F, they were found to be quite hollow; whereas when they were cut aſunder with a ſharp Penknife when green, in the Middle of this great Caſe was found another ſmall round Caſe, the Interſtices between the two Caſes being filled with Multitudes of ſtringy Fibres which ſeemed to ſuſpend the leſſer Caſe in the Middle of the other, in which without doubt the Seeds were contained; it grows on the rotten Parts of *Stone*, *Bricks*, *Wood*, *Bones*, *Leather*, &c.

This ſmall Vegetable is wanting in nothing of the Perfections of the moſt conſpicuous and vaſteſt Vegetables of the World, and deſerves to be ranged in as high a State; for we do not know but that all the Contrivances and Mechaniſm requiſite to a perfect Vegetable, are crowded into exceedingly leſs Room than this of *Moſs*; for that Plant already deſcribed, which grows on *Roſe-Leaves*, is ſo exceeding ſmall that near 1000 of them would hardly make the Bigneſs of one ſingle Plant of *Moſs*; and by comparing the Bulk of the latter to that of the biggeſt Vegetable (ſome Trees being, as we are informed, near 20 Foot in Diameter in *Guinea* and *Brazil*) whereas the

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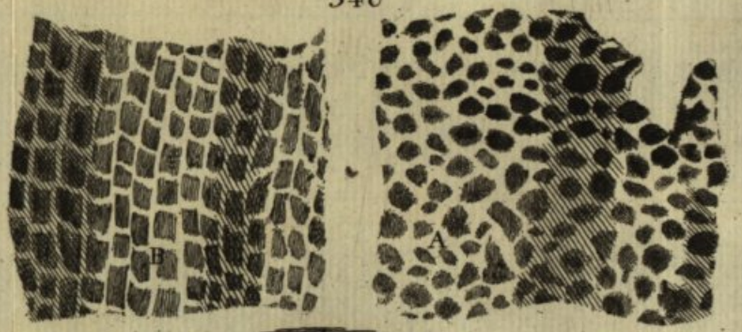

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the Body or Stem of *Moſs* is generally not above $\frac{1}{100}$ Part of an Inch, we ſhall find that the Bulk of one will exceed that of the other, no leſs than 2985,984,000,000; and ſuppoſing the Production of the Roſe-Leaf to be a Plant, thoſe *Indian* Plants will exceed it 1000 Times the former Number, ſo prodigiouſly various are the Works of the *Creator*, and ſo *all-ſufficient* is *he* in his Performance of Things which to *Man* would ſeem impoſſible.

SECT. IV.

Of Sponge.

THE *Microſcope* hath ſhewn us, that *Sponge* is compoſed of an infinite Number of ſmall and ſhort Fibres, curiouſly joined together in the Form of a Net, as appears by Fig. 547. which repreſents a Piece of Sponge as it appeared before the Microſcope, wherein may be ſeen the Joints which for the moſt part are, where only three Fibres meet together, the Length of each between the Joints is very irregular, the Diſtance between ſome two Joints being ten or twelve Times more than between others. The Maſhes likewiſe of this reticulated Body are alſo various, ſome bilateral, others trilateral, and quadrilateral Figures, *&c.*

SECT. V.

Of the Beard of a wild Oat.

THE Beard of a wild *Oat* is a Body of a very curious Structure; it grows out of the Side of the inner Huſk that covers the Grain of a wild *Oat*. Its whole Length when extended does not exceed an Inch and a half. When the Grain is ripe and very dry, which is uſually in the Months of *July* and *Auguſt*, the Beard is bent almoſt to a right Angle, and its under Part is wreathed and very brittle.

If you take one of theſe Grains and wet the Beard in Water, the ſmall bended Top will preſently turn and move round, and by degrees, if it be continued wet enough, the Joint or Knee will ſtreighten itſelf, and if it be ſuffered to dry again, it will gradually bend into its former Poſture. Its Appearance in the Microſcope is repreſented by Fig. 548. which ſhews Part of the Beard at the Knee or Bend. Its whole Surface is adorned with little Channels and interjacent Ridges, which run the whole Length of the Beard, and are ſtreight where the Beard is not twiſted, and wreathed where it is, being thickly ſet with ſmall Briſtles; in the wreathed Part was two very conſpicuous Channels which ſeemed to divide the wreathed Cylinder into two Parts, a bigger and a leſs, the biggeſt at the convex Side of the

Knee; these Clefts are filled with a kind of spongy Substance, very conspicuous near the Knee.

This odly constituted Vegetable is sometimes used, as an Hygrometer,* to discover the various Constitutions in the Moisture and Dryness of the Air; and this it does to Admiration.

CHAP. XLVI.

SECT. I.

Of Salts.

UNDER the Denomination of *Salt*, is to be understood most of that which gives Solidity to Bodies, is dissolvable in Water, and affects the Taste with a peculiar Pungency. There are three distinct Sorts which generally pass under this Name, the *fixed*, *volatile*, and the *essential*: The fixed is what remains after Calcination, and is procured by dissolving the saline Parts of the Ashes in hot Water, and evaporating it until the Salt is left dry at the Bottom; for that will not rise in Vapours. The *volatile* is what easily passes over the Helm, as the Salts of Animals. The *essential Salt* is that which is obtained by Chrystilization from the Juices of Plants, and is of a Nature between the other two, and may most properly be termed essential, having no Force used in its Production.

If there be in a strict Sense any such Thing as a *Principal*, *Salt* is so; but then it must be termed *fossil Salt*, or *Sal Gemma*; for this not only appears to be the plain Production of Nature, but to be the most homogeneous and uncompounded Part Nature can be divided into.

Its first Appearance is in Springs and Rivers, being washed into them by subterraneous Currents; thence by the Sun it is in some measure exhaled by Vapours; from whence it again returns, in *Snow*, *Hail*, and *Dews* (for common Rain-Water does not seem to partake of it;) from this Return the Surface of the Globe is saturated with it; whence it re-ascends in the Juices of Vegetables, and enters into all those Productions, as Food and Nourishment which the Creation supplies.

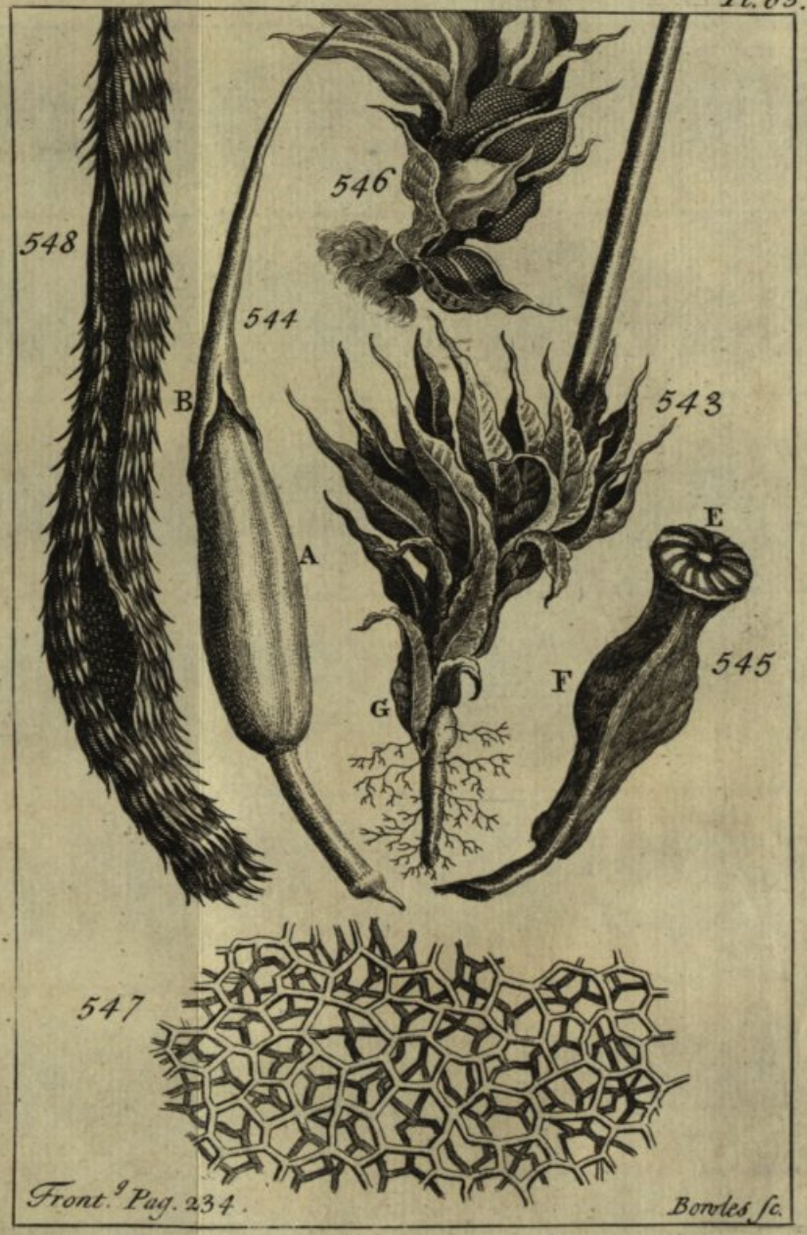
SECT. II.

To extract vegetable Salts.

BURN any Sort of *Herb*, *Flower*, *Fruit*, *Wood*, or whatever it be, and make Ashes thereof; with the Ashes and pure Water in its natural Temper, make Lee; which afterwards strain through moist Paper or a

* If the Reader is desirous of one of these Hygrometers, he may be furnished with them at my Shop, *&c.*

Filter,



Front.g Pag. 234.

Bowles sc.

Filter, ſo that it may become as clear as poſſible; then put the Lee into a Glaſs Veſſel, and let it remain in *Balneo Mariæ*, until a great Part of it evaporates; the Quantity of Water is not determined, generally five Pounds of Water will extract all the Salt from two Pounds of Aſhes; Salts extracted in this Manner, are wont to melt when the Air is ſoft; to prevent which, when you burn the Materials, in order to reduce them to Aſhes, it is requiſite to uſe with them a proper Quantity of Sulphur; and if it happens that the Aſhes are made to your Hand, you may mix them with Sulphur, and keep the ſame at the Fire, till ſuch Time as it be burnt; by this Means the Salt will never come to run, but become more white and cryſtalline. There is no general Rules for the Quantity of Sulphur to be put into the Materials you thus burn, but at a Gueſs, to 100 Pounds of Material, 4 or 5 Ounces of Sulphur is uſually ſufficient. All Salts have a peculiar and determined Figure, which they always keep, altho' they are often reſolved into Water, and afterwards congealed; yet notwithſtanding ſome Sorts of Salts are obſerved to have 2, 3, and 4 Sorts of Figures. Two Sorts have been ſeen in Lettice, in the *Scorzoneras*, in the *Muſk-Melon*, the *Scopa*, in the Roots of *Eſula*, in the *black Hellebore*, in *Endive*, *Eye-bright*, *Wormwood*, *Sorrel*, and in Shoots of *Vines*; three Sorts in *black Pepper*, and in incarnate *Roſes*; four Sorts in white *Hellebore*. Beſides the above-mentioned Diverſity of Figures which are found in *Salts*, it is obſervable, that amongſt all *Salts*, of what Figure ſoever, there are found ſome *cubical*, which though they be never ſo often diſſolved and congealed, appear ſtill of a cubical Figure, or inclining to it. To make the Bodies of the Salts when they congeal; remain diſtinct from each other, that their Figure may be obſerved, and not be entangled and heaped together; it is neceſſary, that very great Diligence be uſed in evaporating the Lee; for if that be wholly evaporated, or too great a Part thereof, the *Salts* make a confuſed Cruſt at the Bottom of the Veſſel; if the Lees are left too weak, the Salts require a very long Time to congeal, and therefore it is requiſite to uſe ſuch Diligence as is not to be gained without long Practice.

Cryſtals of *Salts* are ſuch a Combination of ſaline Particles, as reſemble the Form of a Cryſtal, variouſly modified, according to the Nature and Texture of Salts.

The Method herein uſed is this, diſſolve the *ſaline Body* in Water, after which filter the Solution, which being evaporated until a little Film appears upon it, runs into Cryſtal. Diſſolution and Filtration are made Uſe of, that the Salts may be purged from all Droſs; otherwiſe if any foreign Matter ſhould get in, not only the Tranſparency of the Cryſtals would be impaired, but their Figure alſo would be mangled and broken.

SECT. III.

Of the Figures of Salts.

IT is generally agreed, that all Bodies have their *Salts*, which produce many ſurpriſing Changes, by their different Configurations and Impreſſions, both in Solids and Fluids, in Things animate and inanimate. As to the Figures of them, they are obvious to every Beholder; their Beauty and Variety are ſo admirable, that ſcarce any Thing in Nature can entertain the Eye more agreeably than theſe do, when it is aſſiſted with a good *Microſcope*.

In common *Salt*, we plainly diſcover *quadrilateral Pyramids* with ſquare Baſes. In *Sugar*, the ſame *Pyramids* with oblong and rectangular Baſes. In *Allum*, they riſe with ſix Sides, ſupported with an hexagonal Baſe. The Cryſtals of *Vitriols*, reſemble Icicles, united one to another with great Variety, among which lie ſome Polygons. *Sal-Armoniack* very elegantly imitates the Branches of a Tree; and *Hart's-Horn* looks like a Quiver of Arrows; *Glauber's Sal Mirabilis*, which is made of common *Salt* and *Vitriol*, exhibits the Figure of both Salts. *Nitre* appears in certain priſmatick Columns, not much unlike Bundles of Sticks; among which there are interſpers'd ſome of a Rhomboidal, and Pentagonal Figure, which ſeem to come very near thoſe of common *Salt*. Hence *Lemery* very juſtly remarked, that *Nitre* could not be purified by any Art or Contrivance whatſoever, but ſomething of a *Sal Gem*, or *foſſil Salt*, would ſtick to it; but *Salt* of *Tin* out-does all for Beauty, in which are Lines like little Needles, that ſpread themſelves every where from a Point, as from a Center, ſo as to repreſent a Star, much like what we ſee in the *Regulus of Mars*.

Salts have this peculiar Property, that let them be ever ſo divided and reduced into minute Particles, yet when they are formed into Cryſtals, they each of them re-aſſume their proper Shape; ſo that they may be as eaſily diveſted and deprived of their Saltneſs, as of their Figure. Whence by knowing the Figure of the Cryſtals, we may underſtand what the Texture of the Particles ought to be, which can form theſe *Cryſtals*. And by knowing the Texture of the Particles, we may determine the Figures of the *Cryſtals*. For ſince the Figures of the moſt ſimple Parts remain always the ſame, 'tis evident the Figures which they run into, when compounded and united, muſt be uniform and conſtant.

Eſſential Salts are made by expreſſing the Juice of any Plant, and ſetting it in a Cellar to ſhoot; which ſome do in ſmall Quantities.

Fixed

Fixed Salts are made as follows:

Take any Plant, and burn it on a clean Hearth, and rake the Aſhes as long as any Fire appears among them; put thoſe Aſhes into an unglazed Pan, which ſet in a calcining Furnace, make Fire about it till the Pan is red-hot; where keep it, continually ſtirring the Aſhes without any Blackneſs. Then put them into a clean Pan, and pour hot Water upon them; when that Water is ſufficiently impregnated with Salt, filter it, and evaporate to a Dryneſs, until the Aſhes are left inſipid.

The Salts of *Metals* or *Minerals* are to be come at, by quenching them, when red hot in Water, then filtering, evaporating, and cryſtallizing.

If *Allum* be burnt, diſſolved in Water, and ſtrained, its Cryſtals will conſiſt of two ſexangular Planes, whoſe Sides are bounded by ſix other, three of which are quadrilateral, having between them three of a ſexangular Figure; as at Fig. 548.

Green Vitriol affords Cryſtals, which are made up of ten unequal ſided Planes, the Middle-moſt are Pentagons, and each of its ſharp Ends triangular Planes; as at Fig. 549.

The Cryſtals of our Inland *Salt* Springs are of a cubical Figure, as at Fig. 550.

Salt-Petre ſhoots into long Cryſtals, whoſe Sides are ſix Parallelograms; as at Fig. 551.

It has been already mentioned, that Vinegar owes its Pungency to the Salts which float therein; their Shape is ſeen at Fig. 552. Expoſe a Drop or two of Vinegar to the open Air for an Hour or two upon the Object-carrying Glaſs R, that its watery Parts may evaporate; then apply it to the *Microſcope*.

The *Salts* of *Sugar candy'd*, are repreſented at Fig. 553. The *Salts* of *Nitre* are ſeen at Fig. 554. The *Salts* of *Camphire*, at Fig. 555. *Sal Gem* is repreſented at Fig. 556. and *Sal Armoniack* at Fig. 557.

It is beſt to examine all *Salts* in the ſmalleſt Maſſes, for in them their Shape will be beſt diſcovered.

CHAP. XLVII.

SECT. I.

On ſtriking Fire with a Flint and Steel, &c.

ON ſtriking Fire with a Flint againſt a Steel, little Particles of Steel are ſtruck of, and melted into Globules by the Colliſion; which will be evident on ſpreading a Sheet of white Paper, and obſerving the Place where ſeveral of theſe little Sparks ſeem to vaniſh. Mr. *Hook* examined ſeveral of them with a Microſcope, and found that a black Particle, no bigger

ger than a Pin's Point, appear'd like a Ball of poliſh'd Steel, as at Fig. 558. and ſtrongly reflected the Image of the Window, and of a Stick which he moved up and down between the Light and it. Others were, as to their Bulk, pretty round, but their Surface not ſo ſmooth; ſome were cracked, as Fig. 559. others broke in two, and hollow, as Fig. 561. ſeveral others were found of other Shapes; but that repreſented at Fig. 560. was obſerved to be a big Spark of Fire, and ſtuck to the Flint, by the Root F, at the End of which Stem was faſtened an Hemiſphere, or hollow Ball. It is alſo remarkable, that ſome of theſe Sparks are Slivers, or Chips of Iron vitrified, others are only the Slivers melted into Balls, without Vitrification, * and the third Kind are only ſmall Slivers of the Iron, made red-hot with the Violence of the Stroke given on the Steel by the Flint.

Many Sorts of Sand, ſome gather'd on the Sea-ſhore, or on the Sides of Rivers, and ſome found on the Land, differ in the Size, Form, and Colour of their Grains, ſome being tranſparent, others opake, ſome have rough, and others quite ſmooth Surfaces. It would be endleſs to deſcribe all the Figures to be met with in theſe Kind of minute Bodies, they being ſpherical, oval, pyramidal, conical, priſmatical, *&c.* Mr. *Hook* trying ſeveral magnifying Glaſſes, by viewing a Parcel of white Sand, caſually hit upon one of the Grains, which was exactly ſhaped and wreathed like a Shell, which he ſeparated from the reſt of the Granules, and found it to appear to the naked Eye no bigger than a Pin's Point, but when viewed in the *Microſcope*, it appear'd as in Fig. 562. reſembling the Shell of a ſmall Water Snail; † it had twelve Wreathings, growing all proportionably one leſs than the other, towards the Middle or Center of the Shell, where there was a very ſmall round white Spot. In this minute Shell we have a very good Inſtance of the Curioſity of Nature, in another Kind of Animals, removed by their Smallneſs beyond the Reach of the naked Eye; and as there are ſeveral Sorts of Inſects and Vegetables, ſo ſmall as to have had no Names; ſo likewiſe by this, we find there are alſo exceeding ſmall, or rather minute Shell-fiſh. Nature, by the Aſſiſtance of the Microſcope, having ſhewn to us her Curioſities, in every Tribe of *Animals*, *Vegetables*, and *Minerals*.

SECT. II.

Of ſmall Diamonds or Sparks in Flint.

A *Flint Stone* being broke in Pieces, the inſide Cavity of it appear'd to be cruſted all over with a pretty candid Subſtance, reflecting the Light from ſome of its Parts very vividly; but on examining it with the *Microſcope*, the whole Surface of that Cavity could be perceived to be beſet with

* *Hook's Micr. p.* 44. † *Ibid. p.* 80.

a Mul-

a Multitude of little cryſtalline or adamantine Bodies, curiouſly ſhaped, as at B, Fig. 563. and afforded a very agreeable Object.

An Atom, or Globule of *Quickſilver*, when placed before the Microſcope, ſeems like a convex Mirrour, in which may be ſeen all the circumambient Bodies; as the Windows, Trees, and Furniture, *&c.*

SECT. III.

Of Mercurial Powders, &c.

IN thoſe chymical Preparations of Mercury, which is called *Turbith Mineral*, *Mercurius Vitæ*, *Dulcis*, *Sublimate*, *Precipitate*, and *Mercury Coſmetical*, *Calomel*, and all other mercurial Powders, are found, when examined by the *Microſcope*, to be full of minute Globules of crude and unalter'd Mercury; which ſhews, that thoſe chymical Preparations are not ſo purely exalted and prepared as they are preſumed to be, nor the Mercury any Way tranſmuted, but by an atomical Diviſion rendered inſenſible.

CHAP. XLVIII.

The Nature of Snow, &c.

MANY of the Parts of *Snow*, are for the moſt Part of a regular Figure, and as it were ſo many Rowels or Stars with ſix Points, and are as perfect and tranſparent *Ice* * as any we ſee on a Pool of Water; at each of theſe ſix Points are ſet other collateral Points, and theſe always at the ſame Angles with the principal Points themſelves; that amongſt theſe, many others alike regular, but far ſmaller, may be diſcover'd; there are alſo ſome others, which ſeem to have loſt their Regularity, by various Winds, being firſt gently thawed, and then frozen again into irregular Maſſes; from all which, *Snow* ſeems to be an infinite Number of *Icicles*, regularly figured, not only in ſome few Parts thereof, but originally in the whole Body of it; not ſo much as one Particle of ſo many Millions being originally indeterminate or irregular; that is, a Cloud of Vapours being gather'd into Drops, do forthwith deſcend; in which Deſcent, meeting with a freezing Wind, or at leaſt paſſing through a colder Region of the Air, each Drop is immediately frozen into an *Icicle*, ſhooting itſelf into Points or *Icicles* on all Sides from the Center; but ſtill continuing their Deſcent, and meeting with warmer Air, ſome are thawed and blunted, others broken, but the greateſt Number cling together in ſeveral Parcels, and form what we call *Flakes of Snow*; hence we underſtand why Snow, tho' it ſeems to be ſoft, is really hard, be-

* *Philoſ. Tranſ.* No. 92.

cauſe

cauſe it is a real *Ice*, whoſe inſeparable Property is to be hard, its Softneſs being only apparent. The firſt Touch of the Finger upon any of its ſharp Edges or Points inſtantly thaws them, otherwiſe they would pierce the Fingers like ſo many Lancets; and hence alſo why *Snow*, tho' a real *Ice*, and ſo denſe and hard a Body is notwithſtanding very light, which is the extream Thinneſs of each Icicle in reſpect of its Breadth: Hence it alſo appears, why Snow is white, becauſe it conſiſts of Parts, each of which ſingly is tranſparent, but mixed together, appear white, as the Parts of Froth, Glaſs, Ice, and other tranſparent Bodies, whether ſoft or hard.

A B C D E F, Fig. 564. repreſents a few of an infinite Variety of curious Figures that are to be obſerved in *Snow*.

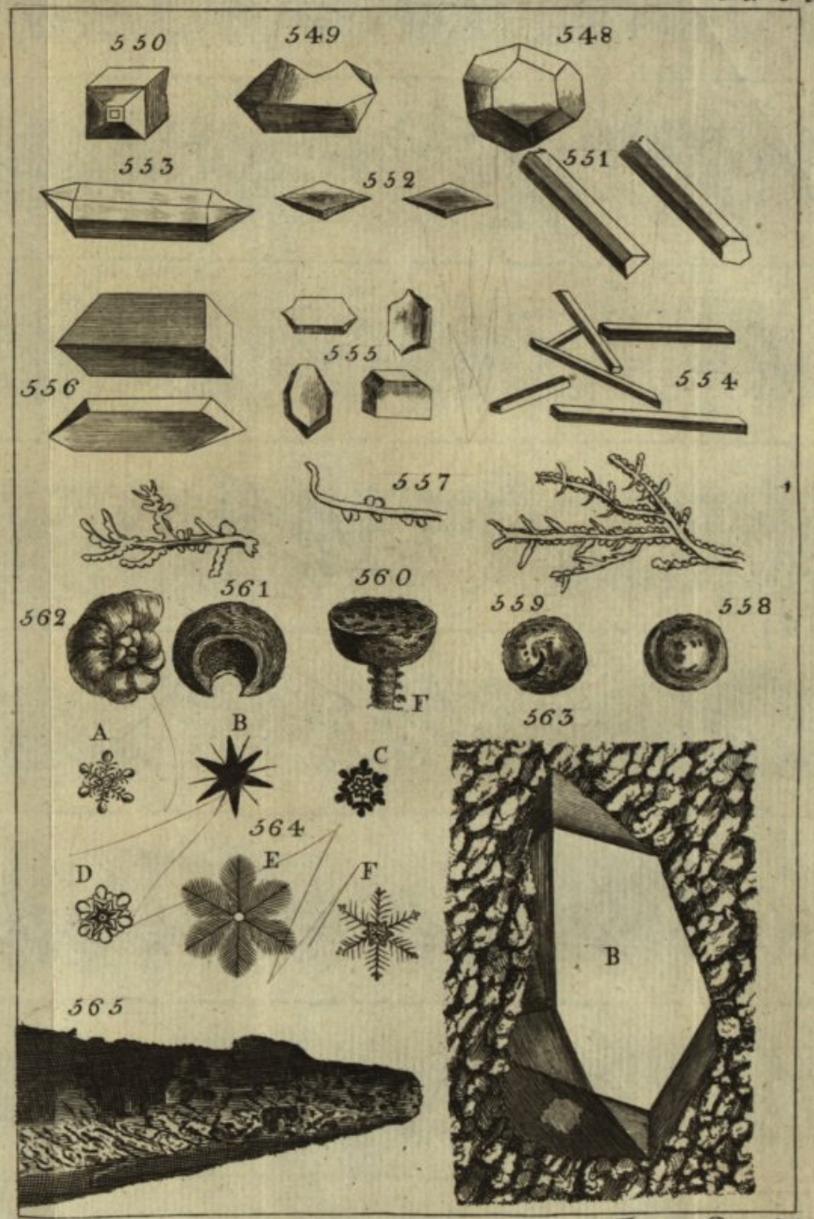
In which it was obſervable, that if they were of any regular Figures, they were always branched out with ſix principal Branches, of equal Length and Shape. As theſe Stems were for the moſt Part of the ſame Make in one Flake, ſo were they in differently figured Flakes, very different; but this was conſtantly obſerved, that of whatever Figure one of the Branches were of, the reſt were exactly the ſame.

The Point of an exceeding ſmall Needle, appeared, when greatly magnified like Fig. 565. neither round nor flat, but very irregular, and tho' to the naked Eye it was very ſmooth and ſharp, yet upon this Examination, it appear'd to be full of Holes * and Scratches; ſo unaccurate is human Art in all its Productions, even in theſe which ſeem to be the moſt neat, that if examined with an Organ more accurate than that by which they were made, the more we ſee of their Shape, the leſs Appearance will there be of their Beauty; whereas in the Works of Nature, the deepeſt Diſcoveries ſhew us the greateſt Excellencies; for in the Sting of a Gnat, or a Bee, the Proboſcis of a Butterfly, or Flea, they appear, when examined by the Microſcope, to be formed with the moſt ſurpriſing Beauty, exquiſite Workmanſhip, and an exact Regularity of, and Likeneſs in Parts is preſerved in each Particular of every Species; an evident Argument, that he who was, and is the Author of all theſe Things, is no other than OMNIPOTENT; being able to include as great a Variety of Parts and Contrivances in the moſt minute Point, as in the largeſt Body.

Fig. 566. repreſents a very ſmall Dot, Tittle, or Point, that is generally the Mark of a full Stop or Period. Amongſt Multitudes that were obſerved by the *Microſcope*, few could be found ſo round and even as this here delineated, † but when greatly magnified, it appear'd to be rough, jagged, and uneven all about its Edges, and very far from being truly round, as at Fig. 567. the moſt curious and ſmoothly engraved Strokes and Points, when examined by the Microſcope, look but like ſo many Furrows and Holes; and their printed Impreſſions, but like ſmutty Daubings on a Mat,

* *Hook's Micr. p. 2.* † *Ibid. p. 2.*

or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or uneven Floor, made with a blunt extinguiſhed Brand. Several Pieces of ſmall Writing, reckoned very curious of their Kind, one of which in the Breadth of a Silver Two-pence, compriz'd the *Lord's Prayer*, the *Apoſtles Creed*, the *Ten Commandments*, and about ſix Verſes beſides out of the *Bible*, being examined by the *Microſcope*, ſhew'd what the Writer had aſſerted was true, but withal diſcovered it to be compoſed of as ſhapeleſs, barbarous, and uncouth Letters, as if written in *Arabian* and *Chineſe* Characters.

A Part of the *Edge* of a very keen *Razor* was ſo placed between the Microſcope, and the Light, that there appear'd a Reflection from the very Edges, and was perceived to be ſharper in ſome Places than in others, indented at others, broader and thicker at others, and unequal and rugged; that Part of the Edge which is poliſhed by the Hone, appear'd to be prodigiouſly full of Scratches, croſſing each other every Way; beſides it had ſeveral deep Furrows. That Part of the *Razor* which was poliſhed upon the Wheel, look-ed almoſt as rough as a plowed Field. *

Mr. *Leeuwenhoek* cauſed himſelf to be ſhaved with the ſharpeſt *Razor* he could pick out of five by the Help of a magnifying Glaſs. At firſt it was very ſoft and eaſy, but at laſt it grew ſo painful he could not endure it, and upon viewing it with his *Microſcope*, he found in it many more Notches than at firſt. In another he found little Holes in ſix ſeveral Places near the Edge. He waſhed the Back of his Hand with plain Water, and then with this ſame *Razor* ſcraped off the little Hairs, and on obſerving the *Razor* again, found that thoſe little Holes were turn'd into Notches, and that ſeveral Pieces of the Razor were broken out. From whence it appears, that if the Razor be too ſoft, it yields to the Hairs, if too hard, the Hair cauſes ſeveral Notches in it. In ſhort when we obſerve thro' a Microſcope the ſeveral Notches there are in the fineſt Razor, it is ſurpriſing how any of them can cut ſo well. †

Fig. 568. repreſents a Piece of exceeding fine *Lawn*, as it appear'd thro' the *Microſcope*, which from the great Diſtances between its Threads, appears like a Lattice, and the Threads themſelves ſeem coarſer than Rope-Yarn.

Fig. 569. exhibits a microſcopick Appearance of a very fine Piece of Ribband, being not much unlike that Subſtance of which *Door-Mats* are made. If the Silk be white, each Thread appears like a Bundle or Wreath of tranſparent Cylinders; if colour'd, they appear curiouſly tingid, each of which affording in ſome Part or other a vivid Reflection, in ſo much, that the Reflection of Red appear'd as if coming from ſo many Garnets or Rubies.

Hence it is evident, that there are but few *artificial* Things worth obſerving with a *Microſcope*, for which Reaſon I ſhall conclude here; the

* *Hook's Micr. p.* 4. † *Phil. Tranſ.* No. 273.

Productions of *Art* being ſuch rude miſhapen Things, that when viewed with that Inſtrument, we can obſerve very little in them but their Deformity. The moſt curious Carvings, appear no better than thoſe rude *Ruſſian* Images mentioned by *Purchas*; where three Notches at the End of a Stick ſtood for a Face: And the moſt ſmooth and poliſhed Surfaces that we can poſſibly meet with, appear rough and uneven. Therefore why ſhould we endeavour to find Beauties in Things which were deſigned for no higher a Uſe than to be viewed by our naked Eye? But only that we may ſee the *Defects* of human Art, when compared to thoſe of *Nature*, in whoſe Forms there are ſomething ſo ſurprizingly ſmall and curious, and their deſign'd Buſineſs ſo far removed beyond the Reach of our natural Sight, that the more we magnify thoſe minute Objects, the more Excellencies and Myſteries appear; and the more we are enabled to diſcover the Weakneſs of our own Senſes, as well as the Omnipotency and infinite Perfections of the *Great* CREATOR.

F I N I S.

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A

CATALOGUE

OF

Mathematical, Philoſophical, and *Optical*

INSTRUMENTS,

As *Made* and *Sold* by

GEORGE ADAMS,

At Tycho Brahe's *Head, in* Fleet-Street, London.

THE Study of the Mathematicks is now ſo generally eſteemed, as to become a neceſſary Part of almoſt every Gentleman's Education. Nor need we wonder at the great Progreſs, which this Science has, of late Years, made in moſt Parts of *Europe*; ſince it contains ſuch an inexhauſtible Fund of uſeful Knowledge, as is ſufficient to gratify almoſt every Taſte, and employ every Talent. The nobleſt Genius may, in the Purſuit of it, exert his utmoſt Faculties; and the meaneſt will not fail of finding ſomething that is within his Reach. The Theory affords an ample Field to the ſpeculative Part of Mankind, and the Practice is productive of ſeveral Advantages to Men of Action and Buſineſs.

In order, therefore, to render this Treatiſe, in ſome Meaſure, of general Uſe, I have ſubjoined an extenſive CATALOGUE, of the greateſt Part of *Mathematical, Philoſophical,* and *Optical* Inſtruments, that are now in Uſe among the moſt judicious and learned Men throughout *Europe.*

Mathematical Inſtruments are the Means by which thoſe noble Sciences, Geometry and Philoſophy, are render'd uſeful in the Affairs of Life. By their Aſſiſtance an abſtracted and unprofitable Speculation, is made beneficial in a thouſand Inſtances: In a Word, they enable us to *connect Theory* with *Practice*, and ſo turn what was only bare Contemplation, into the moſt ſubſtantial Uſes.

The Knowledge of these leads to that of *practical* MATHEMATICKS, and *experimental* PHILOSOPHY; so that the Uses of mathematical and philosophical Instruments, make perhaps one of the most *serviceable Branches* of Learning in the whole World; and the natural Way, therefore, of rendering this Knowledge general and diffusive, is by making that of its *Instruments* so.

As *practical* Mathematicks, and *experimental* Philosophy, teach us the *Powers* of Nature, the *Properties* of natural Bodies, and their mutual Actions on one another: This Knowledge cannot be attained without *Instruments*, and the Conclusions and Proofs we expect from it, depend very much upon their *Exactness*. In order therefore to give a sufficient Satisfaction to those Gentlemen who have honour'd me with their Custom, it hath always been my particular and greatest Aim to produce such *Instruments* as *might facilitate* the *Progress* of *Mathematical* and *Philosophical Learning*, which *Motive* hath been, and still is as pressing with me as that of *Interest*. For,

In the Construction of all the Machines I have ever made, my first and greatest Care hath been to procure good *Models* and *Drawings*, several of them I have imitated from the *best Authors*, as well *Foreigners*, as those of *our own Country*; I have alter'd and improved others, and have added many new ones of my *own Invention*. And,

1. In all my Peformances I endeavour not to *augment* the Instruments and Machines with *superfluous Ornaments*, both that they may be of *frequent Use* to those of *middling Fortunes*, and that their *Neatness* may render them not unworthy of a Place in the Cabinets of the Curious.

2. That their *Exactness* may be particularly attended to, I always inspect and direct the several Pieces myself, see them all combined in my own House, and finish the most *curious* Parts thereof with my own Hands.

3. To the End that their *Construction* may be as *simple* and *substantial* as the *Uses* of the Instruments will *admit*; it is my constant Study to contrive them in such a Manner that they may be managed with the *greatest Ease*.

4. I also have Respect to their being made applicable to *several Operations*, especially when the *Extent* of their *Use* does not *prejudice* their *Simplicity*, to the End that Instruments may not be multiplied without Necessity.

In the following CATALOGUE I have ranged the Instruments in *Classes* under the Heads of their several *Branches*, and have *number'd* each particular *Instrument*, so that if a Gentleman is desirous of any one or more of them, and is at any Distance from LONDON, he need only send me the Numbers adjoining to those he intends to purchase, and he shall be served with Fidelity, and at the lowest Prices.

Instruments