Natura quaeam magis quam minimis notata est.
At a Meeting of the Council of the ROYAL SOCIETY, 1691. cc. 1691.

D [Numerous cross marks and unclear text.]

[Unreadable text.]

[Signature: W. R. S.]

[Unreadable text.]
At a Meeting of the Council of the ROYAL SOCIETY, Feb. 22. 1681

Dr. Grew having read several Lectures of the Anatomy of Plants, some whereof have been already printed at divers times, and some are not printed, with several other Lectures of their Colours, Odours, Tafis, and Salts; as also of the Solution of Salts in Water, and of Mixture; all of them to the satisfaction of the said Society: It is therefore Ordered, That He be desired, to cause them to printed together in one Volume.

CHR. WREN P.R.S.
THE ANATOMY OF PLANTS
WITH AN IDEA OF A
Philosophical History of Plants.
And several other
LECTURES,
Read before the
ROYAL SOCIETY.

By NEHEMIAH GREW M.D. Fellow
of the ROYAL SOCIETY, and of the
COLLEGE of PHYSICIANS.

Printed by W. Rawlins, for the Author, 1682.
THE

ANATOMY

OF

PLANTS

WITH AN

IDEA

OF A

Philosophical History of Plants,

And Several Other

LECTURES

Read before the

ROYAL SOCIETY

By NICHOLAS FLEMING, M.D., Fellow of the Royal Society, and of the College of Physicians.

Printed by W. Robinson, for the Author, 1682.
TO HIS MOST SACRED MAJESTY
CHARLES II.

King of Great Britain, &c.

May it please Your Majesty,

HE Dedication of one Part of the following Anatomy having been very graciously received by Your Majesty: I am now emboldened most humbly to present the Whole into Your Royal Hands.

By which Your Majesty will find, That there are Terræ Incognitæ in Philosophy, as well as Geography. And for so much, as lies here, it comes to pass, I know not how, even in this Inquisitive Age, That I am the first, who have given a Map of the Country.

Your
Tour Majesty will here see, that there are those things within a Plant, little less admirable, than within an Animal. That a Plant, as well as an Animal, is composed of several Organical Parts; some whereof may be called its Bowels. That every Plant hath Bowels of divers kinds, containing divers kinds of Liquors. That even a Plant lives partly upon Aer; for the reception whereof, it hath those Parts which are answerable to Lungs. So that a Plant is, as it were, an Animal in Quires; as an Animal is a Plant, or rather several Plants bound up into one Volume.

Again, that all the said Organs, Bowels, or other Parts, are as artificially made; and for their Place and Number, as punctually set together; as all the Mathematick Lines of a Flower or Face. That the Staple of the Stuff is so exquisitely fine, that no Silk-worm is able to draw any thing near so small a Thread. So that one who walks about with the meanest Stick, holds a Piece of Nature's Handicraft, which far surpasses the most elaborate Woof or Needle-Work in the World.

That by all these Means, the Ascent of the Sap, the Distribution of the Aer, the Confection of several sorts of Liquors, as Lymphas, Milks, Oyls, Balsames; with other parts of Vegetation, are all contrived and brought about in a Mechanical way.
The Epistle Dedicatory.

In sum, Your Majesty will find, that we are come a-shore into a new World, whereof we see no end.

It may be, that some will say, into another Utopia. Yet not I, but Nature speaketh these things: the only true Pallas, wherewith it is treasonable for the most curiously banded Arachne to compare. In whose Name, I, the meanest of her Pupils, do in all humility crave Your Majesty's Gracious Patronage. Whereof I cannot doubt, since Your Majesty hath been pleased to be the Founder, and to style Yourself the Patron of that Society, of which I have the honour to be a Member. Your Majesty deeming it to be a more Noble Design, to enlarge the Territories of Knowledge, than those of Dominion: and the Highest Pitch of Human Glory, not to rule, in any sort, over many; but to be a Good Prince over Wise Men. I am

Your Majesty's

most humble

and

most obedient

Subject

NEHEMIAH GREW.
THE

PREFACE.

T is a Politick or Civil Virtue in every prudent mans Eye, To set himself an example, in what he doth, unto others. And in so doing, he looks upon himself as accountable, in some sort, to all Men. To those therefore, who may either expressly, or tacitly, expect the Reasons, upon which I first undertook the Anatomy of Plants, and also made the after-progres therein; I shall summe them up as follows.

The first occasion of directing my Thoughts this way, was in the Year 1664, upon reading some of the many and curious Inventions of Learned Men, in the Bodies of Animals. For considering, that both of them came at first out of the same Hand; and were therefore the Contrivances of the same Wisdom: I thence fully assured my self, that it could not be a vain Design; to seek it in both. And being then newly furnish'd with a good stock of Seeds, in order to raise a Nursery of Plants; I resolved, besides what I first aimed at, to make the utmost use of them for that purpose: that so I might put somewhat upon that side the Leaf which the best Botanicks had left bare and empty. And in which, notwithstanding some other Learned Men had inferred somewhat of this nature; as Dr. Highmore in his Book of Generation, Dr. Sharrock of the Propagation of Plants, and Mr. Hook in his Micrography: yet but collaterally, and without shewing any purpose of managing this Part of Natural History. And although it seemed at first an Ob-

ccion
The Preface.

jection in my way, That the first projectors seldom bring their business to any good end; yet I also knew, That if Men should stay for an Example in everything; nothing extraordinary would ever be done.

But notwithstanding the reasonableness of the Design; yet I did not forget, that, in respect of the Undertaker, there might be Impar congruis. And therefore, before I had ventured very far, in the Year 1668, I imparted it to my Brother-in-Law, the Learned Dr. Henry Sampson, now Fellow of the College of Physicians in London. Who not only very well liked the same; but also excited me to a vigorous and accurate prosecution of it. Which he did, partly, by mentioning a very pertinent passage of Dr. Glisson, in the Preface to his Book de Hepatie, (a) which I had not then read.

(a) Ch. I.

Plantes quoque in bunc cenfum (sc. Anatomicum) veniunt; varië enim Partium textura, & differentis constitutis: & procul dubio, ex accurata earundem dictione, utiles valde observationes nobis exugere: præfertimque in illis (inferioris licei ordinis) rebus examinandis operam impendere, quam in transcriptionibus ut fape sit, aliorum laboribus, inutiliter atatem transfigere. Quippe hoc pacto, ignararum apum more, aliena dumtaxat alvearia expilamus, nihilque bono publico adjicimus.

After I had finished the First Book, that I might know the sense also of other Learned Men, whether the steps I had already taken, would warrant me to proceed any further: I put some part of it into the same Hand; who, in the Year 1670, communicated the same to Mr. Oldenburge, then Secretary to the Royal Society; and after he had read it over, it was, upon his motion, delivered to that excellent Person Dr. John Wilkins then Bishop of Chester, who produced it at a Meeting of the Royal Society, and desired, they might see the rest. Which, or the greatest part, being also presented to them, the Right Honourable the Lord Vicount Brouncker, then President of the Royal Society, was pleased to peruse the same. Presently, after which, at a Meeting of the Council of
The Preface.

of the said Society, the following Order was made, and entered in their Council-Book with this Date, and in these words:

May 11th 1671.

Then was Licensed Dr. Nehemiah Grew's Book, Entitled, The Anatomy of Vegetables begun; together with an account of Vegetation grounded thereupon. And Ordered to be Printed by the Printer to the Royal Society.

Hereupon, I was obliged to send the Book to the Press. And upon the 9th of November following in the same Year 1671, when it was near being printed, my Lord Brouncher signed the forementioned Order: the Printer, whose Name was to be inserted therein, not having received his Diploma till that time.

The Book being quickly after printed off; I ordered it to be Presented to the Royal Society; which was accordingly done at one of their Meetings December 7, 1671. And also to be sent to the Bishop of Chester; who was pleased to signify his acceptance thereof by a Letter dated at Chester, December 26th 1671, now filed amongst others in the Custody of the Royal Society: part whereof, in regard it relates to matter of Fact, I shall here recite.

Sir,

I did yesterday receive your Book; and am very sensible of the Honour you have done me in the Dedication of it. You was very happy in the choice
The Preface.

of this Subject to write upon; one of the most Noble and the most Cognis parts of Philosophy; and such an one, as hath hitherto lain uncultivated. And you have been very successful in your first Attempt about it, in so many remarkable Observations and Discoveries, as you have made already. I could heartily wish, that you would still apply your self to this kind of Enquiries. You will find that Additionals will come in more copiously and easily. And it is not fit, that any one should, by his Superstitions, carry away the praise from him, who was the first Inventor, and who laid the Foundations, wherein the greatest difficulty doth consist, &c.

Having thus submitted my self to the Judgment of many Learned Men; I saw that my Journey must not here end. So that, like one who is got into a Wood, I thought I might as fairly find my way out, by going on, as by making a retreat. Whereupon, I began to draw up a Scheme of the whole Design.

While I was doing this, I received news from London, that the same day, December 7. 1671, in which my Book, then printed, was presented to the Royal Society: there was also presented a Manuscript (without Figures) from Seignior Malpighi, upon the same Subject; dated at Bononia, November, 1st 1671. the same, which Mr. Oldenburger, when it came to be printed, calleth his Idea. And of this, entry was made in their Journal Book. So that the Royal Society having now a Prospect of the good service of an Ancient Member, and one, who had highly merited by his Works then extant; from thence forward, I looked upon my self to be excused.

But soon after, receiving another Letter from the Bishop of Chester, dated at London, Febr. 18. 1672. I found
The Preface.

found the matter otherwise; and that the Society were pleased to engage me to proceed. Whereof entry was made by the Secretary in their Journal Book, at one of their Meetings, April, 18. 1672, in these words:

The Society was made acquainted with one particular lately passed in the Council; viz. That the Bishop of Chester had there proposed Dr. Grew to be a Curator to the Royal Society for the Anatomy of Plants: and that the Council had approved of that Proposal. Upon which, it was Ordered, That the Thanks of the Society be returned to the Lord Bishop of Chester, for this Proposal, and to the Council for their Approbation of the same.

This they might be induced to do; upon considering, that it would be no disadvantage to the credit of those matters, which were so new and strange, to be offered to the World from a double Authority. For one, although he may have no mind to deceive; yet is it more likely for one, than for two, to be deceived. Likewise, that the same Subject, being prosecuted by two Hands, would be the more illustrated by the different Examples produced by both. And that, as in other matters, so here, the defects of both, would mutually be supplied.

Whether for these, or other Reasons also, they were pleased to pass the forementioned Order; that being done, it had been very ill manners in me, not to have answered their expectation therein. And therefore re-assuming the Design I had laid by, and having reduced it to some intelligible Idea, it was submitted to the Censure of the Royal Society: and it was thereupon ordered it should be printed.
The Preface.

Not long after, I received a Curious and Learned Book from Monf. Dodart, Archiater to the Prince of Conde, and Fellow of the Royal Academy at Paris; in pursuance of whose Order, it was by him composed and published. Which being a Design of a like Import, I was glad to see it so far justify'd by that Illustrious Society, as well as by our own.

In this Idea, one principal Thing I insist upon, for a Philosophical History of Plants, is Anatomy. And, agreeing to the Method therein proposed, all the Observations contained in the First Book, except one or two, were made with the Naked Eye. To the end, I might first give a proof, How far it was possible for us to go, without the help of Glasses: Which many Ingenious Men want; and more, the patience to manage them. For the Truth of these Observations, Seignior Malpighi, having procured my Book to be translated into Latin for his private use, speaks his own sense, in some of his Letters to Mr. Oldenburge, printed at the end of his Anatomy of Plants. And some of them, have since been confirmed, both by our Learned Country-men Dr. Wallis, and Mr. Lister, and by the Ingenious Mr. Lewenboeck, abroad.

Having thus begun with the bare Eye; I next proceeded to the use of the Microscope. And the Observations thereby made, first on Roots, and afterwards on Trunks and Branches, together with the Figures, were all exhibited to the Royal Society at several times from May 15. 1672. to April 2. 1674; being the Materials for the Second and Third Parts: and hereof Memorials were inserted in their Journal Books.

After this, the Royal Society received from Seignior Malpighi his Second Part of the Anatomy of Plants, together with the Figures therein described, and his Letters to their Secretary, dated at Bononía Aug. 26th of the same year 1674. when, and not before, he gave leave that the two said Parts should be printed.
The Preface.

So soon as I had finished the Second and Third Parts, I proceeded to the Last, &c. of Leaves, Flowers, Fruits and Seeds: and those Things I met with, more remarkable, were presented to the said Society in the Years 1676 & 1677. And the publishing of the former Parts successively, as well as of all together, hath been done in pursuance of their several Orders for the same.

Having concluded the History of Perfect Plants; I intended to have subjoined the Description of those which are Imperfect. Also of Parasitical, Marine, and Sensitive Plants. And lastly, a view of the chief Particulars, wherein the Mechanisme of a Plant, is different from that of an Animal. But these things I leave to some other Hand.

The First Book, a little after it came forth; was translated into the French Tongue, by Mons. Le Vaissier, an Ingenious Gentleman in Paris; elegantly, and in the Judgment of those who are well skilled in that Language, with much exactness, as to the sense. He having taken special care, to have all the difficulties of our own, by Me, cleared to him. And in a late Book Entituled, Philosophia vetus & nova printed at Noriberg 1682. the Learned Author seems to have made use of this Translation, for all that he hath taken notice of in that my First Book.

By the Ingenious Collectors of the German Ephemerides, both my First, Second, and Third Books, are all published in Latine. But their unskilful Interpreter doth often fail of the Grammatical Sense. Whose Errors, many of them very gross, I desire may be imputed neither to them, nor to my self.

Besides these, the Second Lecture of Mixture is also translated into French, by Mons. Mesmin a Learned Physician in Paris: whose Version is very well approved by those who are competent Judges hereof.

This,
This, and the rest which follow, are placed, not in the order of Time; but more according to their Nature or Relation one to another. All of them intended as a Commentary upon some particulars mentioned, either in the First Lecture, or in the Idea.

In the Plates, for the clearer conception of the Part described, I have represented it, generally, as entire, as its being magnified to some good degree, would bear. So, for instance, not the Barque, Wood, or Pith of a Root or Tree, by itself; but at least, some portion of all three together: Whereby, both their Texture, and also their Relation one to another, and the Fabric of the whole, may be observed at one View. Yet have I not every where magnify'd the Part to the same degree; but more or less, as was necessary to represent what is spoken of it. And very highly, only in some few Examples, as in Tab. 40. which may suffice to illustrate the rest. Some of the Plates, especially those which I did not draw to the Engravers hand, are a little hard and stiff: but they are all well enough done, to represent what they intend.
AN IDEA OF A Philosophical History OF PLANTS.

Read before the ROYAL SOCIETY.

January 8. and January 15. 1672.

By NEHEMIAH GREW M.D. Fellow of the Royal Society, and of the College of Physicians.


LONDON;
Printed by W. Rawlins, 1682.
Me.Bot.Garden,
AN IDEA OF PHILOSOPHICAL HISTORY OF PLANTS.

ROYAL SOCIETY.

January 8, and January 15, 1747.

BY J. NEWMAN DEW, M.D., Fellow of the Royal Society, and of the College of Physicians.

THE SECOND EDITION.

LONDON.

Printed by W. Kneeland. 1762.
TO THE
Most Illustrious
THE
ROYAL SOCIETY,
The following

IDEA
is most HUMBLY
PRESENTED.

AND,
In their NAMES also

PROPOSED
TO THE

CONSIDERATION
Of other

Learned Men.

By the AUTHOR

NEHEMIAH GREW.
TO THE
Most Illustrious
The ROYAL SOCIETY
The following
IDEA
Is more humbly
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And In their Names also
PROPOSED
To the
Consipiration
Or other
Learned Men.
By the AUTHOR
W. HENMSRUN GREN.
THE

CONTENTS.

UNT0 what Degree the knowledge of Plants is arrived, §. 1. Wherein defective, §. 2. Why concluded to be so, §. 3. Yet capable of Improvement, §. 4. And worthy of it, §. 5.

Dives Infances given, wherein; first of the Organical Parts, as to their external Accidents and Oeconomical Uses, §. 6. Then of their Contents, Qualities, and Powers, §. 7. And an Improvement of this Part, will further that of divers other parts of knowledge; whereof Instances are given, §. 8.


The Second, A like Survey of the Organical Parts by Anatomy, as that which is very necessary, §. 17. In what manner to be prosecuted, both without, and with the Microscope, §. 18. What thereupon to be observed, §. 19. And what, from observation made, probably attainable, §. 20.

The Contents.

Affiliation, 42.  Fusion, 43.  Calcination, 44.  By Composition with other Bodies, 45.  And by Compounding the Experiment itself, 46.  What hence attainable, 47.

The Fourth, A like Survey of the Principles, as well as of the Contents, of the Organical Parts, 48.  The Difficulty hereof, in some respects cleared, 49.  Further, by two Instances, 50, 51.  Some Remarks hereupon, of the Principles of Plants, 52.  From hence will be attainable a further knowledge of the Modes of Vegetation, 53.  Of the Qualities of Vegetables, 54.  And of their Powers, 55, 56.

The Fifth, A like Survey of those Bodies, either from which these Principles are derived, or wherewith they have any communion, 57.  Which are Fouir in general, viz. Earth, and all solid Receptacles, 58.  Water, and all liquid Receptacles, 59.  Air, 60.  And Sun, 61.

A Sixth General Inquiry, only hinted, 62.

The Conclusion, 63.
AN IDEA OF A Philosophical History OF PLANTS.

If we take an account of the Degrees whereunto the Knowledge of Vegetables is Advanced, it appeareth, That besides the great Varieties, which the Successful Arts of Florists, or Transplantations from one Climate to another, have produced; we have very many Species brought to light, especially Natives of the Indies, which the Ancients, for any thing that appears in their Writings now extant, were ignorant of. In which particular Cinthus, Columna, Bambinus, Boccone, and others, have performed much. Withall, That their Descriptions (of all Parts above ground) their Places and Seasons, are with good diligence and precifness set before us. Likewise their Order and Kindred; for the adjufting whereof our Learned Countryman Mr. Ray, and Dr. Morrison, have both taken very laudable pains. As also the ordering of them with respect to their Alimental and Mechanick Uses; for which, amongst others, Mr. Evelyn and Dr. Beal have deferred many thanks, and great praise. We are also informed, of the Natures and infallible Faculties of many of them. Whereunto so many as have affifted, have much obliged their Posterity.
2. §. By due Reflection upon what hath been Performed; it also
appears, what is left Imperfect, and what Undone. For the Virtues of
most Plants are with much uncertainty, and too promiscuously ascribed
to them. So that if you turn over an Herb, you shall find almost
every Herb, to be good for every Disease. And of the Virtues of
many, they are altogether silent. And although, for the finding out,
and just appropriation of them, they have left us some Rules, yet not
all. The Descriptions likewise of many, are yet to be perfected; es-
pially as to their Roots. Those who are very curious about the
other Parts, being yet here too remiss. And as for their Figures, it
were much to be wished, That they were all drawn by one Scale or,
at most, by Two; one, for Trees and Shrubs; and another for Herbs.
Many like-wis of their Ranks and Affinities, are yet undetermined.
And a great number of Names, both English and Latin, not well given.
So what we call Goat's-Rue, is not at all of kin to that Plant, whose
General Name it bears. The like may be said of Wild-Tansy, Stock-
Flowers, Horie-Radio, and many more. So also when we say
Bells Major, & Minor, as we commonly do, these Names would im-
itate, That the Plants to which they are given, differ (as the great
double Marigold, doth from the last) only in Bulk: whereas, in Truth,
they are two Species of Plants. So we commonly say, Centantium
Major & Minor, Chelidonium Major & Minor, and of others in like man-
ner, which yet are distinct Species, and of very different Trikes. But for
the Reason of Vegetation, and the Causes of those infinite Varieties
therein observable (I mean so far as Matter, and the various Affec-
tions hereof) are instrumen tal thereunto) almost all Men have seemed
to be unconcerned.

3. §. That Nothing hereof remaineth further to be known, is a
Thought not well Calculated. For if we consider how long and gra-
dual a Journey the Knowledge of Nature is; and how short a Time
we have to proceed therein; as on the one hand, we shall conclude it
our fate and profit, To see how far Others have gone before us: to
shall we beware on the other. That we conceive not unduly of
Nature, whilst we have a just value for Those, who were but her Di-
jiders, and interdicted by Her. Their Time and Abilities both, being
short to her; which, as She was first Designed by Divine Wisdoms;
formay Her vall Dimensions beft be adjudged of, in being compared
Therewith. It will therefore be our Prudence, not to insist upon
the Invidious Question, Which of Her Souls have taken the fairest
measure of Her; but to be well satisfied, as yet She hath not
been Circumscribed by Any.

4. §. Nor doth it more behove us to consider, how much of the
Nature of Vegetation may lie before us yet unknown; Than, to be-
lieve, a great part thereof to be knowable. Not concluding from the
acknowledged, much less supposed Ineffectualness, of any Men's
Understandings; but from what may be accounted Possible, as to the Nature
of things themselves; and from Divine Providence, by Infinite Ways
conducting to the knowledge of them. Neither can we determine
how great a part This may be: Because, It is impossible to Measure, what
we See not. And since we are most likely to under-measure, we shall
herby but intrench our Endeavours, which we are not wont to carry
beyond the Idea, which we have of our Work.

5. §. And
5. §. And how far forever this kind of Knowledge may be attainable, its being so far allo worthy our attainment will be granted. For beholding the Many and Elegant Varieties, wherewith a Field or Garden is adorned; those would not say, That it were exceeding pleasant to know what we see; and not more delightful, to one who has Eyer, to discern that all is very fine; than to another who hath Reason, to understand how. This surely were for a Man to take a True Inventory of his Goods, and his best way to put a price upon them. Yea it seems, that this were not only to be Partaker of Divine Bounty; but also, in some degree, To be Cofortner in the Secrets of Divine Art. That which were very desirous, unless we should think it imperative for us to design the Knowing of That, which God hath once thought fit to Do.

6. §. If for these, and other Reasons an inquiry into the Nature of Vegetation may be of good Import; it will be requisite to see, first of all, What may offer itself to be enquired of; or to understand, what our Scope is: That so doing, we may take our aim the better in making, and having made, in applying our Observations thereunto. Amongst other Inquiries therefore, such as these deferre to be proposed. First, by what means it is that a Plant, or any Part of it, comes to Grow, a Seed to put forth, a Root and Trunk; and this, all the other Parts, to the Seed, again, and all these being formed, by continual Nutrition still to be increased. How the Aliment by which a Plant is fed, is duly prepared in its several Parts; which way it is conveyed unto them; and in what manner it is assimilated to their respective Natures in them all. Whence this Growth and Augmentation, is not made of one, but many differing Degrees, unto both extremes of small and great; whether the comparison be made betwixt several Plants, or the several Parts of one. How not only their Sizes, but also their Shapes are so exceeding various; as of Roots, in being Thick or Slender, Short or Long, Entire or Parted, Stringed or Ramified, and the like: of Trunks, some being more Entire, others Branched, others Shrubb'd; of Leaves, which are Long or Round, Even-edg'd or Elcallop'd, and many other ways different, yet always Flat: and so for the other Parts. Then to inquire, What should be the reason of their various Motions: that the Root should descend; that its descent should sometimes be perpendicular, sometimes more level: That the Trunk doth ascend; and that the ascent thereof, as to the space of Time wherein it is made, is of different measures; and of divers other Motions, as they are observable in the Roots, Trunks, and other Parts of Plants. Whence again, these Motions have their Different, and Stated Terms; that Plants have their set and peculiar Seasons for their Spring or Birth, for their Full Growth, and for their Tuming; and the like. Further, what may be the Causes as of the Seasons of their Growth; so of the Periods of their Lives; some being Annual, others Biennial, others Perennial; some Perennial both as to their Roots and Trunks; and some as to their Roots only. Then, as they pass through these several Seasons of their Lives, in what manner their convenient feeding, housing, clothing or protecting otherwise, is contrived; wherein, in this kind and harmonious Economy, one Part, may be officious to another, for the preservation of the health and life of the whole. And lastly, what care is taken, not only for themselves, but for their Posterity; in what
An Idea of a

what manner the Seed is prepared, formed and fitted for Propagation:
and this being of so great concernment, how sometimes the other Parts
also, as Roots, in putting forth Trunks; Trunks in putting forth Roots;
yea in turning oftentimes into Roots themselves; whereas, in the se-
cond Book of the Anatomy of Plants, I shall give some instances. With
other Heads of Inquiry of this kind.

7. § Nor are the Nature, Faculties, and Contents of Vegetables
less various, or a particular Inspection hereinto, of less concernment.
For since All, or Most, seem to grow in the same manner, with one Sun,
one Rain, indifferent well upon one Soil, and, to outward appearance,
to have the same Common Parts; it may be asked, How it comes to pass,
that their Liques, or other Contained Parts, are of such different
Kinds; one being Watry, another Winy, a third Oily, a fourth Mil-
ky, and the like. How also there is such a variety in their Sensible
Qualities, as their Colours, Tastes, and Smells; what those Materials
are, which are necessary to the Being of these Qualities; and those
Formalities, wherein their Essence both consists; as what it is that makes
a Plant, or Flower, to be white or red; fragrant or fetid; bitter or sweet;
or to be of any other Colour, Smell, or Taste. In like manner, their Fa-
culties and Powers, what that is, or those things are, by which they
are constituted; as whence one becomes Purgative, another Venomous,
a third Diaphoretick; &c. These, I say, with many other particular
Inquiries depending hereupon; as they cannot but much oblige the
Reason of Man to be obsequious to them, so by bringing in at least,
some satisfaction, will no less reward it. Especially, if it be withal
considered, that besides our satisfaction as to the Nature of Vegetables,
some further Light, to divers other parts of Knowledge, may likewise
hence arise.

8. § For since the present Design will engage us, to an accurate
and multifarious Observation of Plants; we may hereby be enabled
to range and sort them with more certainty, according to the Degrees
of their Affinity. And all Exoticks, Plants or Parts of Plants, may
probably be reduced to some such Domesticks, unto which they may
bear the best Resemblance. Again, it may frequently conduct our
minds to the consideration of the State of Animals; as whether there
are not divers material Agreements betwixt them both; and what
they are. Wherein also they may considerably differ, and what those
things are which are more essential to their distinction. And be-
sides, not only to compare what is already known of both; but also,
by what may be observed in the one, to suggest and facilitate the finding
out of what may yet be unobserved in the other. So also the confide-
ration of the Colours, Smells and Tastes of Vegetables, may conduci to
the Knowledge of the fame Qualities in General; or of what it is, that
constitutes them such, in any other Body: not as they are actually re-
ceived by Sense; but so far, as such Materials or external Circumstan-
ces, are requisite to their becoming the Adequate Objects thereof. It
may lead us also to inquire into further Ways of Cultivation, with re-
spect to the whole Plant, or to the Flower, Fruit, or other Part:
To amend them as to their Sizes, Colours, Tastes, Fruitfulness, or other-
wise: To think of other Ways of Propagation; or to apply those al-
ready known to other Plants than hath been used. Likewise the Know-
ledge of their Mechanical Uses may hereby be enlarged; both as to the

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11. 6. First then the various Figures of their several Parts should be observed; and that with respect both to the Forms, and the Positions, by which their Roots, Trunks, Branches, Leaves, Flowers, Fruits, and Seeds may vary, or agree; and those several Liners, by which both the said Varieties are determin'd. In which of these Parts, the agreement chiefly lies; this being both more observable, and more material in some of them; less in the Root, more in the Flower, or Seed. And in how many of these Parts together; whether one, more, or all. By both which, the Orders and Degrees of Affinity, which are many, may be accounted; either as to what we strictly call Kindred, or else Analogy. For there are found, not only Herbs accounted of several Tribes, which are ally'd; and some of the Smallest, which are of kin to the Greatest: But there are also, probably, some Herbs, which have a particular Relation, to many Kinds of Shrubs; and some Shrubs, to many Kinds of Trees. Thus the several sorts of Latice, are of Kin, together in the First Degrees, with Endive, in the Second. The several Clarys, amongst themselves in the First, with Horchound, in the Second, with Lamium, in the Third. All Strawberries agree together, in the First Degree; with Cynoglossum, in the Second; with Tormentil in the Third; and with Avena, &c. in other Degrees more remote. So Agrimony, hath alike Analogy unto strawberies, as Goats-Rue, hath to Cleaver: And strawberry, the like unto the Raisp; as Gooseberry to the Vine; or Barret, to the Rose. Amongst the several Sorts of Grapes, there are some which match all those of Corn; which is but a greater kind of Grapes. So again all Pulses, are not only of kin, in their several Degrees, to one another; but likewise, to almost all kinds of Trefoys, as Melilot, Eremegreek, and the common Cleavers themselves; as by comparing not only their Leaves, but Flowers, Seeds, and Cods, together, may be evident. For the several parts of the Flower of a Trefoyl, are to many more Flowers, containing so many Cods of small seeds, all, in shape, agreeable to the Flowers, Cods, and Seeds of Pulce. The same Relation, which Trefoys have to the Peas or other Pulse; Colts-foot, hath to Buttrm-Bur; Chickweed to Leucanthemum; Ground-fell, to Jacobia; or Scordadion, to Foxglove; Or, to go higher, as the Leguminous Kinds of Herbs, have to Sena, or some other of the Lodged Shrubs and Trees. And, as among Animals, there are some which connect several Kinds; as the Bats both Beasts and Birds; So, among Plants, there are some allies, which seem to stand between two Tribes; as Lappa, between Knapsweeeds and Thistles; Lampanes, between the Intyaceous Kind, and the Monke-cars.

12. 6. From hence likewise, the Natures of Plants may be conjectured. For in looking upon divers Plants, though of different Names and Kinds; yet if some affinity may be found betwixt them, then the Nature of any one of them being well known, we have hence ground of conjecture, as to the Nature of all the rest. So that at every Plant may have somewhat of Nature individual, to it itself; so, as far as it obtainseth any Visible Communities with other Plants, so far, may it partake of Common Nature with those allies. Thus the Wild, and Garden Cucumber, have this difference; that the one pergeith strongly, the other, not at all; yet in being Divertick, they both agree. The Natures of Umbelliferous Plants, we know, are various; yet 'tis most probable, that they all agree in this one, "sit in being Carminative."
The several sorts, both of Corn and Grass, are all akin; there is no doubt therefore, but that the Seeds of Grass themselves (of Rye and Oats it is tried) if it were worth the while to order them, as Barley, would yield an inflammable Spirit. So likewise the several Kinds of Puls, have some one community in their Form, as is said: for which reason, I question not, but that in some Cales, wherein Ceres are esteemed a good Medicine; a Decoration of the better sort of Puls, especially that we call the Sugar-Puls, may go beyond them. As doth also the Flower or Meal of Beans, that of the Seeds of Fenugreek; even there, where they are accounted excellent. So Tulips, Lillies, Clovers, Jacob's, and Onions themselves, with many others, in their several Degrees, are all allied. If therefore Clovers, Onions, Lillies, agree in one or more Faculties, then why may not all the rest? as in being Anodynes; or in some other Common Nature; whereby, in their Vegetation, their Parts are Governed and Over-ruled, to one Common or Analogous Form.

13. 5. The Proportions likewise, amongst the several Parts of Vegetables, for the same Reasons, deserve to be observed; the comparison being made, both betwixt the Parts of several Plants, and the several Parts of one. And here again, either betwixt any Two of the Parts, or any One of them, and the Whole besides, or all the rest put together. So some larger Seeds, produce a small Root; as those of Cucumers; and others smaller, produce one very great; as those of Bryony. Some Plants, as the Melon, though themselves but very slender, yet have a vast and bulky Fruit; others again, as Thistles, and many yet more substantial, have no other Fruit besides their Seed. So the Seeds of all Puls, and especially, the Garden Bean, though large, yet produce but a small Plant; but those of Foxglove, Mullen, Burdock, Sun-flower, &c. being themselves much less, do yet produce a far greater. And especially, those Seeds, which are inclosed in the Thicker sort of Cover, (analogous to that I have elsewhere called the Secondine) as that of Penny; whose Seed, so called, is only the Neft wherein the true and real Seed is lodged, no bigger than a little Pins head; which is also observably of the Seeds of divers other Plants. These, and the like Proportions, as they lie betwixt the several Parts, should be noted: and to what Plants or Parts especially, any of them may agree: comparing also in what other kind of Properties an agreement betwixt the said Parts may be found: that so doing, we may, if possible, amongst all their Individual Natures, be instructed to single out those Common Ones, which are concomitant to such Agreeing Properties.

14. 6. The several Seasons also of Plants, and of their Parts, should be considered. Observing at what particular Times of the Year, any of them chiefly Spring, Early or Late, The Times wherein they Germinate; whether for some Space only, or all the Year long. Wherein they Spring, after Sowing; or Flower, after Springing, sooner, or later. Which Flower, the first Year, or not till the second. Which after the Leaves are put forth, or before them; for so, some do, as the Clovers, Vervain, Bears-foot, Hepatica ancrea, and others; all the Leaves, at the time of their flowering, being old, or of the foregoing Year's growth. So likewise the Maturation of the Fruit or Seed; how long after the Flower, and the like. All or some of which Varieties, being
Laid together, we may probably conjecture the Causes thereof, and the Nature of the Plants in which they are seen: for the Degree of Heat may be necessary for the Fermentation, or for the better Distribution of the Sap of such a Plant; or for the Impregnation of the Air, to be mixed therewith; or the due Disposing of the Soil, to render the most convenient Aliment thereunto. So the Principles of such Plants, which flower all the Year, may be more equally proportion'd. Those which flower before the Leaves put forth, as the Coreopsis Veruea, and those which flower in Spring, may be accounted Rank, and full of Volatile Salt. But Autumn Plants especially, to abound with a Fixed: and the like.

15. The proper Places also of Plants, or such wherein they have, from their Seeds, or other way of Propagation, a Spontaneous growth, should be considered. And that as to the Climate; whether in one Colder, Temperate, or more Hot. The Region; Continent, or Island, The Soil; as Sea, or Land, Watry, Boggy, or Dry. Hills, Plains, or Valleys; Open, in Woods, or under Hedges; Against Walls, rooted in them, or on their Tops; and the like. And perhaps the Seeds of some Plants, as of Moths, (which, through their smallness, will ascend like Moths in the Sun) may fly or swim for some time; in the Air, viz. till they begin to shoot, and so become heavy enough, to fall down upon the Ground. From whence, in like manner, as from their Seeds, their particular Natures may be directed unto. In that, to far as we may conjecture the nature of such an Air, Soil, or Seat, we may also of such a Plant, to which they are congenial.

16. So likewise, those many Varieties observable in the Motions of Plants, and of their Parts, both Kinds and Degrees; Ascending, Descending, and Horizontal; Rectilinear, and Spiral Motions, should be noted; to what Plants they agree, and wherein any of these Motions may be analogous to those of Animals. And in a word, any other Familiar Properties of Plants. And then, to Compare them all together; both being necessary. For Thoughts cannot work upon nothing, no more than Hands. He that will build an House, must provide Materials. And on the contrary, the Materials will never become an House, unless, by certain Rules, we join them all together. So, it is not, simply, the Knowledge of many things, but a multifarious Copulation of them in the Mind, that becomes proficient of further Knowledge. And thus much for the first General Mean.

17. The next which I propose, and that a most necessary one, is Anatomy. For when upon the Dissection of Vegetables, we see so great a difference in them, that not only their Outward Figures, but also their Inward Structure, is so Elegant; and in all, so Various; it must needs lead us thus to Think, That these Inward Varieties, were either to no End; or if they were, we must assign to what. To imagine the first, were exceeding vain; as if Nature, the Handmaid of Divine Wisdom, should with Her fine Needle and Thread, hitch up so many several Pieces, so difficult, and yet so groundles a Work. But if for some End, then either only to be looked upon, or some other besides. If for this only, then this must be such as in respect whereof, Her Work is at no time, nor in any degree fruitful; the contrary whereunto, is most manifest. For although Men do every where, with frequent pleasure, behold the Outward Elegancies of Plants,
Plants; yet the Inward Ones, which, generally, are as Precise and Various as the Outward; we see, how usual it is, for the beholding of Those, to be omitted by them. And besides, when we have observed Nature's Work, as well as we can; it may be no impediment to our best Endeavours, to believe, that some Parts of it, will still remain behind, Unseen. So that if to be Seen, were the only End of it, it must needs be wholly frustrate, as to the greater number of Men; and, in some part, as to all. Wherefore, we must suppose some other Ends of the said Varieties, which should have their Effect, and so Those, not be in vain, whether Men behold them or not; which are, therefore, such as have respect to Vegetation: That the Corn might grow, so; and the Flower, so; whether or no Men had a mind, leisure, or ability, to understand how.

18. If then the Anatomy of Vegetables be so useful a Mean, we ought not to strengthen it; but to force this, as well as the rest, to its utmost Extent. And therefore, first of all, To go through all the Parts, with equal care; examining the Root, Trunk, Branch, Leaf, Flower, Fruit, and Seed. Then to Repeat or Retrograde the Direction, from Part to Part: in that, although the best Method of Delivery, for clear Discourse, can be but one, according to that of Nature, from the Seed forward, to the Seed: yet can it not but be useful, for That of Direction, to proceed to and fro; somewhat or other being more visible in each several Part, from whence still an Hint may be taken, for the ushering in the observation of it in the others. To examine, again, not only all the Parts, but Kinds of Vegetables, and comparatively, to observe divers of the same size, shape, motion, age, sap, quality, power, or any other way the same, which may also agree, in some one or more particulars, as to their Interior structure, and to make this comparison, throughout all their Parts and Properties. To observe them likewise, in several Seasons of the Year, and in several Ages of the Plants, and of their Parts; in both which, divers of them may be noted to change, not only their Dimensions, but their Nature; also; as Fruits, do into Ligaments; and Cartilages, into Bones, sometimes, in Animals. And to do all this by several Ways of section, Oblique, Perpendicular, and Transverse; all three being requisite, if not to Observe, yet the better to Comprehend, some Things. And it will be convenient sometimes to Break, Tear, or otherwise Divide, without a Section. Together with the Knife it will be necessary to join the Microscope; and to examine all the Parts, and every Way, in the use of That. As also, that both Immediate, and Microscopical Infections, be Compared: since it is certain, That some things, may be demonstrated by Reason and the Eye conjunct, without a Glass, which cannot be discovered by it; or else the discovery is so dark, as which, alone, may not be safely depended on.

19. By these several Ways of inspection, it will be requisite, To observe their Compound parts; as Simply considered, and as variously proportioned, and Disposed. As Simply considered, to note their Number; what, and whether the same, in all; their Kinds, wherein different in the same, or divers Vegetables: their Original, in part, or in whole: structure, as to their Contexture and their Curiosities; Their Contexture, within themselves severally, and as joyned together: their Curiosities, as to their size, Shape, and Number; in which a great variety
variety will be found. Next their positions one amongst another, which are also various; as Anterior, Posterior, Collateral, Surrounding, Medi-}

date, Immediate, Near, Remote; both as they respect the several Parts, and the several portions of one: And all these, as few, or more; those or others of them, may be diversely compounded together. And then the Proportions they bear one to another; whether as to Minor-}

tity, Equality, or Excess; each Part compared with each, and that as to the several Degrees appearing in the said Proportions; the Varieties whereof may be exceeding numerous. For if we should suppose but Four considerable Parts generally constitutive of a Vegetable: These four, produce a Variety four ways. First, when One is Une-}

equal; and then it produceth only Four Varieties; and those two ways, 

self, when one is Greater, and the other three, Equal and Less; or when one is Less; and the other three, Equal and Greater. Secondly, when Two be Unequal; and then they produce Six Varieties. Thirdly, when Three be Unequal, which produceth Twelve Varieties. Or lastly, when all Four be Unequal; which produceth Twenty four; which general Varieties, may be further multiplied by their several 

Degrees.

20. §. From all which, we may come to know, what the Com-}

munities of Vegetables are, as belonging to all; what their Distinc-

tions, to such a Kind; their Properties, to such a Species; and their Pe-

culiarities, to such Particular ones. And as in Metaphysical, or other Contemplative Matters, when we have a distinct knowledge of the Communities and Differences of Things, we may then be able to give their true Definitions: so may we possibly, here attain, to do like-

wise: not only to know, That every Plant Inwardly differs from an-}

other, but also wherein; so as not more freely to Define by the Out-

ward Figure, than by the Inward Structure. What that is, or those things are, whereby any Plant, or Sort of Plants, may be distinguish-

ed from all others. And having obtained a knowledge of the Com-

munities and Differences amongst the Parts of Vegetables; it may con-

duct us through a Series of more facile and probable Conclusions, of the ways of their Causality, as to the Communities and Differences of Ve-

getation. And thus much for the Second General Mean.

The Third General Mean.

HAVING THUS far examined the Organical and Containing Parts of Vegetables; it will be requisite, more distinctly, to observe those also which are Fluid, or any others Contained in them: and that, for our better understanding both of the Nature of Vegetable, and of the said Contained Parts. And to make inquiry, First of their Kinds; as Spirits; both such as agree, in general, in being 

Vivous, and those that are Special, to particular Plants. Aers and 

Vapours; for the existence whereof, in all Vegetables, there are Ar-

guments certainly concluding. And for the difference of their Na-

tures, in being more dry, or moist, more fimple or compounded, as they are existent in several Parts, there are probable ones. Lymp-

hua's, or clear and watry Saps, which mott Plants, in one Part or other, at some time of the Year, do Bleed Much; as in Mallow and Vi-
llet Leaves; in many Seeds, as of Quinces, Clary; Fruits, as in Cucum-

ners; distinct from the watry Sap, as by permitting it to stand and gelly upon the Vessels from whence it flows, is plain: And in the young Berrys of White Bryony, when about the bignefs of a Pepper-

Corn;
Corn; the juice whereof is so viscous, that the twentieth part of a
Grain, will draw out above a Yard in length. Oyles; not only in
Seeds, and some Fruits, but other Parts; as in certain little cavities in
the Leaves of Sarine, visibly collected while they are growing. Gums
or Resins, as in Pine, Fir, and others of this Kind. Milks, as
in a vast number of Plants, and amongst them, many not suspected
to yield any. For, of Herbs, not only most of the Umbelliferous Kind,
are Milky, but all or most of the Intybus, Poppys, Tracheliums,
Periwinkles, divers Thistles; and even Onions, if cut at the bottom; with a great many more. Of Trees, not only the Little
Maple, but the young Shoots of Laurel, especially being bruised; as also those of
Elder, and some others. To which may be added, such Maculages,
which though not so properly contained within the Parts, yet are
found lying over them; as over the first Spring-leaves of all kinds of
Ducks; between the Leaves and the Veil wherein they are involved.
That fine white Flower or Powder, which lies over the Leaves of some
Plants, as of Bears-Bear: And in Prunes-Prunus, about certain Apertures
only on the edges of the Leaves.

22. Of all these should be observed, first their Receptacles; some of them, being proper to one or others, common to two or more
of them: since it is certain, that some of them do Transmigrate from
one, into another Receptacle, or that the same Receptacle is filled with
Fluid Bodies, of a quite different Nature, at the different Seasons of
the Year, and Ages of the Vegetable. And it is also very probable, that
two of some of them, may, sometimes, be contained in one Receptacle,
at the same time; as in Animals, the Lymphs in the D. Thoracicus, and
that, and the Chyle, in the Sanguineous Vessels.

23. Then their Motions; both Natural, and such as may be
exercised by Art: and those either by Defensive or Ascent; and in
ascending, through what different Channels or Parts of the Trunk; since
it is certain, that there is a variety, both in respect of the Seasons, and
of Vegetables. Where it will fall in, to observe the Tapping of Trees.
As also their Bleeding: to what Trees it is proper to bleed: in those to
which it is, with what difference of Celerity: and when their peculiar
Season: for none will bleed at all times; neither will all bleed at the
same. And then their Collateral Motion, together with the Mode of
their Transition from one Organical Part to another.

24. Next their Quantities, either of one; as the Comparison
is made betwixt several Plants, or betwixt the Parts of the same. So
the true Seed of all Plants, containeth more Oyl, in proportion, than
any of the other Parts. Or else of divers, as coexistent and bearing such
a proportion one to another in the same Part; of most of which, it
may be known by their respective Receptacles. Yet the Computation
must not be made from the number of the said Receptacles, simply;
but as that is in conjunction with their Capacity; and as their Capacity
is proportioned to their surrounding Sides; the Sides of those of the
leaves, Capacity, being usually as thick, as those of the greatest; so that
suppose Ten letter, to lie within the compass of One greater; the Content
of thele altogether, would scarce be equal to half the Content of
that One.
25. 6. Also their Consequence, i.e. of so many of them as are discriminable by Touch; in being Soft or Hard; Thin or Thick; Mucilaginous, Gummoous, Glutinous, Friable, &c. And these in their several Degrees, in which there is a Variety, as in the Milks of some Plants, which are more Dilute, than that of others: Mucilages, which in some, are very thick and Viscous, in others, more diluted and coming nearer to a Watery Sap. And by This, to be compared in the same manner, as by Quantity.

26. 5. Likewise their Colours, Smells, and Tastes: The general and particular Kinds of all which should be noted. And to what Contained Parts, and in what Variety, they appertain. So most Resinous Gums are Tinctur'd, some, not; as that which drops from the Downy Fleece, is as clear as Rock-water. The Milks of some Plants are Pale, as in Burdock; of others Whiter, as in Dandelion, Scorzonera; Citrine, as in the Root of Trachelium, Angelica; Yellow, as in Lovage. In some Plants, Olorous, as in Umbelliferous; in others not, as in Chloro-ceous. That of Little Maple, Tasteful; of Garden Chervil, Sweet; of Fenil, Hot; of Scorzonera, Astringent; of Dandelion, Bitter; and generally, in other Plants; but with many Degrees of Strength, and in conjunction with other Tastes. But most Mucilages, have little either Colour, Taste, or Smell; and the like. Here also the same Qualities are to be inquired into, as, in general speaking, they are said to belong to a Vegetable. Since it is more than probable, that all Colours (excepting White, which is sometimes common both to Containing and Contained Parts) all Odours, and Tastes, which are more immediately, and without a resolution of their Essential Principles, perceptible in a Plant; are not ascribable either to the Organical, or Containing Parts; but only to those, Contained in them; as from divers reasons hereafter may appear.

27. 6. And first, their Colours; where, with respect to several Plants and Parts, they are more Changeable, as Red, in Flowers; or Constant, as Green, in Leaves. Which, with respect to several Ages of one Part, are more fading, as Green in Fruits; or durable, as Yellow in Flowers. In what Parts more Single, as always in the Seed; or more Compound, as in the Flower; and in what Plants more especially, as in Pancy. Which proper to Plants that have such a Taste or Smell, as both, in White Flowers, are usually less strong. To plants that flower in such a Season, as a Yellow Flower, I think, chiefly, to Spring Plants. And to Plants that are natural to such a Soil or Seat, as to Water-plants, more usually, a white Flower. What, amongst all Colours, more Common to Plants, as Green; or more Rare, as Black. And what all these Varieties of Colours are upon Cultivation, but chiefly, in their natural Soil. To observe also with their superficial Colours, those within: so the Roots of Docks, are Yellow; of Bistort, Red; of Arums, Purple; but of most, White. Where the Inward, and Superficial Colours agree; as in the Leaves; or vary, as in the other Parts frequently. And in what manner they are Situated; some universally spreading, others running only along with the Veins, as in the Leaves of Red Dock, and the Flowers of Wood-sorrel.

28. 6. Next their Odours; what may be their principal Seat; whether one or divers Seats in the same Plant. What the chief Matter out of which they are continually bred. What Similitude betwixt the
the Smells of divers Vegetables; as betwixt Banne, and a Limon; the Green Leaves of Meadow-sweet, and the green Rinds of Walnuts. Or betwixt thole of Plants and Animals; as the smell of green and well-grown Carduus, is like to that rank scent, ab oliporum axilis spiritus. Which have a more sensiblę smell; as most have; and which have left, as Corn. Where the green Leaf is the most Fragrant Part, as in Muck-Cranesbill; where the Flower, as in Roses; the Root, as in Sweet Columne. Where all the Parts have some Odour, where fome, or one, only; as in Sour-re-grafs, only the Flowers, unless the Leaves are bruised; and in Arum, the Peftil only; for neither the Leaf, nor Root hath any smell, unless cut; but this is strong enough, not much unlike to Humane Excrements.

29. 6. But especially their Tafles, which it much importeth us more precisely to diftinguith; First, by their general Kinds: for the number, even of these, may be computed greater than usually it is. I remember not, that Heat and Acritude, with respect to Taste, are diftinguithed; yet Arum-Root is very Pungent, without any proper Heat; and Cloves, are very Hot, without any proper Pungency. So the White Roots of Tarrow, have a Taste, hardly any other way perceptible, than by causing a gentle glowing and continued Warmth upon the Tongue. Also their Respondencies one to another, as that of Ze-dawry, and of the leffer Cardamoms, is somewhat like to Camphirè. Likewise their Degrees in which there is a great latitude, and may be extended from One to Ten, or with easie distinction, from One to Five: So the Root of Sorrel, is Bitter in the fift, of Dock, in the fecd; of Dog-Rose, in the third; of Dandelion, in the fourth; of Gentian, in the fift: observing them, not only as they vary in feveral Kinds of Plants, but the feveral Species of one, as in Cichory, Hawkweed, Dandelion. And then their Compositions; for Tafles are as truly conjunct in one Part, as Colours: by which, the latitude is fill greater; In that all Kinds of Tafles, in all their Degrees, and in differing Numbers, may be variously Compounded togethe: For the moft part, Three, as in the Leaves of sharp-pointed Dock, Astringent, and Sour; in Sorrel-Roots, Astringent and Bitter; and in Alces, Bitter and Sweet; the one in the fift, the other, in the fift Degrees; as upon an unprejudiced tryal may be perceived: and yet more evidently in the Gall of any Land-Animal. Sometimes three, as in Agrimony, Bitter, Rough, and Sour; and in the others, Bitter, Rough, and Sweet. And sometimes, perhaps more. The Sensible diftinction of all which, may lye almost as wide, as of Plants themselves. Wherefore, although it may be thought raifless, to take away the diftinction of Hot, Cold, Moifit, Dry, Thin, Grop, and other Qualities, in their feveral Degrees, which the Ancients have affixed to particular Plants: yet since they have done it, to many of them, with much uncertainty; and that, withal, they are, more properly, the Effects and Operations of Plants, than their Qualities; Practical Observation, may therefore approve it useful, to add these Sensible Ones of various Tafles, precisely diftinguishing their Conjunctions and Degrees. Lastly, their feveral Varieties and Mutations, with respect to the Subject wherein they refe, should alfo be noted. As, of all Tafles found in Plants, Bitter and Sour, are moft common; Sweet and Salt, moft rare. Which latter, is not only perceptible in fome Sea-Plants, but upon fome others, as upon the freth
Leaves of Tamarisk, which being licked while they grow, or when immediately gathered, are plainly Savoury. How they vary with the Age of the Plant, or Part; as the Roots of Radishes, growing up to Seed, lose the strength of their Tastes; so molt Fruits are first Savoury, then Sweet. What proper to the several Parts of any one Plant; so the Leaves of Wormwood are extraordinary Bitter; the Root fearfully so at all, of an Hot, but quite different Taste. What more Common, or Rare, to any Part; so no Root that I ever tasted, is Savoury. And how they Alternate in several Plants; as the Root of Stock-July-flower is Bitter, and not the Leaves; on the contrary, the Leaves of the Water-Arfmart, are Bitter; but not the Root; and the like. To which we may add the difference of Time wherein the Tastes of Plants are perceived; as thofe of Arum, and Rape-Croffont, are both Bitter; but that of the frift, as it is slowly perceived, so it continues long; that of the other, quickly comes, and quickly goes.

30. 6. Amongst the other Adjuncts of the Contained Parts, though not of these only, the Faculties of Vegetables are to be reputed. For fo the Root of Jalap, which is Purging, is as truly contained in the Organic Parts of that Root, as Blood is in Veins: It will be requisite therefore to make particular obfervation of these also. And frift, what Faculties chiefly may reside in Plants, above others: so there is none of known Life in Salvation, except by holding in the mouth: Although we may ask, Why fome amongft them, may not (being Taken inwardly) have a power to evacuate by This, as well as other Violent ways? Where the Faculty is more universally spread over all the Parts of a Vegetable, as in Arum. Where belonging chiefly or wholly to any particular Parts or Parts; as chiefly to the Root of Rhubarb, and only to the true and proper Seed of Barbado Nuts. Whether fome Faculties, may be proper to fome Parts especially. What conjunction they may have with any fenfible Qualities. So, many Purgers, are not only Refonisous and Gummos; But alfo Musclaginous; as Bryony, wild Cucumber, Lapathum Sativum; and therefore probably Rhubarb, when growing; Mallows, Violets, &c. Such as are Purging and Vomitory, though fome of them have a ftrong Taste, yet the greater part, and of thofe, many of the ftronger part, have no Taste, or not Great; as Snow, Jalap, Scammony, Hellebore, Arum, and others, Amongst which, although Hellebore hath a very Durable Taste, yet is it not very High or Great. So alfo, thofe that are most fcnfibly tainted, are, I think, for the folt part, more or lefs Bitter; either simply, as Colocynth; or Bitter and Astringent, as Rhubarb; or Bitter and Sweet, as Aloe; or Bitter, Astringent, and Sweet, as Arrick. Few are Hot, as Iris, or Simply Sweet. And though fome may be Subacid, that are Mollifying or Lenitive, yet no proper Purger or Vomit is Savoury. Such Plants as are of a soft and fweetish Taste, without Viciflity, may be accounted good Antifepticks, especially against the Sea, or other Salis-Scarses; as are good fweet Peas: And sometimes the Water or Spirit of the Skulls, which may easily be drawn from them, being frift duly fermented, and hath a true Vinous Taste; but very mild, and not unpleafant. Thofe Plants, whose Parts are not only Hot but Volatile, as Onion, are generally good for Burns. Such as have a Balsamick Taste or Smell, with a little Astringency, as Hypericum, Golden-Rod, Lamium Lateum, &c. the belt Wound-Herbs. And fuch as are gently Bitter,
Bitter, and Penetrant upon the Tongue, or in the Throat, as Daia, Anagtis,good Cleaners. That such Bodies, principally, are Analgesic, which are Yellow, I think, is more than a conjecture; Yell of Eggs, Fenugreek Seeds, Lint-lead Oyl, May-Butyr, Marrow, Pungated Hamana, Hyso-
cyanus latens, Saffron, Sulphur, Opium, all Analgesic and Yellow. How likewise their Faculties and Qualities may vary their Degrees, either differently or together: so Aloe and Colocynth, are both Bitter in the highest Degree; yet Aloe, which is also Sweet, Purgeth more moder-
rately; Colocynth, which is Bitter, but not Sweet, most Violently. How far the Faculties of Vegetables, as well as their Qualities, may be Com-
poinded, where, and which chiefly; as Afflicting and Purgative in Rhusarb. Where this Question may be put, Whether divers other, and yet more extreme Faculties, as well as these of Afflicting and Pur-
gative, may not somewhere or other be also found, or made, to meet: whereby the same Plant, or some Preparation of it, may be most Pot-
tent, and yet most Innocent; the Malignity thereof excelling its Pow-
er, and the Virtue its Sovereignty at the same time. And lastly, what Affinity there may be betwixt them; as most Plants, that are strong Purgatives, and especially Vomitories, I think, are also Sternotatory, as white Hellebore, Tyalp, Tobacco: and on the contrary, such as are Sternotatory, are some of the most proper and most potent Medicines for the Head, Brain, and Genus Nervoam. Taken inwardly, as Liliam
convul. &c. and the like.

31. §. Thus far a particular observation of the Qualities and Fac-
uties of the Contents of Vegetables may proceed, as they are existent in their Natural Estate. From which, although some probable Conjectures may be made, of their Material and Formal Essences, and of the Causes of their determinate Varieties; or the Modes of Vegetation necessary thereunto: yet will our Conceptions hereof be more facile, clear,
and comprehensive, if by all other Ways of Observation, they be like-
wise examined, according as Experiment may be applicable to any of
them.

32. §. As by Continuance: to some Plants give their smell, not without Rubbing, or not so well; as the green Leaves of Stramonium, Scor-
vogras, and many more: others lose it by Rubbing, as the flowers of
Violets, Carnations, Borage, &c. others yield it both ways, as Refo-
mary, &c. So some Apples mend their Taste, by Scoaping, and Pe-
ars by Rowling, espically that called the Rowling Pear.

33. §. By Agitation: which doth that, sometimes, by Force, which Digestion, doth by Heat: so any cold Oyl and a Syrup being, in a due manner, agitated together, of two Fluid bodies will become one Con-
fident, as is known.

34. §. By Frigitation: how far the Juices of Plants, either without or within them, may be any of them, or some more than others, sub-
ject to Cold: and thereby to be deprived of their Motion or natural Con-
sistence: or may suffer alteration in their Colour, Tast, or Smell.

35. §. By Infusion: where I mean Infusion only in Common Water;
So both Cassia Lignea, and Cinnamon are a little Mucilaginous; but the former more. Some of the Contents of Plants, may be wholly
dissolved in Common Water; some but in part others not at all; or very little; which is proper to some Milks, as well as Gums. The Col-
ours, Smells or Tastes they hereupon yield, are found various; and in
some
some very unexpected: So the green Leaves of Balm, being duly infuded in common Water, without any other Body added, tincture it with a clear and deep Red, near that of Claret Wine, as I have often tried.

36. § By Subsinating 5 So the Juice of Sorrel, being ordered as that of Grapes, will, in time, let fall a kind of Tartar or Essential Salt. And so perhaps will that of many other Plants, without any previous Decolation, although that be commonly thought to be necessary.

37. § By Digestion with Fermentation; either of the entire Vegetables, or of the Juices, or other Contents; and these by themselves, or with common Water. And hereby to note, what difference may be in the Strength, Celerity, or Continuance of the Fermentation. Likewise, how their Qualities may thereby be altered; as the Smell of Violet-flowers, from a most excellent Fragrancy, may, by Digestion, be reduced to an odious and abominable stink, like that of the black Mud of Gutter.

38. § By Digestion with Calcination; to the Colour of the Juice of Limes, from Transparency (if that be Colour) may be turned to a perfect Red. Whereas it is that many are deceived in the Preparation called the Tincture of Corals, supposing the Corals to give the Mensura its Colour. Whereas the Mensura will obtain it, only by Digestion, without any Corals, mixed with it.

39. § By Decotion 5 either of Vegetables themselves, or of their Liquors; and to observe what alterations follow. So Turpentine boiled becometh friable; Sugar, Bitter, and of a Brown Red. Tunips lose their Biting Tafle; Onions, their Piaceancy; yet neither of them convey those excellent Qualities to the Water. The same may be observed in the Decotion of Sweet-Fennel-seeds, Aniseeds, and others, losing much of their Tastes themselves, and yet conveying very little of them to the Liquor wherein they are boiled; the greater portion of their Volatile parts, and to their Virtue and Tafle therewith, flying away. Whereof therefore it is much better to make an Emulion, than to decoct them; or to make an Emulion from them, with their own Decotion, especially if the Medicine be intended to be Carminative, as I have frequently observed. The Decotion should also be carried on throughout all degrees to that of an Extract; by which the Qualities thereof, sometimes, are much altered; as the Colour of all or most green Leaves, from a kind of Yellow, deepens at last into a dark one, as Black as Pitch.

40. § By Distillations; both with the cold Still, Alembick, Choppel, and open Furnace: and to note what Vegetables thus give their Smell or Tafle, in what Degrees of Strength, either under, or over their natural ones; as Mint, Pennyroyal, and the like, which are Aromatick and Hot, give their Tastes perfect; but Wormwood, which is Aromatick and Bitter 5 gives it but by halves, pretty fully as Aromatick and little as Bitter. And Carduus, though also to exceeding bitter, yet not being Aromatick, yieldeth a much weaker Tafle. Also what Vegetables yield Oyl most plentifully; and what difference may be in those Oyls, as to their Colour, Weight, or otherwise; as that of Cokes is sometimes Red; of Cinnamon, limpid; both Ponderous. So to distill Juices, Gums, or other Contents, with an hot fire; and to see, what Bodies they yield, and of what Qualities as Turpentine is known to yield, besides its
its Oyl, a fibucid Water; Vinegar, an Eager Spirit; as that part may be called, which Chemists are wont to call the Phlegm.

41. §. By Arefection; so Milky which are Liquid, and White in their Natural Estate, in Standing, grow Gummos, Yellow, and other-wise different, so doth that of Scorzovera; and that of Fenil becomes a Balsamical, but Limpid Oyl. The Roots of Angelica, being dry'd, and cut by the length, exhibit their small Ven's fill'd with an Aromatick Rofin. In the whiter parts of Rhubarb, is gathered a kind of Saline Concret; by which, this Root, in chewing, seems as if it were a little gritty. Cabbage-stalks, fliced, and laid in the Shade to dry, gather on them a kind of Nitrous Horr. Raifins and Corins contain, not only a sweet Juice, but also a true Sugar, which lies curdled in the Pulp, as the more Saline parts do in Green Soap. And the like is gather'd on the out-side of a Fig; saving, that it is more Nitrous, as lying next the Aer. The Roots of Arum, upon drying, lose much of the Strength of their Taffe; but the contrary may be noted of many other Roots, which, upon drying, increase it. Some, being cut and laid by, change their Natural Colours, into Red, Purple, Yellow, Green, or White; as Liquorifb, into White, in some places; and Peony, into Red: and sometimes into two; as Patience, into Yellow and Red.

42. §. By Affation; thus Apples, by roasting, eat more Sowre. The Root of Horfe-Radifh, toasted, taflèth like a Turnep. Potatoes, Orions, and many other Roots, and Parts, have their Taffes, either Altered or Refracted; which chiefly, and in what manner, should be observed. There is one alteration, as remarkable, as commonly known; and is that which followeth upon roasting or baking in one kind of the Waldenfian Pears, which, for a Walden, we corruptly call a War- den.

43. §. By Ufion; wherein some Plants, or Parts of them, burn very quietly; others, not without violent motions; so Fenil-Seeds, held in the flame of a Candle, will fmit and fputtle, like the Serum of Blood. Some Vegetables lose their smell, as Roses; others, keep it, as Rosemary; and others, mend it, as Lignum Aloes. To note, not only the alteration of their qualities, but what they yield; as Tarpe- tine, which, in Distillation, yieldeth Oyl and Water, both limpid; upon Ufion, theweth nothing but a black Root. So Benzoin, by Distillation, Oyl; by Ufion, while Flowers, as is known.

44. §. By Calculations; and here to obferve, wherein the Caput Mortuum of one, may differ from, or agree in Nature with that of another; and also to compare thefe with thofe of Animal Bodies. As also in their Quantities. And to compare them with what they yield by Di- stillation and Ufion as to both. Thus far they have been tried fingly, or by themselves. They should also be examined.

45. §. By Composition; not only with Water, as in fimple Infusions, &c. but with any other Bodies, which may have a power of acting upon them, or upon which, these may have a power to act. And fo to make Infusions, Distillations, Decotions, Digestions, in divers kinds of Liquors, as Vinegar, Urine, Spirit of H. H. Wine, Blood, Milk, or others. So in Infusions, some Red Colours are heightned by Acids; Blews, turned Purple; fo fetid Spirits (as of H.H.) may be render'd much more grateful, by being Reftrified, once or twice, with fresh Aromaticks.

To obferve all that follows, upon mixing the Liquors, or other Parts of
of Plants together; as Oyl of Tarantine, by Digestion with a Lixivial Salt, extrac'thence a Red Tincture. Or with Salts, Earths, Metals, or any other Bodies; as the Juice of the green Leaves of Rasberry, Primrose, and divers other Plants (I think principally such as are Altringent) expressed upon Steel, as it drieth, becometh of a Purple Colour.

46. §. Lastly, by Compounding the Experiment it self, or joyning two or more of them, upon the same matter: as Fermentation and Distillation, as is used for some Waters. Infusion and Fermentation, as in making of Beer. Fermentation and Coction, or rather Action, as in making of Bread. Resolution and Distillation, as may be tryed upon some Herbs; and with what difference from what may be noted, upon their being distilled, moist.

47. §. Having proceeded thus far, by all the above particular Ways of Observation; a Comparative Prospect must be taken of them: by which, at last, the Communions and Difference of the Contents of Vegetables, may be discerned; the manner of their Conjuction and Original, partly, be judged of; and wherein it is, that the Essence of their several Natures and Qualities doth consist, in some measure comprehended. And consequently, both from the knowledge of their particular Natures, and the Analogy found betwixt them; we may be able, better to conjecture, and try, what any of them are, or may be good for. For certainly, we shall then know, more readily, to apply things unto, and more fitly to prepare them for, their Proper Uses, when we first know, what they are. Notwithstanding, since the Faculties of Plants, do often lie more reclus; it is best, therefore, not wholly to acquiese in such Conjectures, as their Tastes, or other sensible Properties may suggest; but to subjoin Experiment. In making of which, and in passing a Judgment thereupon, many Caution's, both in respect of the Plant whereof, and the Subject whereupon it is made, are requisite to be attended. Which yet, in regard they result not so directly from the Matter at present in hand; I shall not, therefore, here infift upon them. And thus much for the Third General Means.

The Fourth General Means.

48. §. THE Contents of the Organical Parts of Vegetables, having been thus duly Examined: it will be requisite to make the like Inquiry into their Principles; or the Bodies, immediately concurrent and essential to their Being. And of these, we are to observe, First, their Number; whether well reducible to five, six, seven, or more, or fewer: and the Special Differences observable under any one General; since there are many Bodies, of very different Natures, confounded under one Name. Next their Conjunction; which they are, that either under or over those observable in animal, or other Bodies; are here joyned together in a Plant; How far common to the Organical Parts of divers Plants; or to the several Organical Parts of one; or how far different in them. So the predominant Principle of the Parenchymous Parts of a Plant, that it is an Acid, seems evident, From the general Nature of Fruits; and of Core; and most Parenchymous Roots, which are either Spirituous, or Sower, or by Digestion, do easily become such. Likewise their Proportions; which stand in the greatest, which in the leaf, or in the manner Quantities, and in what Degrees; both in divers Vegetables, and in the several Organical Parts of one. And then the Concentration and Union of them altogether; as to the degrees
gree of their Closernes or Laxity; or the manner of their Implication and Coherency; or as to their Location, one being more Central, another more Exposed and Rampant over the rest; or otherwise different. To examine these Principles by their Colour, Taste, Smell, Constancy, Fixity, Volatility, Weight, Figures, or other Accidents. And to these purposes, to go through the formentioned Ways of Experiment; as Distillation, Calcination, Distillation, &c. as any of them may appear applicable herunto. So the Essential Salt of Wormwood, which may be obtained from the Lixivium; is Bitter, transparent, and commonly, of a Cylindrical figure; whereas that which is obtained by Decotion, or from the Extract, is tasteless, greyish, and almost Cubick: and that in the Extract of the Green Leaves of Violets, appears in fine transparent Shoots, like so many little Needles. And it is probable, That the Salts of most Kinds of Plants, whether Lixivial or Essential, and of these, whether obtained by Decotion, or otherwise, have either their Figure, or other Qualities, proper to themselves, whereby they are all distinguished one from another. And lastly, to make Experiment upon these Principles, mixing them with one another, or with other Bodies, or otherwise.

49. §. I know it will be difficult to make observations of this kind upon the Organical Parts of Plants, severally. Yet I have thought of some Ways, whereby true and undeceivable ones may be made. And the better to illustrate what I mean, I shall give one or two Instances of Trial to this purpose. For the making of which, and some others of the like nature, I considered, That upon the Anatomical Analysis of all the Parts of a Plant, I had certainly found, (and shall hereafter shew) That in all Plants, there are Two, and only Two Organical Parts Essentially distinct, viz. The Pithy Part, and the Lignous Part, or such others as are analogous to either of these. So that, if we can think of any Plants, which will afford us either of these two, though not perfectly, yet in some good measure, simple and unmixed: We may then see, by putting them to a Chymical Test, what Principles and Proportions of Principles, concern to specify their Substantial Forms.

50. §. To the Pithy Part, Starch, or pure Manchet is analogous, as having very little of the Lignous mixed with them. I therefore ordered 1/3 of Starch to be put into a Retort, and with a Receiver affixed, to be set in a Sand Furnace; and that all it would yield, should, by degrees, be forced over; which, besides what was evaporated at the Neck of the Receiver, was about 1/3 of an acid and eager Liquor, of a heavy and blackish Oyl, and of a light Oyl 2/3. The Caput Mortuum could not be reduced to Ashes, by the strongest heat which a naked fire in that Furnace would produce.

51. §. To the Lignous part, Hemp or Flux is analogous, having very little of the Pithy mixed with them. I caused therefore 1/3 of Flux to be put into a Retort, and manage'd as the Starch; whereupon, it yielded a Liquor, as I remember, somewhat like the former, and about the same quantity; no Oyl which remained liquid, when cold; but instead of that a Baryr, almost of the Constancy and Colour of the Oyl of Must, and of this above 2/3, or near six times the quantity of the Oyl which was yielded by the Starch. The Caput Mortuum being burned to a white Ash, yielded some portion of a Lixivial Salt.
From whence, I shall, at present, only make these two Remarks; 1st. That although the chief portion, as to quantity, in both these Bodies, (as in most Plants) is an Acid Liquor; yet the latter, yields also some of an Alkali, which the other doth not. So that they are the Lignous Parts of a Plant, generally, which yield the Alkalick Salt, or at least in the greatest Proportion. 2dly. That the Sulphurious or Oleous Principle, is also much more predominant in the Lignous Part, than in the Pithy. To these, the like Tryals upon other Plants, should be added; and other ways. So, in regard the Soot of most Woods, yields a Volatile Alkali; it were fit to examine, Whether the Soot which is made of the Pithy Parts; and that, of the Lignous, afford the said Alkali, in equal quantity; or whether, as is most likely, that of the Lignous doth afford it in a far greater: and the like.

The prosecution of what is here proposed, will be requisite, To a fuller and clearer view, of the Modes of Vegetation, of the Sensible Natures of Vegetables, and of their more Recluse Faculties and Powers. 1st. of the Modes of Vegetation. For suppose we were speaking of a Root; from a due consideration of the Properties of any Organical Part or Parts thereof; 'tis true, that the real and genuine Cause may be rendered, of divers other dependent Properties, as spoken generally of the whole Root. But it will be asked again, What may be the Causes of those first and Independent ones? Which, if we will seek, we must do it by inquiring also, What are the Principles of those Organical Parts? For it is necessary, that the Principles whereof a Body doth consist, should be, if not all of them the active, yet the capacitating Causes, or such as are called Cause sine quibus non, of its becoming and being, in all respects, both as to Substance and Accidents, what it is: otherwise, their Existence, in that Body, were altogether superfluous; since it might have been without them: which if so, it might then have been made of any other; there being no necessity of putting any difference, if neither those, whereof it is made, are thought necessary to its Being, Wherefore if we will allow a Body, and to the Organical Parts of a Vegetable to have Principles, we must allow these Principles their necessary Life; and that the Shapes or other Properties of the said Parts, are as much dependant upon the Nature of these, as is the Roundness of a Drop of Ink, upon the Fluidity of Water, ingredient to it.

Again, the Principles of the Organical Parts being known, we may from thence obtain a further knowledge of the Natures, and Caution or Original of their Contents; since these Contents are not only included in the said Organical Parts, but also Created by them and must needs be so, whether we will suppose the Principles of these Contents to be pre-existant to their reception thereinto, or not. For, if not pre-existent, what can be clearer, than that the said Parts give them their Existence? And if pre-existent, yet in regard they are distinguished, and such only of them admitted in such sort into an Organical Part, from amongst others, as are apt to combine and mix together in such a Form, and to constitute such a Liquor; it is as clear, that the Existence, if not of those Principles, yet of that Liquor, is dependent on the said Part.
55. §. And by means of the said Organical Parts, it is, that their Contents become such and such peculiar Mixtures; it is hence also manifest, that, by the same means, they are of such distinct Faculties and Powers: Because the Faculty or Power of a Body, lieth not in any of its Principles apart; but is a Reflexion from them all; or from their being, in such peculiar sort and manner, United and Combined together. So the Principles of the Purgative Parts of a Root, as of Rhubarb, although we should suppose them to be existent in the surrounding Earth; yet we cannot lay, That Earth, or the Principles therein contained, are Purgative; but only that they are such, as by being combined together, in such a peculiar way, may become so. So the several parts of a Clock, although they are and must be all pre-existent to it, and it is their Form, by which they are, what they are; yet is it the setting together of such Parts, and in such a way only, that makes them a Clock. And since we see that the Mixture of two Bodies of two different Qualities, as of Two Colours, will produce a Third Colour, differing from them both; as Blue and Red, do a Murrey: Why should not Two or More Bodies of different Natures, be so combined together, as to produce a Third Nature? Or wherefore may not that be allowed to be performed by Nature, which by Artificial Compounding of Medicines, or other Bodies, is designed, and oftentimes effected? I'll give but one Instance; Water, Grecse, and an Alcarmate Salt, may be easily so ordered, as to be invected with new Qualities, Nature, and Powers: the Salt, to lose its extreme fiery Pungent Tsplice; the Tallow, its Smell; and being before invectible with the Water, to mingle therewith: neither Tallow, Salt, nor Water alone, will fetch out a spot of Grecse; but all united easily do it: the same Three Bodies united, are, in some Cases, as in the Jaundies, no ill Medicine; any of which, given alone, may rather prove prejudicial, than a cure: and all this done, only by duly boiling them together into one Body, which we call Sopoe.

56. §. Whence again, if it be such an Union, and Proportion, of such a sort of Principles, which produceth such a Faculty; and that we may, by any means, come to know what these are; we may, possibly, also attain to the knowledge of such Rules, whereby any kind of Faculty may be made; as to Compound such Bodies, which are neither Purgative nor Vomitory, so together, as to be invected with those Faculties. And if to Make them, then consequentially, to Mend, Exalt, Strengthen, and Enable them, with greater ease and certainty. And thus much for the Fourth General Mean.

57. §. HITHERTO, We have considered the Materials of a Vegetable, only as Ingredient to it: there yet remains a Fifth Story to be ascended: which is, to consider these Materials as they are derived from abroad: and as, after they are received and naturalized, they may, with others yet abroad, have any kind of correspondance. And therefore are Four in general, seed, Earth, Water, Air, and Sun; all which, in that they contribute to universally to Vegetation, and to whatsoever is contained in a Vegetable, it is therefore requisite, that of these likewise, Particular Observation should be made.

58. §. And First, of the Earth, and of all Solid Receptacles of Plants. Where we are to consider their several Kinds; as Mellow, Sandy, Clayie, Chalky, and others. Their Ingredients; as Rank and E

Mellow
Mellow Earth, with Sand, or with Clay; or Sand with Clay; or altogether; and in what Proportions. The Principles wherewith any one of these Ingredients is separated from the rest, and put to the Teft of Distillation, Sublimation, Calcination, or other, either alone, or by mixture with other Bodies, may be Resolved. And by their Qualities, as Colour, Smell, Taste, &c. both Ingredients and Principles to be examined. To make trial of the growth of Plants, in all kinds of simple Soils; either Earthy or Mineral, as Clay, Marl, Oker, Fulfurs Earth, Bole Arminiac, Vitriol, Allum, &c. or Vegetable, as Rooten Wood, Brans, Starch, or Flower, &c. or Animal, as Dungs, pounded Fleth, dried and powdered Blood, and the like; that it may appear, how far any of these may contribute to the growth of a Plant; or to one, above another.

59. §. Next of the Water, and of all Liquid Receptacles. Where the several kinds of Water, from Wells, Springs, Rain, and Rivers are, by their Qualities and Faculties, to be examined; as these, and by these, their Principles, either in their Natural State, or upon Digestion, or otherwise, may be observable: Since Common Water it self, is undoubtedly compounded of several Principles; the simplicity thereof, not being argued, from its Clearness and Transparency; for a Solution of Alum, though it containeth a considerable quantity of Earth, is yet very Clear: nor from its seeming to have neither Smell nor Taste; for Water-drinkers will tell you of the varieties of both in different Waters. Besides, if these Qualities should be accounted rather Phantastic, than Sensible; the difference of Waters is yet more manifest, from their different Effects, observed by Cooks, Laundresses, Brewers, and others, that have occasion to use them: for not to mix with Sop, without curdling; not to boil Meat tender, or without colouring it red; and the like, are the vices of some Waters, not of others, which yet would seem, in Colour, Taste, and Smell, to be the same. Tryal should also be made of the growth of Plants in all kinds of Liquid Receptacles, as Common Water, Snow Water, Sea Water, Urine, Milk, Whey, Wine, Oyl, Ink, &c. Or any of these, with a solution of Salt, Nitre, Sulphur, Sop, or other Body. And hereby to observe what follows, either in the Liquor, or in the Plant it self: as any fixed Body, being weighed before its distillation in Water; and if the Plant, let herein, groweth; the Water, being then evaporated; whether the quantity of that dissolved body, continue the fame, or is lessened. So, whether any Vegetable will become Opium, by growing a considerable time in a plain Solution or Water-tincture of Opium; and the like. Which Experiments, what event ever they have, yet at least, for our further Instruction in the Nature of Vegetation, may be of use.

60. §. Next of Air, where it will be requisite to inquire, what sort of Bodies may be herein contained: It being probable, from the variety of Meteoric Forms formed herein; and of Vapours and Exhalations continually advanced hereinto; that some or other of them, may bear an Analogy to all Volatile Bodies, whether Animal, Vegetable, or Mineral. The flourishing also of Frozen Dew; and the Green Colour, which the Air gives the Ground or Water, when, for some time exposed to it; and other effects; seem to argue, that it is impregnated with Vegetable Principles. To consider also the peculiar Nature of that Body, which is strictly called, Air, And of that true Aerial Salt, which to me, seemeth probable,
bale, that it is dissolved in the Air, as other Salts are in Water, or in the Vaporous parts of the Air. As also to try, what different Effects, a diversity of Air may have upon a Vegetable; as by setting a Plant, or Seed, either exceeding Low, as at the bottom of a deep Well; or exceeding High, as on the top of a Steeple. Or else by exposing some Soil to the Air, which is absolutely free from any Seed, and so, as no Seed can light upon it; and to observe, whether the Air hath a power of producing a Vegetable therein, or not: and the like.

61. §. Lastly of the Sun; as to which, it may be considered, What Influence it may have upon the Plant itself; upon the Soil; Or upon the Air. Whether that Influence is any thing else besides Heat: or may differ from that of a Fire, otherwise, than by being Temperate, and more Equal. That it doth, seems evident from an Experiment sometime since given us, in one of the Parisian Journals des Sceaux, and which I therefore think very applicable to our present purpose. If you hold a Conceave at a due distance, against a Fire, it will collect and call the Heat into a burning Focus: but if you put a piece of plain Glass between them, the Glass will scatter the Heat, and destroy the Focus. Whereas the Sun-Beams, being gathered in like manner, will pass through the interposed Glass, and maintain their Focus. As for That, of the Collection of the Sun-Beams, by the help of Glassses, in the form of a Magnifier, or of Flowers, and such like, I desire to suspend my thoughts of them, till I see them. I will only say thus much further at present. That I do not understand why the Sun should not have some Influence upon Bodies, besides by Heat; if it may be granted, That the Moon hath; for which, it should seem, there are some good Arguments.

62. §. WE HAVE thus far examined the Principles necessary to Vegetation. The Question may be put once more, In what manner are these Principles so adapted, as to become capable of being assembled together, in such a Number, Configuration, Proportion, and Union, as to make a Vegetable Body? For the comprehension whereof, we must also know, What are the Principles of these Principles. Which, although they lie in so great a variety of obscurity; yet, I think, I have some reason to believe, that they are not altogether undiscoverable. How far they may be so, I am so far from Determining, that I shall not now Conjecture.

63. §. THIS is the Design, and these the Means I propose in order The Contitoreunto. To which, I suppose, they may all appear to be necessary, clearly.

For what we obtain of Nature, we must not do it by commanding, but by courting of Her. Those that woo Her, may possibly have her for their Wife: but She is not so common, as to prostitute her self to the belt behaved Wit, which only prattles upon itself, and is not applied to her. I mean, that where ever Men will go beyond Phantastie and Imagination, depending upon the Conduet of Divine Wisdom, they must Labour, Hope and Persever. And as the Means propounded, are all necessary, so they may, in some measure, prove effectual. How far, I promise not: the Way is long and dark: and as Travellers sometimes amongst Mountains, by gaining the top of one, are so far from their Journeys end; that they only come to see another lies before them: so the Way of Nature, is so impervious, and, as I may say, down Hill and up Hill, that how far ever we go, yet the surmounting of one difficulty, is wont still to give us the prospect of another. We may
therefore believe, our attainments will be imperfect, after we have done all: but because we cannot attain to all, that therefore we should endeavour after nothing: is an inference, which looks so much awry from the practical sense of men, that it ought not to be answered. Nor with better reason, may we go about determining, what may be done. The greatest designs that any men undertake, are of the greatest uncertainty, as to their success: which if they appear to be of good import, though we know not how far they are attainable, we are to propound the means, in the utmost use whereof only, we can able to judge: a war is not to be quitted, for the hazards which attend it; nor the councils of princes broken up, because those that sit at them, have not the spirit of prophecy, as well as of wisdom. To conclude, if but little should be effected, yet to design more, can do us no harm: for although a man shall never be able to hit stars by shooting at them; yet he shall come much nearer to them, than another that throws at apples.
TO THE RIGHT HONOURABLE

WILLIAM

Lord Vi-Count Brouncker,

THE PRESIDENT,

And to the

Council and Fellows

OF THE

ROYAL SOCIETY,

The following

ANATOMY

Is most HUMBLY
PRESENTED

By the AUTHOR

NEHEMIAH GREW.
THE

ANATOMY

OF

PLANTS

BEGUN

WITH

A GENERAL ACCOUNT OF

VEGETATION

Grounded on

THE FIRST BOOK

Presented in Manuscript to the Royal Society
Some time before the first of May, 1751
And Read in the House of Commons on the 30th June next

by

NICHOLAS HUMPHREY, F.R.S.

Fellow of the Royal Society, and of the College of Physicians

The Second Edition

LONDON

Printed by W. Bradbury, 1663.
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LONDON,
Printed by W. Rawlins, 1682.
Mo.Bot. Garden,
1902.
RIGHT HONOURABLE

WILLIAM

Lord V-Counsellor

the

President

And to the

Council and Fellows

of the

ROYAL SOCIETY

The following

ANATOMY

a more Humble

Presented

By the Author

Zephemnon Gray
TO THE
Right Reverend
JOHN
Lord Bishop of
CHESTER.

MT LORD,

Hope your pardon, if while you are holding 
That best of Books in one Hand, I here present some Pages of that of Nature into your other: Especially since Your Lordship knoweth very well, how excellent a Commentary This is on the Former; by which, in part, GOD reads the World his own Definition, and their Duty to him.

But if this Address, my Lord, may be thought congruous, 'tis yet more just; and that I should let Your Lordship, and others know, how much, and how deservedly, I esteem Your extraordinary Favours. Particularly, that you were pleased, so far to animate my Endeavours, towards the Publishing the following Observations. Many
Epistle Dedicatory.

ny whereof, and most belonging to the First Chapter, having now lain dormant, near seven years; and might still, perhaps, have so continued, had not Your Lordships Eye, at length, created Light upon them. In doing which, You have given one, amongst those many Tokens, of as well Your readiness to promote Learning and Knowledge by the hands of others; as Your high Abilities to do it by Your Own: Both which, are so manifest in Your Lordship, that, like the first Principles of Mathematical Science, they are not so much to be asserted, because known and granted by all.

The Consideration whereof, my Lord, may make me not only Just, in owning of your Favours; but also most Ambitious of your Patronage: Which yet, to bespeak, I must confess, I cannot well. Not that I think, what is Good and Valuable, is always its own best Advocate: for I know, that the Censures of Men, are humorous, and variable; and that one Age, must have leave to frown on those Books, which another, will do nothing less than kiss and embrace. But, chiefly, for this Reason, lest I should so much as seem desirous, of Your Lordships Soliciting my Cause, as to all I have said. For as it is your Glory, that you like not so to shine, as to put out the least Star; so were it to Your Dignity, to borrow Your Name, to illustrate the Spots, though of the most conspicuous. I am,

My Lord,

Your Lordships
Most Obliged,

And

Most Humble Servant

NEHEMJAH GREW.

Coventry,
June 10. 1671.
THE CONTENTS.

CHAP. I.
Of the Seed in its State of Vegetation.


CHAP. II.
Of the Root.

The Contents.


CHAP. III.

Of the Trunk.


The Appendix.

Of Trunk-Roots and Claspers.

Trunk-Roots of two kinds, 6, 1, 2. Claspers of one kind, 3. The Uses of both, 4, to the end.
The Contents.

CHAP. IV.

Of the Bud, Branch, and Leaf.

The parts of the Germe and Branch the same with those of the Trunk, 6, 1, 2. The manner of their growth, 3. How nourished, 4. And the use of Knots, 5. How formed 6. The parts of a Leaf, 7. The positions of the Fibres of the stalks of Leaves, 8. For what uses, 9, 10. The visible cause of the different circumference of Leaves, 11. And of their being flat, 12. And filamentous, 13. The foulds of Leaves, their kinds and use, 14, 15, 16. The protections of Leaves, 17. The use of the Leaf, 18, to the end.

The Appendix.

Of Thorns, Hairs and Globulets.


CHAP. V.

Of the Flower.


CHAP. VI.

Of the Fruit.

The vital parts of all, the same, 6, 1. The number, description, and original of the parts of an Apple, 2. Of a Pear, 3, 4. Of a Plum, 5, 6, 7. Of a Nut, 8. Of a Berry, 9. The use of the Fruit, 10, to the end.
The Contents.

CHAP. VII.

Of the Seed in its State of Generation.

THE ANATOMY OF PLANTS,

BEGUN.

With a General Account of Vegetation,

Founded thereupon.

CHAP. I.

Of the Seed in its State of Vegetation.

EING to speak of Plants, and, as far as Inspection, and consequent Reason, may conduct, to enquire into the visible Constitutions, and Uses of their several Parts: I choose that Method, which, to the best advantage, may suit with what we have to say hereon. And that is the Method of Nature herself, in her continued Series of Vegetations, proceeding from the seed sown, to the formation of the Root, Trunk, Branch, Leaf, Flower, Fruit, and last of all, of the seed also to be sown again: all which, we shall, in the same order, particularly speak of.

2. 6. The Essential Constitutions of the said Parts are in all Plants the same: But for Observation, some are more convenient; in which I shall chiefly insist. And first of all, for the Seed, we choose the great Garden-Bean.
3. §. If then we take a Bean and dip yet, we shall find it cloathed with a doubled Vessel or Coat. These Coats, while the Bean is yet green, are separable, and easily distinguished. Or in an old one, after it hath lain two or three days in a mellow Soil; or been soaked as long a time in Water: as in Tab. 1. When it's dry, they cleave so closely together, that the Eye not before instructed, will judge them but one; the inner Coat (which is of the most rare contexture) so far shrinking up, as to feem only the roughness of the outer, somewhat resembling Wafers under Magna-vons.

4. §. The Inner Coat, in its Natural State, is every where twice, and in some places, thrice as thick, as the Outer. Next to the Radicle, which I shall presently describe, it is six or seven times thicker; and encompasses the Radicle round about, as in the same Figure appears.

5. §. At the thicker end of the Bean, in the outer Coat, a very small Foramen presents itself, even to the bare Eye. In Diffedion 'tis found to terminate against the point of that Part which I call the Radicle. It is of that capacity, as to admit a small Virginal Wyse: and is most of all conspicuous in a green Bean. Especially, if a little magnified with a good Spectacle-Glass. This Foramen is not a hole casually made, or by the breaking off of the stalk; but designately formed, for its use hereafter mentioned. It may be observed not only in the great Garden-Bean, but likewise in the other kinds; in the French-Bean very plainly; in Peas, Lupines, Fetche, Lentilles, and other Pulse; 'tis also found; and in many Seeds not reckoned of this kindred, as in that of Fennugreek, Medica Tornata, Goats-Rue, and others: In many of which, 'tis so very small, as scarcely, without the help of Glasses to be discovered; and in some, not without cutting off part of the Seed, which otherwise would intercept the light hereof.

6. §. That this Foramen is truly permeable, even in old Setting-Beans, and the other Seeds above named, appears upon their being soaked for some time in Water. For then, taking them out, and crushing them a little, many small bubbles will alternately arise and break upon it.

7. §. Of all Seeds which have thick or hard Covers, it is also observable, That they have the same likeness perforated, as above said, or in some other manner. And accordingly, although the Coats of such Seeds as are lodg'd in Shells or Stones, being thin, are not visibly perforated; yet the Stones and Shells themselves are; as in Chap. 7, shall be seen how. To which Chapter, what is farther observable, either as to the nature and number of the Covers of the Seed, I also refer.

8. §. The Coats of the Bean being stripp'd off, the proper Seed shews itself. The parts whereof it is compos'd, are three; the Main Body, and two more, appendant to it; which we may call, the Three Organical Parts of the Bean.

9. §. The Main Body is not one entire piece, but always divided, lengthwise, into two halves or Lobes, which are both jointed together at the Base of the Bean. These Lobes in dry Beans, are but difficulty separarated or obli v'd; but in young ones, especially boil'd, they easily flipp apart.
10. § Some very few seeds are divided, not into two Lobes, but into more; as that of Cress into Six. And some are not at all divided, but entire; as the Grains of Corn. Excepting which few, all other Seeds, even the smallest, are divided, like as the Bean, into just two Lobes. Whereof, though in most Seeds, because of their minuteness, we cannot by dissection be inform'd; yet otherwise, we easily may, as in this Chapter shall be seen.

11. § At the Bafis of the Bean, the two other Organical Parts stand appendent; by mediation whereof, the two Lobes meet and join together. The greater of these two Parts stands without the two Lobes, and upon divesting the Bean of its Coats, is immediately visible. 'Tis of a white colour, and more glossy than the Main Body, especially when the Bean is young. In the Bean, and many other Seeds, 'tis situated somewhat above the thicker end, as you hold the Bean in its most proper posture for growth. In Oak-Kernels, which we call Acorns, Apple-Kernels, Almonds, and many other Seeds, it stands prominent just from the end; the Bafis and the End being in these the same, but in the Bean divers.

12. § This Part is found not only in the Bean, and the Seeds above mentioned; but in all others: being that, which upon the Vegetation of the Seed, becomes the Root of the Plant; which therefore may be called the Radicle: by which, I mean the Materials, abating the Formality, of a Root. In Corn, it is that Part, which Matrices, upon itsShootings forth, call the Cone. 'Tis not easy to be observed, lying in some few Seeds, amongst which, that of the Bean is the most fair and ample of all I have seen. But that of some other Seeds, is, in proportion, greater; as of Fennogreek, which is full as big as one of its Lobes.

13. § The lesser of the two said Appendents lies occult between the two Lobes of the Bean, by separation whereof only it is to be seen. 'Tis enclosed in two small Cavities, form'd in the Lobes for its reception. Its colour comes near to that of the Radicle; and it is founded upon the Bafis thereof, having a quite contrary production, st. towards the Cone of the Bean; as being that very Part, which, in process, becomes the Body or Trunk of the Plant. In Corn, it is that Part, which after the Radicle is sprouted forth, or Cone, shoots towards the smaller end of the Grains; and by many Matrices, is called the Acropire.

14. § This Part is not, like the Radicle, an entire Body, but divided, at its loofe end, into divers pieces, all very clofely couched together, as Feathers in a Bunch; for which reason it may be called the Plume. They are so clofet that only two or three of the outmost are at first seen; but upon a nice and curious separation of these, the more Interior Hill may be discovered. In the Bean, this may be done: but in very few other Seeds; because of the extreme smallnes of the Plume. Now as the Plume is that Part which becomes the Trunk of the Plant, so these pieces are so many true, and already formed, though not Display'd Leaves, intended for the said Trunk; and folded up in the same Pleasure, wherein upon the sprouting of the Bean, they afterwards appear. In a French Bean, and especially in the larger white Kind, or in the great Indian Phaetona, the two outmost are very fair and elegant. In the great Garden-bean two extraordinary small Plumes often, if not always, stand one on either side the great one now described; From which,
The Anatomy

Book I.

which, in that they differ in nothing save in their size, I therefore only here just take notice of them. And these three Parts, i.e. the Main Body, the Radicle, and the Plume, are concurrent to the making up of a Seed; and no more than these.

15. §. Having thus taken a view of the Organical Parts of the Bean, and other Seeds; let us next examine the Similar, i.e. those whereof the Organical are compos'd: a distinct observation of which, for a clear understanding of the Vegetation of the Seed, and of the whole Plant arising thence is requisite: To obtain which, we must proceed in our Anatomy.

16. §. Dissecting a Bean then, the first Part occurring is its Cuticle. The Eye and first Thoughts, suggest it to be only a more dense and glossy Superficies; but better Enquiry discovers it a real Cuticle. This is so exquisitely thin, and for the most part, so firmly continuous with the Body of the Bean, that it cannot, except in some small Rags, be distinctly seen, which, by carrying your Knife all into the Bean, and then very gently bearing upward what you have cut, will separate and shew it self transparent. This Cuticle is not only spread upon the Convex of the Lobes, but also on their Flats, where they are contiguous, extending it self likewise upon both the Radicle and Plume, and so to the whole Bean.

17. §. This Part, though it be so far common with the Coats of the Bean, as to be like those, an Integument; yet are we in a quite different Notion to conceive of it: For whereas the Coats, upon setting the Bean, do only administer the Sap, and, as being superficed from their Office, then die; as shall be seen: this, on the contrary, with the Organical Parts of the Bean, is nourisht, augmented, and by a real Vegetation co-extending.

18. §. Next to the Cuticle, we come to the Parenchyma itself; the Part throughout which the Inner Body, whereof we shall speak anon, is diffaminated; for which reason I call it the Parenchyma. Not that we are so meanly to conceive of it, as if (according to the stricter Sense of that word,) it were mere concreted Fuyce. For it is a Body very curiously organiz'd, consisting of an infinite number of extreme small bladders; as in Tab. I. is apparent. The Surface hereof is somewhat dense, but inwardly, 'tis of a laxer Contexture. If you view it in a Microscope, or with a very good Spectacle-Glass, it hath some Similitude to the Pith, while sappy in the Roots and Trunks of Plants; and that for good reason, as in Ch. 2. shall be seen. This is best seen in green Beans.

19. §. This Part would seem by its colour to be peculiar to the Lobes of the Bean; but as is the Cuticle, so is this also, common both to the Radicle and Plume; that is, the Parenchyma or Pulp of the Bean, as to its essential Substancce, is the same in all three. The Reason why the colour of the Plume, and especially of the Radicle, which are white, is so different from that of the Lobes, which are green, may chiefly depend upon their being more compact and dense, and thence their different Tinctures. And therefore the Lobes themselves, which are green while the Bean is young; yet when it is old and dry, become whitish too. And in many other Seeds, as Acorns, Almonds, the Kernels of Apples, Plums, Nuts, &c. the Lobes, even fresh and young, are pure white as the Radicle it self.
But although the Parenchyma be common, as is said, to all the Organical Part; yet in very differing proportions. In the Plume, where it is proportionably least, it maketh about three Fifths of the whole Plume; in the Radicle, it maketh above five Sevenths of the whole Radicle; and in each Lobe, is so far over-proportionate, as to make at least nine Tenths of the whole Lobe.

By what hath been said, that the Parenchyma or Pulp is not the only constituting Part, besides the Cuticle, is imply’d: there being another Body, of an essentially different substance, enbofom’d here-in: which may be found not only in the Radicle and Plume, but also in the Lobes themselves, and so in the whole Bean.

This Inner Body appears very plain and conspicuous in cutting the Radicle athwart, and so proceeding by degrees towards Tab. 1. f. 10, the Plume, through both which it runneth in a large and straight Trunk. In the Lobes, being it is there in so very small proportion, ’tis difficultly seen, especially towards their Verges. Yet it with a sharp Knife you smoothly cut the Lobes of the Bean athwart, divers small Specks, of a different colour from that of the Parenchyma, standing therein all along in a Line, may be obser’d; which Specks are the Terminations of the branches of this Inner Body.

For this Inner body, as it is existent in every Organical Part of the Bean; so is it, with respect to each Part, most regularly distributed. In a good part of the Radicle ’tis one entire Trunk; towards the Bases thereof, ’tis divided into three main Branches; the middle one runneth directly into the Plume; the other two on either side it, after a little space, pass into the Lobes; where the said Branches dividing themselves into other smaller; and those into more, and smaller again, are terminated towards the Verges of each Lobe; in which manner the said Inner Body being distributed it becomes in each Lobe a true and perfect Root.

Of this Seminal Root, as now we’ll call it, from the Description here given, it is further observable: That the two main Branches thereof, in which the several Ramifications in each Lobe are all united, are not committed into the Seminal Trunk of the Plume, nor yet stand at right angles with that and the Radicle, and so with equal respect towards them both: but being produced through part of the Parenchyma of the Radicle, are at last united therein to the main Trunk, and make acute Angles therewith: as may be seen in the same. f. 14. Tab. 1. f. 14.

This Seminal Root being so tender, cannot be perfectly excarnated, (as may the Vessels in the Parts of an Animal) by the most accurate Hand. Yet by dilution begun and continued, as is above declared, its whole frame and distribution may be easily obser’d. Again, if you take the Lobe of a Bean, and lengthwise pare off its Parenchyma by degrees, and in extreme thin slices, many Branches of the Seminal Root, (which by the other way of Dilution were only noted by so many Specks) both as they are fewer about the Bases of the Bean, and more numerous towards its Verges, in some good distinction and entireness will appear. For this you must have new Beans; or else soaked in Water, or buried for some time.

As the Inner Body is branched out in the Lobes, so is it in the Plume: For if you cut the Plume athwart, and from the Bases proceed along the Body thereof, you’ll therein find, first, one large Trunk, or
or Branch, and after four or five very small Specks round about it, which are the terminations of so many lesser Branches therewith distributed to the several parts of the Pile of. The distribution of the Inner Body, as it is continuous throughout all the Organical Parts of the Beam, is represented, Tab. 1.f. 14.

27. s. This Inner Body is, by diffusion, best observable in the Beam and great Lapine. In another larger Pulse it shews likewise some obscure Marks of itself. But in no other seeds, which I have observed, though of the greatest size: as of Apples, Plums, Nuts, &c. is there any clear appearance hereof, upon diffusion, lying in the Radicle and Pile of the reason of which is partly from its being, in most seeds, so extraordinary little; partly from its Colour, which in most seeds, is the same with that of the Parenchyma itself, and so not distinguishable from it.

28. s. Yet in a Gourd-seed, the whole Seminal Root, not only its Main Branches, but also the Sub-divisions and Injections of the lesser ones, are without any diffusion, upon the separation of the Lobes, on their contiguous Flats immediately apparent.

And as to the existence of this Seminal Root, what Diffusion cannot attain, yet an ocular inspection in hundreds of other seeds, even the smallest, will demonstrate; as in this Chapter shall be seen how.

29. s. In the mean time, let us only take notice; That when we say, every Plant hath its Root, we reckon short. For every Plant hath really two, though not contemporary, yet successive Roots: its Original or Seminal-Root within the Lobes or Main Body of its Seed; and its Plant-Root, which the Radicle becometh in its growth: the Parenchyma of the Seed, being in some resemblance, that to the Seminal Root at first, which the Mould is to the Plant-Root afterwards; and the Seminal Root being that to the Plant-Root, which the Plant-Root is to the Trunk. For our better understanding whereof, having taken a view of the several Parts of a Beam, as far as Diffusion conduces; we will next briefly enquire into the Use of the said Parts, and in what manner they are the Fountain of Vegetation, and concurrent to the being of the future Plant.

An Account of the Vegetation of the Seed.

30. s. THE GENERAL Cause of the growth of a Beam, or other Seed, is Fermentation. That is, the Beam lying in the Mould, and a moderate access of some moisture, partly dissimilar, and partly congenerous, being made, a gentle Fermentation thence ariseth. By which, the Beam swelling, and the Sap still increasing, and the Beam continuing still to swell, the work thus proceeds: as is the usual way of explicating. But that there is simply a Fermentation, and so a sufficient supply of Sap is not enough: but that this Fermentation, and the Sap wherein 'tis made, should be under a various Government, by divers Parts thereto subhervient, is also requisite: and as the various preparation of the Aliment in an Animal, equally necessary: the particular process of the Work according whereof, we find none undertaking to declare.

31. s. Let us look upon a Beam then, as a piece of Work to fram'd and set together, as to declare a Design for the production of a Plant; which, upon its lying in some convenient Soil, is thus effected. First of all, the Beam being enfolded round in its Coats, the Sap wherewith it is fed, must of necessity pass through these: By which means, it is not
Book I. of Plants.

not only in a proportionate quantity, and by degrees; but also in a purer body; and possibly not without some Vegetable Tincture, transmitted to the Bean. Whereas, were the Bean naked, the Sap must needs be, as over-copious, so but crude and immature, as not being filtered through as fine a Cotton as the Coats be. And as they have the use of a Filtrum to the transient Sap, so of a Vessel to that which is still deposited within them; being alike accommodated to the lucrative Fermentation hereof, as Bottles or Barrels are to Beer, or any other Fermentative Liquor.

32. §. And as the Fermentation is promoted by some Aperture in the Vessel; so have we the Foramen in the upper Coat also contrived. That if there should bencd of some more airy Particles to excite the Fermentation; through this, they may obtain their Entry. Or, on the contrary, should there be any such Particles or Steam, as might damp the genuine proceeding thereof, through this again, they may have ease if. Or, if, by being ever copious, they should become too high a Ferment; and so precipitate those soft and low degrees, as are necessary to a due Vegetation. The said Aperture being that, as a common Partick, here to the Sap, which what we call the Bung-hole of the Barrel, is to the new tun'd Liquor.

33. §. And the Radicle being designed to shoot forth first, as presently shall be shown'd how; therefore is it distinctly surrounded with the Inner and more succulent Coat. That being thereby suppled on every side, its eruption may be the better promoted.

34. §. The Sap being pass'd through the Coats, it next enters the Body of the Bean; yet not indiscriminately neither; but, being filtered through the Outer Coat, and fermented in the Body of the Inner, is by mediation of the Cuticle, again more finely filtr'd, and so entereth the Parenchyma it itself under a fourth Government.

35. §. Through which Part the Sap passing towards the Seminal Root, as through that which is of a more spacious content; beides the benefit it hath of a farther percolation; it will also find room enough for a more free and active fermenting and maturation herein. And being moreover, part of the true Body of the Bean, and so with its proper Seminalities or Timbres copiously repeat; the Sap will not only find room, but also matter enough, by whose Energy its Fermentation will still be more advanced,

36. §. And the Sap being duly prepared here, it next paffeth into all the Branches of the Seminal Root, and so under a fifth Government. Wherein how delicate 'tis now become, we may conceive by the proportion betwixt the Parenchyma and this Seminal Root; so much only of the best digested Sap being discharged from the whole Stock in that, as this will receive. And this, moreover, as the Parenchyma, with its proper Seminalities being endowed; the Sap for the supply of the Radicle, and of the young Root from thence, is duly prepared therein; and with its highest Tincture and Impregnation at last enriched.

37. §. The Sap being thus prepared in the Lobes of the Bean, 'tis thence discharged; and either into the Plumes, or the Radicle, mutual forthwith issue. And since the Plume is a dependent on the Radicle; the Sap therefore ought first to be dispensed to this; which accordingly, is ever found to shoot forth before the Plumes: and sometimes an inch or two in length. Now because the primitive course of the Sap into
The Radicle, is thus requisite; therefore, by the frame of the Parts of the Bean is it also made necessary. The two main Branches of the Sema-
nal Root, being produced, as is before observed, not into the Plumae, but the Radicle. Now the Sap being brought as far as the Semo-
nal Root, in either Lobe; and according to the conduct thereof continu-
ing still to move: it must needs immediately issue into the same Part,
whereinto the main Branches themselves do; that is, into the Radicle.
By which Sap, thus bringing the several Timidures of the Parts afore-
said with it, being now fed: it is no longer a mere Radicle, but is
made also seminal, and so becomes a perfect Root.

38. §. The Plume, all this while, lies close and still. For the fake
of which, chiefly it is, that the Bean and other Seeds are divided into
Lobes, viz. That it might be warmly and safely lodged up between
them, and so secure'd from the Injuries so tender a Part would sustain
from the Mould; whereof, had the Main Body been entire, it must,
upon the cleaving of the Coats, have lay'n contiguous.

39. §. But the Radicle being thus impregnated and shot into a
Root: 'tis now time for the Plume to rouze out of its Cloyster, and
germinate too; In order whereof, 'tis now fed from the Root, with
laudable and sufficient Aliment. For as the Supplies and Motion of
Sap were first made from the Lobes, towards the Root: so the Root
being well shot into the Mould, and now receiving a new and more
copious Sap from thence; the motion hereof must needs be stronger,
and by degrees proceed in a contrary course, fr. from the Root to-
ward the Plume: and, by the continuation of the Semoinal Root, is di-
rectly conducted thereto; by which being fed, it gradually enlarges
and displays itself.

40. §. The course of the Sap thus turned, it issues, I say, in a
direct Line from the Root into the Plume: but collateral, into the
Lobes also; fr. by those two aforesaid Branches which are obliquely
transmitted from the Radicle into either Lobe. By which Branches the
said Sap being disbursed back into all the Semoinal Root, and from
thence, likewise into the Parenchyma of the Lobes, they are both thus
fed, and for some time augmenting themselves, really grow: as in Lu-
pines is evident.

41. §. Yet is not this common to all Seeds. Some rot under-
ground; as Corn; being of a laxer and less Oleous Substance, differing
herein from most other Seeds; and being not divided into Lobes, but
one entire thick Body. And some, although they continue firm, and
are divided into Lobes, yet rise not; as the great Garden Bean. In
which, therefore, it is observable, That the two Main Branches of the
Lobes, in comparison with that which runs into the Plume, are but
mean; and so insufficient to the feeding and vegetation of the Lobes:
the Plume, on the contrary, growing to lusty, as to mount up without
them.

42. §. Excepting a few of these TwoKinds, all other Seeds what-
ever, (which I have observed) besides that they continue firm; upon
the Vegetation of the Plume, do mount alto upwards, and advance
above the Ground together with it; as all Seeds which spring up with
one or more Dissimilar Leaves: These Dissimilar Leaves, for the most
part Two, which first spring up, and are of a different shape from those
that follow, being the very Lobes of the Seed, divided, expanded, and thus
advanced.
43. The Impediments of our apprehension hereof are the Colour, Size and Shape of the Dissimilar Leaves. Notwithstanding, that they are nothing else but the Main Body of the Seed, how I came at first to conceive, and afterwards to know it, was thus. First, I observed in general, that the Dissimilar Leaves were never jagged, but even edged: And seeing the even verges of the Lobes of the Seed hereunto responding, I was apt to think, that those which were so like, might prove the same. Next descending to particular Seeds, I observed, first, of the Lupine; that, as to its Colour, advancing above the Ground, (as it usueth to do) it was always changed into a perfect Green. And why might not the same by parity of Reason be inferred of other Seeds? That, as to its size, it grew but little bigger than when first set. Whence, as I discern'd (the Augmentation being but little) we here had only the two Lobes: So, (as some augmentation there was) I inferred the like might be, and that, in farther degrees, in other Seeds.

44. Next of the Cucumber-Seed, That, as to its Colour, often appearing above ground, in its primitive white, from white it turns to yellow, and from yellow to green; the proper colour of a Leaf. That, as to its size, though at its first aris, the Lobes were little bigger than upon setting; yet afterwards, as they chang'd their Colour, so their dimensions also, growing to a three-four-five-fold amplitude above their primitive size. But whereas the Lobes of the Seed, are in proportion, narrow, short and thick: how then come the Dissimilar Leaves, to be so exceeding broad, or long, and thin? The Question answers itself: For the Dissimilar Leaves, for that very reason are so thin, because (very broad or long; as we see many things, how much they are extended in length or breadth, so much they lose in depth, or grow more thin; which is that which here befall's the now eifoliated Lobes. For being once dis-imprisoned from their Coats, and the course of the Sap into them, now more and more encreased; they must needs very considerably amplify themselves: and from the manner wherein the Sperminal Root is branched in them, that amplification cannot be in thickness, but in length or breadth. In both which, in some Dissimilar Leaves, 'tis very remarkable: especially in length, as in those of Lattice, Thorn-Apple, and others; whose Seeds, although very small, yet the Lobes of those seeds growing up into Dissimilar Leaves, are extended an Inch, and sometimes more, in length. Though he shall attempt to get a clear sight of the Lobes of Thorn-Apple; and some others, by Dissection, will find it no easy Task; yet is that which may be obtained; and in the Latu Book shall be shew'd. From all which, and the observation of other Seeds, I at last found, that the Dissimilar Leaves of a young Plant, are nothing else but the Lobes or Main Body of its Seed. So that, as the Lobe did at first feed and impregnate the Radicle into a perfect Root; so the Root, being perfected, doth again feed, and by degrees amplify each Lobe into a perfect Leaf.

45. The Original of the Dissimilar Leaves thus known, we understand, why some Plants have none; because the Seed either rifeth not, as Garden-Beans, Corn, &c. Or upon rifting, the Lobes are little altered, as Lupines, Peas, &c. Why, though the proper Leaves are often indented round; the Dissimilar like the Lobes are even-edged. Why, though the proper Leaves are often hairy, yet these are ever smooth. Why some have more Dissimilar Leaves than two, as Cress, &c.
wliich have six, as the Ingenious Mr. Sharrock also observes. The reason whereof is, because the Main Body is not divided into Two, but Six, distinct Lobes, as I have often counted. Why Radishes seem at first to have four, which yet appear plainly two: because the Lobes of the Seed, have both a little Indenture, and are both plaited, one over the other. To which, other Instances might be added.

46. The use of the Dissimilar Leaves is, first, for the protection of the Plume; which being but young, and so but soft and tender, is provided with these, as a double Guard, one on either side of it. For this reason it is, that the Plume, in Corn, is trifled up within a membranous Sheath: and that of a Bean, cooped up betwixt a pair of Sutures: But where the Lobes rise, there the Plume hath neither of them, being both needle-like.

47. §. Again, since the Plume, being yet tender, may be injur'd not only by the Air, but also for want of Sap; the supplies from the Root being yet but flow and sparing; that the said Plume therefore, by the Dissimilar Leaves, may have the advantage likewise of some refreshment from Dew or Rain. For these having their Bases a little beneath that of the Plume, and expanding themselves on all sides of it, they often stand after Rain, like a Vessel of Water, continually soaking and suppling it, left its new access into the Air, should flourish.

48. §. Moreover, that since the Dissimilar Leaves by their Bases intercept the Root and Plume, the greater and groser part of the Sap, may be, by the way, deposited into those; and so the purest proceed into the yet but young and delicate Plume, as its highest Aliment.

49. §. Lastly, we have here a demonstration of the being of the Seminal Root: which, since through the colour or smallness of the Seed, it could not by Diffcction be observ'd, except in some few; Nature hath here provided us a way of viewing it in the now effoliated Lobes, not of one or two Seeds, but of hundreds; the Seminal Root visibly branching itself towards the Cone or Verge of the said Lobe, or now Dissimilar Leaves.
Of the ROOT.

AVING Examind and pursu'd the Degrees of Vegetation in the Seed, we find its two Lobes have here their utmost period; and, that having conveyed their Seminalities into the Radicle and Plume; thence, therefore, as the Root and Trunk of the Plant, still survive. Of these, in their order, we next proceed to speake; and first, of the Root: whereof, as well as of the Seed, we must by Dillection inform ourselves.

2. §. In Dillection of a Root then, we shall find it with the Radicle, as the Parts of an Old Man with those of a Fetus, substantially, one. The first Part occurring is its Skin, the Original whereof is from the Seed: For that extreme thin Cuticle which is spread over the Lobes of the Seed, and from thence over the Radicle, upon the shootting of the Radicle into a Root, is co-extended, and becomes its Skin.

3. §. The next Part is the Cortical Body. Which, when it is thin, is commonly called the Barque. The Original hereof, likewise is from the Seed; or the Parenchyma, which is there common both to the Lobes and Radicle, being by Vegetation augmented and prolonged into the Root, the same becomes the Parenchyma of the Barque.

4. §. The Contexture of this Parenchyma may be well illustrated by that of a Sponge, being a Body Porous, Dilative and Pliable. Its Pores, as they are innumerable, so, extreme small. These Pores are not only receptive of so much Moisture as to fill, but also to enlarge themselves, and so to dilate the Cortical Body wherein they are: which by the shriveling in thereof, upon its being expos'd to the Air, is also seen. In which dilatation, many of its Parts becoming more lax and dilatant, and none of them suffering a solution of their continuity; 'tis a Body also sufficiently pliable; that is to say, a most exquisitely fine-wrought Sponge.

5. §. The Extent of these Pores is much alike by the length and breadth of the Root; which from the shrinking up of the Cortical Body, in a piece of a cut Root, by the same dimensions, is argu'd.

6. §. The proportions of this Cortical Body are various: If thin, 'tis, as is said, called a Barque; and thought to serve to no other end, than what is vulgarly ascrib'd to a Barque; which is a narrow conceit. If a Bulky Body, in comparison with That within it, as in the young Roots of Cichory, Asparagus, &c. 'tis here, because the fairest, therefore taken for the prime Part; which, though, as to Medicinal use, it is; yet, as to the private use of the Plant, not so. The Colour hereof, though it be originally white, yet in the continued growth of the Root, divers Tinctures, as yellow in Dock, red in Bistort, are thereinto introduced.
7. 8. Next within this Part stands the Lignous Body: This Lignous Body, lying with all its parts, so far as they are visible, in a Circle or Ring. Yet are there divers extreme small Fibres thereto parallel, usually mixed with the Cortical Body; and by the somewhat different colour of the said Cortical Body where they stand, may be noted. These Fibres the Cortical Body, and Skin, altogether, properly make the Barks. The Original of this Lignous Body, as of the two former, is from the Seed; or, the Seminal Roots of both the Lobes, being united in the Radicle, and with its Parenchyma co-extensive, is here in the Root of the Plant, the Lignous Body.

8. 9. The Contexture hereof, in many of its parts, is much more close than that of the Cortical; and their Pores very different. Whereas those of the Cortical are infinitely numerous, these of the Lignous are in comparison nothing so. But these, although fewer, yet are they, many of them, more open, fair and visible: as in a very thin Slice cut athwart the young Root of a Tree, and held up against the light, is apparent. Yet not in equally; in Caro-Tree, Gooseberry-Tree, &c. Such as, in Oak, Plums, and especially Damascenes, more; in Elder, Fines, &c. most conspicuous. And as they are different in number and size, so also (whereon the numerous Pores of the Pores of the Cortical Body principally depends) in their shape. Whereas those of the Cortical Body are extended much alike both by the length and breadth of the Root; these of the Lignous, are only by the length, which especially in Vines, and some other Roots is evident. Of these Pores, it is also observable, that although in all places of the Root they are visible, yet most fair and open about the filamentous Extremities of some Roots, where about, the Roots have no Pith; as in Fennel. And in many Roots, higher.

9. 10. The proportion betwixt this Lignous Body and the Cortical, is various, as was said; yet in this, constant, as that in the filamentous and smaller Parts of the Root, the Lignous Body is very much the less; running like a slender Wier or Nerve through the other surrounding it. Whereas in the upper part, it is often times of far greater quantity than the Cortical, although it be encompass'd by it. They stand both together pyramidally, which is most common to Infant Roots, but also in many others.

10. 11. The next Part observable in the Root, is the Infirmity. The existence hereof, so far as we can yet observe, is sometimes in the Radicle of the Seed itself; I cannot say always. As to its substantial nature, we are more certain; that it is the same with that of the Parenchyma of the Radicles; being always at least augmented, and so, in part, originated from the Cortical Body, and, so, at second hand, from the said Parenchyma. For in dissecting a Root, I find, that the Cortical Body doth not only envelop the Lignous, but is also wedged, and in many Pieces inserted into it; and that the said inserted Pieces make not a mere Indenture, but transmit and lie themselves quite through as far as the Pith; which in a thin Slice cut athwart the Root, as so many lines drawn from the Circumference towards the Center, shew themselves.

11. 12. The Pores of the Infirmity are sometimes, at least, extended somewhat more by the breadth of the Root, as about the top of the Root of Borage may be seen; and are thus different from those of the
the Cortical Body, which are extended by the length and breadth much alike; and from those of the Lignous, being only by its length.

12. 6. The number and size of these Infections are various. In Hawthorn, and some others, and especially Willows, they are most extreme small; in Cherries and Plums they are Bigger; and in the Vine and some other Trees, very fairly apparent. In the Roots of most Herbs they are generally more easily discoverable; which may lead to the observation of them in all.

13. 6. These Infections, although they are continuous through both the length and breadth of the Root; yet not so in all Parts, but by the several shootings of the Lignous Body they are frequently intercepted. For of the Lignous Body it is (here left) observable; that its several Shootings, betwixt which the Cortical is infected, are not, throughout the Root, wholly distinct, straight and parallel: but that all along being enarch'd, the Lignous Body, both in length and breadth, is thus disposed into Braces or Occultations. Betwixt these several Shootings of the Lignous Body thus ocultated, the Cortical shootings, and being also ocultated answerably Brace for Brace, that which I call the Infection is framed thereof.

14. 9. These Occultations are so made, that the Pores or Fibres of the Lignous Body, I think, notwithstanding, seldom or never run one into another; being, though contiguous, yet still distinct. In the same manner as some of the Nerves, though they meet, and for some space are associated together, yet 'tis most probable, that none of their Fibres are truly ocultated, having perhaps, in the Pleasures.

15. 9. These Occultations of the Lignous Body, and so the interception of the Infections of the Cortical, are not to be observ'd by the traverse cut of the Root, but by taking off the Barque. In the Roots of Trees, they are generally obscure; but in Herbs often more distinctly apparent; and especially in a Turnip: the appearance whereof, the Barque being stripp'd off, is as a piece of cloke-wrought Network, fill'd up with the Infections from thence.

16. 9. The next and last distinct Part of the Root is the Pith. The substantial nature thereof, is, as was said of the Infection, the same likewise with that of the Parenchyma of the Seed: And according to the best observation I have yet made, 'tis sometimes existent in its Radicle; in which, the two main Branches of the Lobes both meeting, and being ocultated together, are thus dispos'd into one round and tubular Trunk, and so environing part of the Parenchyma, make there of a Pith; as in either the Radicle, or the young Root of the great Bean or Lupine, manner, I think, be well seen.

17. 9. But many times the Original hereof is immediately from the Barque. For in the cognition of divers Roots, both of Trees and Herbs, as of Barberry or Mallow, it is observ'd, That the Cortical Body and Pith, are both of them participant of the same Colour; in the Barberry, both of them ting'd yellow; and in Mallow, green. In cutting the smaller Parts of the Roots of many Plants, as of Borage, Mallow, Parsley, Columbine, &c. 'tis also evident, That the Lignous Body is not there, in the least Concave, but standeth Solid, or without any Pith, Tab 2. f. 5. in the Center; and that the Infections being gradually multiplied afterwards, the Pith, at length, towards the thicker parts of the Root, thaws and enlarges it self. Whence it appears, that in all such Roots, the
The Pith is not only of the same substantial nature, and by the Infections doth communicate with the Barque; and that it is also augmented by it; which is true of the Pith of all Roots; but is moreover, by mediation of the said Infections, wholly originated from it; that is to say, from the Parenchymous Part thereof. The various appearances of the Infections and Pith from the filamentous Parts to the top of the Root, see in Tab. 2. The Pores of the Lignous Body, as it stands entire in the said filamentous Parts, are best seen when they have lain by a night to dry, after cutting.

18. §. A farther evidence hereof are the Proportions betwixt the Cortical Body and Pith. For as about the inferior Parts of the Root, where the Pith is small, the Cortical Body is proportionably great; so about the top, where the Pith is enlarged, the Cortical Body (now more properly becoming a Barque) growth proportionally less, &c. because the Infections do still more and more enlarge the Pith. Likewise the peculiar frame of some Roots, wherein besides the Pith, the Lignous Body being divided into two or more Rings, there are also one or more thick Rings, of a white and soft substance, which stand betwixt them; and are nothing else but the Infections of the Cortical Body collected into the said Rings; but, towards the top of the Root, being infected again, thus make a large and ample Pith; as in older Fennel-Roots, those of Beet, Turnep, and some other Herbs, is seen.

19. §. The Pores of the Pith, as those of the Cortical Body, are extended both by the breadth and length of the Root, much alike; yet are they more or less of a greater size than those of the Cortical Body.

20. §. The Proportions of the Pith, are various; in Trees, but small; in Herbs, generally, very fair; in some making by far the greatest part of the Root; as in a Turnep. By reason of the wide circumference whereof, and so the finer Concoction and Affiliation of its Sap; that Part which in most old Trunks is a dry and harth Pith, here proves a tender, pleasant meat.

21. §. In the Roots of very many Plants, as Turnep, Carrots, &c., the Lignous Body, besides its main utmost Ring, hath divers of its scullated Fibres dispersed throughout the Body of the Pith; sometimes all alike, and sometimes more especially in, or near, its Center; which Fibres, as they run towards the top of the Root, still declining the Center, at last collaterally strike into its Circumference; either all of them, or some few, keeping the Center still. Of these principally, the Succulent part of the Lignous Body of the Trunk is often originated.

22. §. Some of these Pith-Fibres, although they are so exceeding slender, yet in some Roots, as in that of Flower de lis, they are visibly concave, each of them, in their several Cavities also embosoming a very small Pith: the fight whereof, the Root being cut transverse, and laid in a Window for a day or two to dry, may without Glasses be obtained. And this is the general account of the Root; the declaration of the manner of its growth, with the use and service of its several Parts, we shall next endeavour.

23. §. I SAY THEN, That the Radicle being impregnate, and shot into the Moulds, the contiguous moisture, by the Cortical Body, being a Body laxe and Spongy, is easily admitted: Yet not all indiscriminately, but that which is more adapted to pass through the surrounding

Cuticle.
Cuticle. Which transient Sap, though it thus becomes fine, yet is not simple; but a mixture of Particles, both in respect of those originally in the Root, and amongst themselves, somewhat heterogeneous. And being lodg'd in the Cortical Body moderately lax, and of a Circular form; the effect will be an easy Fermentation. The Sap fermenting, a separation of Parts will follow; some whereof will be impacted to the Circumference of the Cortical Body, whence the Cuticle becomes a Skin; as we see in the growing of the Coats of Cheeses, of the Skin over divers Liquors, and the like. Whereupon the Sap passing into the Cortical Body, through this, as through a Manic Hippocratis, is still more finely filtrèd. With which Sap, the Cortical Body being dilated as far as its Tone, without a solution of Continuity, will bear; and the supply of the Sap still renew'd: the purest part, as most apt and ready, recedes, with its due Tinctures, from the said Cortical Body, to all the parts of the Lignous; both those mixed with the Barque, and those lying within it. Which Lignous Body like-wise super-inducing its own proper Tinctures into the said Sap; 'tis now to its highest preparaton wrought up, and becomes (as they speak of that of an Animal) the Vegetative Ros or Cambium: the noblest part whereof is at last coagulated in, and assimilated to the like substance with the said Lignous Body. The remainder, though not united to it, yet tinctur'd therein, thus retreats, that is, by the continual appulse of the Sap, is in part carried off into the Cortical Body back again, the Sap whereof it now tinctures into good Aliment. So that whereas before, the Cortical Body was only relaxed in its Parts, and so dilated; 'tis now increas'd in real quantity or number of parts, and so is truly nourish'd. And the Cortical Body being satureate with so much of this Vital Sap as serves itself; and the second Reminders discharged thence to the Skin; this also is nourish'd and augmented therewith. So that as in an Animal Body there is no infaturation or growth of Parts made by the Blond only, but the Nervous Spirit is also thereunto affilient; so is it here: the Sap prepared in the Cortical Body, is as the Blond, and that part thereof prepared by the Lignous, is as the Nervous Spirit; which partly becoming Nutritum to it self, and partly being discharged back into the Cortical Body, and diffusing its Tincture through the Sap there, that to the said Cortical Body and Skin, becomes also true Nutritum, and so they all now grow.

24. §. In which growth, a proportion in length and breadth is requisite: which being rated by the benefit of the Plant, both for firm standing and sufficient Sap, must therefore principally be in length. And because it is thus requisite, therefore by the constitution of one of its Parts, &c. the Lignous Body, it is also made necessary. For the Pores hereof, in that they are all extended by its length, the Sap also according to the frame and site of the said Pores will principally move; and that way as its Sap moves, the same way will the generation of its Parts also proceed; &c. by its length. And the Lignous Body first (that is by a priority causal) moving in length it self; the Cortical also moves therewith. For that which is nourish'd, is extended: but whatever is extended, is mov'd: that therefore which is nourish'd, is mov'd: The Lignous Body then being first nourish'd, 'tis likewise first mov'd, and so becomes and carries in it the Principle of all Vegetative motion in the Cortical, and so they both move in length.
25. §. Yet as the Lignous Body is the Principle of Motion in the Cortical; so the Cortical is the Moderator of that in the Lignous: As in Animal Motions, the Principle is from the Nervous; yet being once given to the Muscle or Limb, and that moving proportionally to its Structure, the Nervous also are carried in the same motion with it. We suppose therefore, that as the principal motion of the Lignous Body is in length, so is its proper tendency also to Ascend. But being much exceeded both in Compass and Quantity by the Cortical, as in the smaller parts of the Root it is; it must needs therefore be over-born and governed by it; and so, though not lose its motion, yet make it that way where in the Cortical Body may be more obedient to it; which will be by descent. Yet both of them being sufficiently pliable, they are thus capable, where the Soyl may oppose a direct descent, there to divert any way, where it is more penetrable, and so to descend obliquely. For the same reason it may also be, that though you let a Beam with the Radicle upward; yet the Radicle, as it shoots, declining also gradually, is thus arch'd in form of an Hook, and so at last defends. For every declination from a perpendicular Line, is a mixed motion betwixt Ascent and Descend; as that of the Radicle also is, and so seeming to be dependent upon the two Contrary Tendencies of the Lignous and Cortical Bodies. What may be the cause of those Tendencies (being most probably external, and a kind of Magnetism) I shall not make my Task here to enquire.

26. §. Now although the Lignous Body, by the position and shape of its Pores, principally groweth in length; yet will it in some degree likewise in breadth: For it cannot be suppos'd that the purest Sap is all received into the said Pores; but that part thereof likewise, laying about its superficial Parts, is there tintur'd and agglutinated to them. And because these Pores are prolonged by its length; therefore it is much more laxe and easily divisible that way; as in flitting a Stick, or cleaving of Timber, and in cutting and hewing them athwart is also seen. Whence it comes to pas'; that in shooting from the Center towards the Circumference, and there finding more room, its said original Laxity doth easily in divers places now become greater, and at length in open Parts plainly visible. Betwixt which Parts, the Cortical Body, being bound in on the one hand, by the surrounding Skin and Mounds, and prefled upon by the Lignous on the other, must needs invert it self; and so move contrary to it, from the Circumference towards the Center. Where the said contrary motions continued as begun, they at last meet, unite, and either make or augment the Pith. And thus the Root is fram'd, and the Skin, the Cortical and Lignous Bodies, so as is said, thereunto concurrent. We shall next shew the use of the two other Parts, &c. the Inserfment and Pith; and first of the Pith.

27. §. ONE true use of the Pith is for the better Advancement of the Sap, whereof I shall speak in the next Chapter. The use I here observe, is for the quicker and higher Fermentation of the Sap: For although the Fermentation made in the Cortical Body was well subservient to the first Vegetations, yet those more perfect ones in the Trunk which after follow, require a Body more adapted to it; and that is the Pith; which is so necessary, as not to be only common to, but considerably large in the Roots of most Plants; if not in their inferior parts.
parts, yet at their tops. Where though either deriv’d or amplify’d from the Cortical Body, yet being by its Infections only, we may therefore suppose, as tho’ so this, to be more finely constituted. And being also from its coarctation, while infected, now free; all its Pores, upon the supply of the Sap, will more or less be amplified: Upon which accounts, the Sap thereinto received, will be more pure, and its fermentation therein more active. And as the Pith is superior to the Cortical Body by its Constitution, so by its Place. For as it thus stands central, it hath the Lignous Body surrounding it. Now as the Skin is the Fence of the Cortical Body, and that of the Lignous; so the Lignous again a far more preheminent one unto the Pith; the Sap being here a brisk Liquor, turn’d up as in a wooden Cask,

28. §. And as the Pith subserves the higher Fermentation of the Sap; so do the Infections its purer Distribution; that separation which the parts of the Sap, by being fermented in the Pith, were disposed for; being, upon its entrance into the Infections, now made: So that as the Skin is a Fence to the Cortical Body, so are the Infections a more preheminent one to the Lignous. And as they subserve the purer, so the freer and sufficient distribution of the Sap: For the Root enlarging, and so the Lignous Body growing thicker, although the Cortical and the Pith might supply Sap sufficient to the nutrition of its Parts next adjacent to them; yet those more inward, must needs be feanted of their Aliment; and so, if not quite starv’d, yet be uncapable of equal growth: Whereas the Lignous Body being through its whole breadth frequently disparted, and the Cortical Body infected through it; the Sap by those Infections, as the Blood by the diluminations of the Arteries, is freely and sufficiently conveyed to its intimate Parts, even those, which from either the Bark or from the Pith, are most remote. Lastly, as the consequent hereof, they are thus affistant to the Latitudinal growth of the Root; as the Lignous Body to its growth in Length; so these Infections of the Cortical, to its better growth in Breadth.

29. §. Having thus seen the solitary uses of the Several Parts of the Root, I shall lastly propound my Conjectures of that Design whereunto they are altogether concurrent, and that is the Circulation of the Sap.

30. §. That the Sap hath a Double, and so a Circular Motion, in the Root; is probable, from the proper Motion of the Root, and from its Office. From its Motion, which is Descent: for which, the Sap must likewise, some where, have such a Motion proper to it. From its Office, which is, to feed the Trunk: for which, the Sap must also, in some Parts or other, have a more especial Motion of Ascent.

31. §. We may therefore suppose, That the Sap moving in the Bark, towards the Pith, through the Infections, thereinto obtains a pass. Which passage, the upper Infections will not favour; because the Pith standing in the same heigh with them, is there large, the fermenting and course of the Sap quick, and so its opposition strong. But through the lower, it will much more easily enter; because there, from the smallness of the Pith, the opposition is little, and from the shortness of the Infections, the way more open. So that the Sap here meeting with the least opposition, here it will bestow itself (feeding the Lignous Body in its passage) into the Pith. Into which, fresh Sap still entering, this being yet but crude, will subside: that first
first receiv'd, and so become a Liquor higher wrought, will more easily mount upwards. And moving in the Pith, especially in the Sap-Fibers there dipp'd, as in the Arteries, in equal altitude with the upper Inserions; the most volatile parts of all will still continue their direct ascent towards the Trunk. But those of a middle nature, and, as not apt to ascend, so being lighter than those beneath them, not to descend neither; they will tend from the Pith towards the Inserions in a Motion betwixt both. Through which Inserions (feeding the Lignum Body in its passage) it is, by the next subsequent Sap, discharged off into the Cortical Body, and so into the Sap-Fibers themselves, as into the Veins, back again. Wherein, being still pursu'd by fresh Sap from the Center, and more occurring from the Circumference, towards the lower Inserions, it thus descends. Through which, together with part of the Sap aforeimb'd from the Earth, it re-enters the Pith. From whence, into the Cortical Body, and from thence into the Pith, the cruder part thereof, is reciprocally discharged; while the most Volatile, not needing the help of a Circulation, more directly ascended towards the Trunk.

CHAP.
HAVING thus declar'd the degrees of Vegetation in the Root; the continuance hereof in the Trunk shall next be shew'd: in order to which, the Parts whereof this likewise is compounded, we shall first observe.

1. §. That which without deflection shews it self, is the CoarSure: I cannot lay of the Root, nor of the Trunk; but what I choose here to mention, as standing betwixt them, and so being common to them both; all their Parts being here bound in closer together, as in the tops of the grown Roots of very many plants, is apparent.

2. §. Of the Parts of the Trunk, the first occurring is its skin: The Formation whereof, is not from the Air, but in the Seed, from whence it is originated; being the production of the Cuticle, there inveting the two Lobes and Plume.

3. §. The next Part is the Cortical Body; which here in the Trunk is no new substantial Formation; but, as is that of the Root, originated from the Parenchyma of the Plume in the Seed; and is only the increase and augmentation thereof. The skin, this Cortical Body, or Parenchyma, and (for the most part) some Fibers of the Lignous Body, mixed herewith, altogether make the Barque.

4. §. Next, the Lignous Body, which, whether it be visibly divided into many sofer Fibers or small Threads, as in the Bean, Fennel, and most Herbs; or that its Parts stand more compact and close, shewing one hard, firm and solid piece, as in Trees; it is, in all, one and the same Body; and that not formed originally in the Trunk, but in the Seed, being nothing else but the prolongation of the Semental Root distributed in the Lobes and Plume thereof.

5. §. Lastly, The Infections and Pith are here originated likewise from the Plume, as the same in the Root, from the Radicle: So that as to their substantial Parts, the Lobes of the Seed, the Radicle and Plume, the Root and Trunk are all one.

6. §. Yet some things are more fairly observable in the Trunk. First, the transversal shootings of the Lignous Body, which in Trunks of several years growth, are apparent in so many Rings, as is commonly known. For several young Fibers of the Lignous Body, as in the Root, so here, shootting in the Cortical one year, and the spaces betwixt them being after fill'd up with more (I think not till) the next, at length they become altogether a firm compact Ring; the Perfection of one Ring, and the Ground-work of another, being thus made concomitantly.
7. 5. From these Annual younger Fibers it is, that although the Cortical Body and Pith are both of the same substantial nature, and their Pores little different; yet whereas the Pith, which the first year is green, and of all the Parts the fullest of Sap, becomes afterwards white and dry: the Cortical Body, on the contrary, so long as the Tree grows, ever keepeth green and moist, fe, because the said Sap-Fibers, annually grow therein, and so communicate with it.

8. 5. The Pores likewise of the Lignous Body, many of them, in well-grown Timber, as in Oaken boards, are very conspicuous, in cutting both lengthwise and traversely. They very seldom, if ever, run one into another, but keep, like so many several Vessels, all along distinct; as by cutting, and so following any one of them as far as you please, for a Foot or half a Yard, or more together, may be observed. And so, the like, in any Case.

9. 5. Besides these, there are a leffer sort; which, by the help only of a good Spectacle Glass may be observed.

10. 5. And these are all the Pores visible without a Microscope.

The use of which, excepting in some few particulars, I have purposely omitted in this first Book, Mr. Hookleth us, besides these, a third, and yet smaller Sort; and (as a confirmation of what, in the Second Chapter, I have said of the Pores of the Lignous Body in general) that they are all continuous and prolonged by the length of the Trunk, as are the greater ones: whereof he maketh Experiment, by filling up, in a piece of Char-coal, all the said Pores with Mercury: which appears to pass quite through them, in that by a very good Glass it is visible in their Orifices at both ends; and without a Glass, by the weight of the Coal alone, is also manifest. All these I have seen, with the help of a good Microscope, in several sorts of Woods. As they all appear in a piece of Oak, cut transversely, See Tab. 3.

11. 5. Upon further Enquiry, I likewise find, That the Pores of the Lignous Body in the Trunks of Herbs, which at first I only supposed, by the help of good Glasses, are very fairly visible: each Fibre being sometimes perforated by 50, 500, or hundreds of Pores. Or what I think is the truest notion of them, That each Fibre, though it seem to the bare eye to be but one, yet is, indeed, a great number of Fibres together; and every Pore, being not meerly a space between the several parts of the Wood, but the Concave of a Fiber. So that if it be asked, what all that Part of a Plant, either Herb or Tree, which is properly called the Woody-Part; what all that is, I suppose, That it is nothing else but a Glasper of innumerable and most extraordinary small Vessels or Concave Fibers: as in a Slace of the Trunk of Burdock' is apparent.

12. 5. Next the Infections of the Cortical Body, which in the Trunk of a Tree and' athwart, are plainly discerned as they run from the Circumference toward the Center; the whole Body of the Tree being visibly compounded of two distinct Substances, that of the several Rings, and that of the Infections, running cross; showing

Tab. 3. f. 6. that in some resembelance in a Plain, which the Lines of Latitude and of the Meridian do in a Globe. The entrance of the Infections into the Wood, is also, upon striping off the Barque, very apparent; as in the same Fig. 8.
13. §. These Injections are likewise very conspicuous in Sawing of Trees length-ways into Boards, and those plain'd, and wrought into Leaves for Tables, Wainscot, Trenchers, and the like. In all which, as in coarse Trenchers made of Beech, and Tables of Oak, there are many parts which have a greater smoothness than the rest; and are so many inserted pieces of the Cortical Body; which being by those of the Lignous, frequently intercepted, seem to be discontinuous, although in the Trunk they are really extended, in continued Plates, throughout its Breadth.

14. §. These Injections, although as is said, of a quite distinct substance from the Lignous Body, and so no where truly incorporated with it, yet being they are in all parts, the one as the Warp, the other as the Woof, mutually inserted and interwoven together, they thus constitute one strong and firmly coherent Body, as the Timber of any Tree.

15. §. As the Pores or Vesicles are greater or less, so are the Injections also: To the bare eye usually the greater only are discernible: But through an indifferent Microscope there are others also, much more both numerous and small, distinctly apparent, as in a transverse piece of Oak.

16. §. In none of all the Pores can we observe any thing which may have the true nature and use of Valves, which is, Easily to admit that, to which they will by no means allow a regres. And their non-existence is enough evident, from what in the first Chapter we have said of the Leaves of the Seeds: in whose seminal Root, were there any Valves, it could not be, that by a contrary course of the Sap, they should ever grow; which yet, where-ever they turn into Dissimilar Leaves, they do. Or if we consider the growth of the Root, which oftentimes is upward and downward both at once. And being cut transversely, will bleed, both the same ways, with equal freedom.

17. §. The Injections here in the Trunk give us likewise a sight of the position of their Pores. For in a planed piece of Oak, as in Wainscot, Tables, &c. besides the larger Pores of the Lignous Body, which run by the length of the Trunk; the Tract likewise of those of the Injections may be observed to be made by the breadth, and so directly crost. Nor are they continuous as those of the Lignous Body, but very short, as those both of the Cortical Body and Pith, with which the Injections, as to their substance, are congenerous. Yet they all stand so together, as to be plainly ranked in even Lines or Rows throughout the breadth of the Trunk: As the Tract of those Pores appears to the naked Eye, see in Tab. 3: Fig. 9. The Pores themselves may be seen in the Root of a Pine described and figured in the Second Book, as it appears through a good Microscope.

18. §. The Pores of the Pith likewise being larger here in the Trunk, are better obervable than in the Root: the width whereof, in comparison with their sides so exquisitely thin, may by an Honey-Comb be girdly exemplified; and is that also which the vast disproportion between the Bulk and Weight of a dry Pith doth enough declare. In the Trunks of some Plants, they are so ample and transparent, that in cutting both by the length and breadth of the Pith, some of them through the transparency of the skins by which they are bounded, or of which they consist, would seem to be considerably
bly extended by the length of the Pith; but are really discontinuous and short, and as tis said, somewhat answerable to the Cells of an Honey-Comb. This is the nearest we can come to them, by the bare Eye without the assistance of a good Microscope. Mr. Hook sheweth in his Micrography, That the Pores of the Pith, particularly of Elder-Pith, so far as they are visible, are all alike discontinuous; and that the Pith is nothing else but (as he calls them) an heap of Bubbles. Although, in regard they are not fluid, but fixed Parts, I shall choose rather to call them, Bladders. As they appear through a good

Tab. 3. f. 6.) Glafs, in a piece of Burdock, See in Tab. 3. But a more particular Description of the Sizes, Figures, and admirable Textures hereof, I have given in several places in the following Books.

19. §. Besides what this Observation informs us of here, it farther confirms what in the Second Chapter we have said of the Original of the Pith and Cortical Body, and of the sameness of both their natures with the Parenchyma of the Seed: which is nothing else but a Mias of Bladders; as in the First Chapter, hath been said.

20. §. In the Piths of many Plants, the greater Pores or Bladders have some of them lesser ones within them, and some of them are divided with crofs Membranes: And betwixt their several sides, have, I think, other smaller Bladders visibly interjected. However, that they are all permeable, is most certain. They stand togethet not confusedly, but in even Ranks or Trains; as those of the Infections by the breadth, so these by the length of the Trunk. And thus far there is a general corresponding betwixt the parts of the Root and Trunk. Yet are there some considerable Disparities betwixt them, wherein, and how they come to pass, and to what especial Use and End, shall next be said.

An Account of the Growth of the Trunk.

21. §. WE SAY then, that the Sap being in the Root by Filtrations, Fermentations, and in what Roots needful, perhaps by Circulation also, duly prepar'd; the prime part thereof passing through the intermediate Circumference, in due moderation and purity is entertain'd at last into the Trunk. And the Sap of the Trunk being purer and more volatile, and so it self apt to ascend; the motion of the Trunk likewise will be more noble, receiving a disposition and tendency to ascend therewith. And what by the Sap the Trunk is in part dispos'd to, by the respective position and quantity of its Parts it is effectually enabled. For whereas in the Root the Lignous Body being in proportion with the Cortical, but little, and all lying close within its Center; it must therefore needs be under its controul; on the contrary, being here comparatively of greater quantity, and also more dilated, and having divers of its Branches standing more abroad towards the Circumference, as both in the Leaves and Body of the young Trunk and Plume, is seen; it will in its own magnetic tendency to ascend, reduce the Cortical Body to a compliance with it.

22. §. And the Trunk thus standing from under the restraint of the Ground in the open Air, the disposition of its Parts, originally different from that of the Parts in the Root, will not only be continued, but improved. For by the force and prelure of the Sap in its collateral Motion, the Lignous Body will now more freely and farther be dilated.
lated. And this being dilated, the Cortical Body also, must needs be
inferted; and is therefore in proportion always, more or less, smaller
here in the Trunk, than in the Root. And as the Cortical Body leisens,
so the Pith will be enlarged, and by the same proportion is here
greater. And the Pith being enlarged it self, its Pores (the Lignous
Body, upon its dilatation, as it were tentering and stretching out all
their sides) must needs likewise be enlarged with it; and according-
ly, are ever greater in the Pith of the Trunk, than of the Root.
And the dilatation of the Lignous Body still continued, it follows,
that whereas the Pith dependent in the Root, is not only in propor-
tion lefs and lefs, but also in the smaller extremities thereof, and some-
times higher, altogether absent: Contrariwise, in the Trunk, it is
not only continued to its top and smallest Twigs, but also there, in
proportion, equally ample with what it is in any other inferior
part.

23. But although the openness of the Air permitting, be al-
ways alike; yet the Energy of the Sap effecting, being different; as
therefore that doth, the dilatation of the Trunk, will also vary. If
that be lefs, fo is this; as in the Trunks of most Trees: If that be
greater, fo this; as in Herbs is common; the Lignous Body being usu-
ally so far dilated, that the utmost Shootings thereof may easily be
seen to jet out, and adjoin to the Skin. And if the Sap be still of
greater energy, it so far dilates the Lignous Body, as not only to am-
plifie the Pith and all its Pores; but also so far to stretch them out,
as to make them tear. Whereupon either running again into the
Cortical Body, or shrinking up towards it, the Trunk thus sometimes
becomes an hollow Stalk, the Pith being wholly, or in part voided.
But generally it keeps entire; and where it doth, the same propor-
tion and respect to the Lignous and Cortical Bodies, as is said. The
Consequences of all which will be, the Strength of the Trunk, the Se-
curity and Plenty of the Sap, its Fermentation will be quicker, its Di-
tribution more effectual, and its Advancement more sufficient.

24. First, the Erect Growth and Strength of the Trunk; this
being, by the position of its several Parts, effect ed: for besides the flen-
dering of the Trunk still towards the top, the Circumferential position
of the Lignous Body, likewise is, and that eminently, hereunto subordi-
nate. So that as the Lignous Body, in the smaller parts, of the Root
standing Central, we may thence conceive and see their pliability to
any oblique motion; so here, on the contrary, the Lignous Body stand-
ing wide, it thus becomes the Strength of the Trunk, and most ad-
vantageous to its Perpendicular Growth. We see the same Defign in
Bones and Feathers: The strongest Bones, as those in the Legs, are
hollow. Now should we suppose the fame Bone, to be contracted in-
to a Solid; although now it would be no heavier, and in that re-
spect, as apt for motion; yet would it have far less strength, than as
its Parts are dilated to a Circumferential posture. And so for Quills,
which, for the same Reasons, in subseriency to flying, as they are ex-
ceeding light; so, in comparison with the thinnest of their Sides, they
are very strong, and much lefs apt to bend, than if contracted into a
Solid Cylinder. We see it not only in Nature, but Art. For hence it
Is, that Joiners and Carpenters unite and set together their Timbers
pieces and several Works oftentimes with double Joyns; which, al-
though
though they are no thicker, than a single one might be made; yet standing at a distance, have a greater strength than that could have. And the same Architecture, will have the same use, in the Trunks of Plants; in most whereof 'tis very apparent; as for instance, in Corn. For Nature designing its Sap a great Access; for its higher maturity, hath given it a tall Trunk: But to prevent its ravenous depopulating either of the Ear, or Soy; although it be tall, yet are its sides but thin: And because again, it should grow not only tall and thrifty, but for avoiding propping up, strongly too; therefore, the same proportion as its height bears, to the thinnest of its sides, doth the greatness of its Circumference also; being so far dilated as to parallel a Spindle.

25. §. Besides the position of the Lignous Body within the compass of a Ring, there are some Shootings thereof, often standing beyond the Circumference of the said Ring, making sometimes a triangular, of a quadrangular Body of the Trunk. To the end, that the Ring, being but thin, and not self-sufficient, these, like Splinters to Bones, might add strength and liability to it.

26. §. Next, the security and plenty of the Sap, For should the Lignous Body, as it doth in the smaller Parts of the Root, stand Central here also, and so the Cortical wholly surround it: the greater part of the Sap would thus be more immediately exposed to the Sun and Air; and being lodged in a laxe Body, by them continually be prey'd upon, and as fast as supplied to the Trunk, be exhausted. Whereas, the Pith standing in the Center, the Sap therein being not only most remote from the Air and Sun, but by the Barque, and especially the Wood, being also surrounded and doubly immured, will very securely and copiously be convey'd to all the Collateral Parts, and (as shall be said how) the top of the Trunk.

27. §. And the Sap by the amplitude, and great porosity of the Pith, being herein more copious, its Fermentation also will be quicker; which we see in all Liquors, by standing in a greater quantity together, proceeds more kindly: And being run'd up within the Wood, is at the same time not only secur'd from lofs, but all extremities, the Day being thus, not too hot; nor the Night, too cold for it.

28. §. And the Fermentation hereof being quicker, its motion also will be stronger, and its Distribution more effectual, not only to the dilatation of the Trunk, but likewise the shooting out of the Branches. Whence it is, that in the Bodies of Trees, the Barque of it self, though it be Sappy, and many Fibres of the Lignous Body mixed with it, yet seldom tendeth forth any; and that in Herbs, those with the least Pith (other advantages not supplying this defect) have the fewest or smallest Branches, or other collateral Growths; and that Corn, which hath no Pith, hath neither any Branches.

29. §. Lastly, the Advancement of the Sap will hence also be more ready and sufficient. For the understanding where, and how, we fuppofe, That in all Trunks whatsoever there are two Parts joyntly hereunto subfervient. In some, the Lignous Body and the Cortical, as in older Trunks; the Pith being either excluded, or dried: But in most, principally, the Lignous Body and Pith; as in most Annual Growths of Trees: but especially Herbs, where the Cortical Body is usually much and often wholly Inferred.
Book I. of Plants.

30. §. Of the Lignous Body it is so apparent by its Pores, or rather by its Vessels, that we need no farther Evidence. For to what end are Vessels, but for the conveyance of Liquor? And is that also, which upon cutting the young Branch of a Sappy Tree or Herb, by an accurate and steady view may be observed. But when I say the Vessels of the Lignous Body, I mean principally them of the younger shootings, both those which make the new Ring, and those which are mixed with the Cortical Body in the Barque; that which ascends by the Pores or Vessels of the Wood, being probably, because in least quantity, more in form of a Vapour, than a Liquor. Yet that which drenching into the fides of its Pores, is with all therunto sufficient Aliment; as we see Orpines, Onions, &c. only standing in a moyiter Aer will often grow. And being likewise in part supplied by the Injections from the younger Shoots: But especially because as it is but little, so (considered as Aliment) it serveth only for the growth of the Wood, and no more; whereas, the more copious Aliment ascendent by the younger Shoots, subserves not only their own growth, but the generation of others; and is besides with that in the Cortical Body the Fountain of Peristaltions, which we know even in Animals are much more abundant than the Nutritive Parts; and doublets in a Vegetable are still much more.

31. §. But these Pores, although they are a free and open way to the ascending Sap; yet that meer Pores or Vessels should be able of themselves to advance the Sap with that speed, strength and plenty, and to that height, as is necessary, cannot probably be suppos'd. It follows then, that herein we must grant the Pith a joyful Service. And why else is the Pith in all Primitive Growths the most Sappy part, why hath it so great a stock of Sap, if not, after due maturation within it self, full to be disbursed into the Fibres of the Lignous Body? Why are the Annual Growths of all both Herbs and Trees, with great Piths, the quickest and the longest? But how are the Pores or Bladders of the Pith permeable? That they are so, both from their being capable of a repletion with Sap, and of being again wholly emptied of it, and again, instead thereof fill'd with Aer, is as certain as that they are Pores. That they are permeable, by the breadth, appears from the dilatation of the Lignous Body, and from the production of Branchers, as hath been, and shall hereafter be said. And how else is there a Communion betwixt This and the Cortical Body? That they are so also, by the length, is probable, because by the best Microscope we cannot yet observe, that they are visibly more open by the breadth, than by the length. And withall are ranked by the length, as those of the Infections by the breadth of the Trunk. But if you let a piece of dry Elder-Pith in some tinged Liquor, why then doth it not penetrate the Pores, so as to ascend through the Body of the Pith? The plain reason is, because they are all fill'd with Aer. Whereas the Pith in a Vegetating Plant, as its Parts or Bladders are still generated, they are at the same time also fill'd with Sap; which, as 'tis gradually spent, is still repaired by more succedding, and so the Aer still keep out; as in all Primitive Growths, and the Pith of Elder it self. Yet the same Pith, by reason of the following Winter, wanting a more copious and quick supply of Sap, thus once become, ever after keeps dry. And since in the aforesaid Trial the Liquor only ascends by the sides of the Pith, that
is of its broken Bladder, we should thence by the same reason conclude that they are not penetrable by the breadth neither, and so no way; and then it need not be ask'd what would follow. But certainly the Sap in the Bladders of the Pith is discharged and repaired every moment, as by its thriv'ling up, upon cutting the Plant, is evident.

32. We suppoze then, that as the Sap ascenderth into the Truth by the Lignous Body, so partly also by the Pith. For a piece of Cotton with one end immers'd in some tinged Liquor, and with the other erect above, though it will not imbibe the Liquor so far as to over-run at the top, yet so as to advance towards it, it will. So here, the Pith, being a porous and spongy Body, and in its Vegetating state, its Pores or Bladders being also permeable, as a curious Filter of Nature's own contrivance, it thus advances, or as people use to say, suck's up the Sap. Yet as it is seen of the Liquor in the Cotton, so likewize are we to suppoze it of the Sap in the Pith; that though it riseth up for some way, yet is their some term, beyond which it riseth not, and towards which the motion of the ascenderth Sap is more and more broken, weak and slow, and so the quantity thereof les and lea. But because the Sap moveth not only by the length, but breadth of the Pith; at the same time therefore as it partly ascenderth by the Pith, it is likewize in part preffed into the Lignous Body or into its Pores. And since the motion of the Sap by the breadth of the Pith not being far continued, and but collateral, is more prone and eafe, than the perpendicular, or by its length; it therefore follows, that the collateral motion of the Sap, at such a height or part of the Pith, will be equally strong with the perpendicular at another part, though somewhat beneath it; and that where the perpendicular is more broken and weak, the collateral will be less; and consequently where the perpendicular tendency of the Sap hath its term, the collateral tendency thereof, and so its preffure into the Pores or Vessels of the Lignous Body, will still continue. Through which, in that they are small, and so their sides almost contiguous, the Sap as fast as preffed into them will easilie run up; as in very small Glasse Pipes, or betwixt the two halves of a Stick liift liift, and then ty'd somewhat loosey together, may also any Liquor be observed to do. By which Advantage the facility and strength of that ascenct will be continued higher in the said Vessels, than in the Pith. Yet since this also, as well as that in the Pith will have its term; the Sap, although got thus far, would at last be stagnant, or at least its ascenct be very sparing, flow and feeble, if not some way or other re-inforced. Wherefore, as the Sap moving by the breadth of the Pith, preffeth thence into the Vessels of the Lignous Body, so having well fill'd thee; is in part by the same Collateral motion disburfed back, into a yet higher Region of the Pith. By which partly, and partly, by that portion of the Sap, which in its perpendicular ascenct was before lodged therein; is thus here, as in any inferior place equally replenished. Whereupon the force and vigour of the perpendicular motion of the Sap herein, will likewize be renew'd; and so its Collateral motion also, and so its preffure into the Vessels of the Lignous Body, and consequently its ascenct therein; and by a preffure, from these into the Pith, and from the Pith into thee, reciprocally carried on; a most ready and copious ascenct of the Sap will be continued, from the bottom to the top, though of the highest Tree.
An Appendix.

Of Trunk-Roots and Claspers.

The distinct Parts whereof these are composed, are the same with those of the Trunk, and but the continuation of them.

1. Trunk-Roots are of two kinds: Of the one, are those that vegetate by a direct descent: The place of their Eruption is sometimes all along the Trunk; as in Mint, &c. Sometimes only at its utmost point, as in the Bramble.

2. The other for are such as neither ascend nor descend, but shoot forth at right Angles with the Trunk; which therefore, though as to their Office, they are true Roots, yet as to their Nature, they are a Middle Thing betwixt a Root and a Trunk.

3. Claspers, though they are but of one kind, yet their Nature is double; not a mean betwixt that of the Root and that of the Trunk, but a compound of both; as in their Circumvolutions, where in they often mutually ascend and descend, is seen.

4. The use of these Parts may be observed as the Trunk Mounts, or as it Trails. In the mounting of the Trunk, they are for Support and Supply. For Support, we see the Claspers of Vines: the Branches whereof being very long, fragile and slender; unless by their Claspers, they were mutually contain'd together, they must needs by their own weight, and that of their Fruit, undecently fall; and be also liable to frequent breaking. So that the whole care is divided betwixt the Gardener and Nature; the Gardener, with his Ligaments of Leather, secures the main Branches; and Nature, with those of her own finding, secures the Lefs. Their Convenience to which end, is seen in their Circumvolutions, a motion, not proper to any other Part: As also in their toughness, though much more slender than the Branches whereon they are appendent.

5. The Claspers of Bryony have a retrograde motion about every Third Circle, to the form a Doublet-Clasp. Probably for the more certain hold; which, if it mis one way, it may be sure to take another.

6. For Supply, we see the Trunk-Roots of Ivy. For mounting very high, and being of a closer or more compact Substance than that of a Vine; the Sap could not be sufficiently supplied to the upper Sprouts, unless these, to the Mother-Root, were joyntly affilient. Yet serve they for support likewise; whence they shoot out, not as in Cress, Brook-lime, &c. reciprocally on each side, but commonly, all on one; that so they may be fatted at the nearest hand.

7. In the Trailing of the Trunk, they serve for stablishment, propagation and shade. For stablishment, the Claspers of Cucumbers are of good use. For the Trunk and branches being long and fragile, the Branches of the Winds would injuriously howe them to and fro, to the dammage both of themselves and their tender Fruits, were
they not by these Ligaments brought to good Association and Settlement.

8. §. As for this end, so for Propagation, the Trunk-Roots of Chamemile do well serve. Whence we have the reason of the common observation, that it grows better by being trod upon: the Mould, where too late, being thus made to lie more conveniently about the said Trunk-Roots newly bedded therein; and that which is sometimes also effected in Rowling of Corn.

9. §. For both these ends, serve the Trunk-Roots of Strawberries; as also for shade; for in that all Strawberries delight; and by the trailing of the Plant is well obtain'd. So that as we are wont to tangle the Twigs of Trees together to make an Arbor Artificial; the same is here done to make a Natural one: as likewise by the Clappers of Cucumbers. For the Branches of the one by the Linking of their Clappers, and of the other by the Tethering of their Trunk-Roots, being couched together; their tender Fruits thus lie under the Umbraige of a Bower made of their own Leaves.

CHAP. IV.

Of the GERME N, BRANCH, and LEAF.

The Parts of the Germin and Branch, are the same with those of the Trunk; the same Skin, cortical and Lignous Bodies, Infertment and Pith, hereinto propagated, and distinctly observable herein.

2. §. For upon Enquiry into the Original of a Branch or Germin, it appears, That it is not from the Superficies of the Trunk; but to deep, as to take, with the Cortical, the Lignous Body into it self: and that, not only from its Circumference, but from in Inner or Central Parts; So as to take the Pith in all. Divers of which Parts may commonly be seen to shoot out into the Pith; from which Shoots, the surrounding and more superior Germs are originated; in like manner as the Succulent Part of the Lignous Body of the Trunk is sometimes principally from those Fibrous Shoots which run along the Pith in the Root.

3. §. The manner wherein usually the Germs and Branch are fram'd, is briefly thus: The Sap ( as is said, Chap. 3.) mounting in the Trunk, will not only by its length, but by its breadth also, through the Infections partly move. Yet, its Particles being not all alike qualified, in different degrees. Some are more gross and sluggish; of which we have the formation of a Circle of Wood only, or of an Annual Ring. Others are more brisk; and by these, we have the Germs propagated. For by the vigour of their own motion from the Center, they impress an equal tendency on some of the inner Portions of the Lignous Body next adjacent
cent to the Pith, to move with them. And since the Lignous Body is not entire, but frequently disparted; through these Departments, the said Interior Parts, upon their Nutrition, actually shoot; not only towards the Circumference, so as to make part of a Ring; but even beyond it, in order to the production of a Germen. And the Lignous Body thus moving, and carrying the Cortical along with it; they both make a force upon the Skin. Yet their motion being moif even and gradual, that force is such likewise; not to cause the least breach of its parts, but gently to carry it on with themselves; and so partly, by the extension of its already existent parts, as of those of Gold in drawing of Guided Wyer; and partly, by the accretion of new ones, as in the enlarging of a Bubble above the Surface of the Water; it is extended with them to their utmost growth. In which growth, the Germen being prolonged, and so displaying its several parts, as when a Perspective or Telescope is drawn out, thus becomes a Branch.

4. §. The same way as the propagation of the Parts of a Germen is contriv'd, is its due nutrition also. For being originated from the inner part of the Lignous Body, 'tis nourished with the beet fermented Sap in the Trunk, &c. that next adjacent to it in the Pith. Besides, since all its Parts, upon their shooting forth, divercificate from their perpendicular, to a Cross Line, as those and the other grow and thrive together, they bind and through each other into a Knot: through which Knot the Sap being strain'd, 'tis thus, in due moderation and purity delivered up into the Branches.

5. § And for Knots, they are so necessary, as to be seen not only where collateral Branches put forth; but in such Plants also, as shoot up in one single Trunk; as in Corn. Wherein, as they make for the strength of the Trunk: so by so many percolations, as they are Knots, for the transmilion of the Sap more and more refined towards the Ear. So that the two general uses of Knots are, for finer standing, and finer growth.

6. §. Lately, as the due Formation and Nutrition of the Gemen are provided for, so is its security also; which both in its position upon the Trunk, and that of its Parts among themselves, may be observed. The position of its Parts shall be considered in speaking of the Leaf. As to its standing in the Trunk, 'tis always berwixt the Trunk or older Branch, and the Basis of the Stalk of a Leaf; whereby it is not only guarded from the Injuries of any contingent Violence; but also from the more piercing assaults of the Cold; so long, till in time 'tis grown larger, and more hardy. The manner and uses of the position of every Germen, considered as after it becomes a Branch, hath already been, by the Ingenious Mr. Sharrack, Hist. of the Prop. of Vegts.

7. §. UPON THE prolongation of the Germen into a Branch, its Leaves are thus displayed. The Parts whereof are substantially the same with those of a Branch. For the Skin of the Leaf, is only the amplification of that of the Branch; being partly by the accretion of new, and partly the extension of its already existent parts, dilated (as in making of Leaf-Gold) into its present breadth. The Fibres or Nerves, dilated through the Leaf, are only the Ramifications of the Branch's Wood; or Lignous Body. The Parenchyma of the Leaf, which
which lies betwixt the Nervae, and as in Gentlewomens Needle-works, fills all up, is nothing else, but the continuation of the Cortal Body, or Parenchymous part of the Barque from the Branch into it self, as in most Plants with a thick Leaf, may easily be seen.

8. §. The Fibers of the Leaf neither shoot out of the Branch, or the Trunk, nor stand in the stalk, in an even Line; but always in either an Angular or Circular posture; and usually making either a Triangle, or a Semi-Circle, or Chord of a Circle; as in Cabbage, Endive, Cabboge, &c. may be observed. And if the Leaf have but one main Fiber, that also is postur'd in a bow'd or Lunar Figure; as in Mint and others. The usual number of these Vascular Threads or Fibres is 3, 5, or 7.

9. §. The reason of the said Positions of the Fibers in the stalk of the Leaf, is for its more Erect growth, and greater Strength; which were the position of the said Fibers in an even Line, and so the stalk itself, as well as the Leaf flat; must needs have been defective; as from what we have said of the Circumferential posture of the Ligament Body in the Trunk, we may better conceive.

10. §. As likew'ise for the security of its Sap: For by this means it is, that the several Fibers, and especially the main or middle Fiber of the Leaf, together with a considerable part of the Parenchyma, are so disposed of, as to just out, not from its upper, but its back, or neither Side. Whence the whole Leaf, reclining backward, becomes a Canopy to them, defending them from those Injuries which from colder Blasts, or an hotter Sun, they might otherwise sustain. So that by a mutual benefit, as these give fuel to all the Leaf, so that again protection to these.

11. §. These Fibers are likew'ise the immediate Visible Cause of the Shape of the Leaf. For if the nethermost Fiber or Fibres in the stalk (which thence runs chiefly through the length of the Leaf) be in proportion greater, the Leaf is long; as in Endive, Cichory, and others: If all of a more equal size, it spreads rounder, as in Lettuce, Dows-foot, Colts foot, &c. And although a Dock-Leaf be very long, whose Fibers notwithstanding, as they stand higher in the stalk, are disposed into a Circle all of an equal size; yet herein one or more peculiar Fibres, standing, in or near the Center, betwixt the rest, and running through the length of the Leaf, may be observed.

12. §. In correspondence also to the fize and shape of these Fibres, is the Leaf flat. In that either they are very small, or if larger, yet they never make an entire Circle or Ring; but either halt of one, as in Borage, or at most three parts of one, as in Muller, may be seen. For if either they were so big, as to contain; or so entire, as perfectly to include a Pith, the Energy of the Sap in that Pith, would cause the said Lignous Ring to shoot forth on every side, as it doth in the Root or Trunk: But the said Fibers being not figur'd into an entire Ring, but so as to be open; on that hand therefore where open they cannot shoot any thing directly from themselves, because there they have nothing to shoot; and the Sap having also a free vent through the said opening, against that part therefore which is thereunto opposite, it can have no force; and so neither will they shoot forth on that hand; and so will they consequently, that way only, which the force of the Sap directs, which is only on the right and left.

13. §.
Book I.

of Plants.

13. §. The several Fibers in the stalk, are all Inoculated in the Leaf, with very many Subdivisions. According as these Fibers are Inoculated near, or at, or both directly to the edge of the Leaf; is it Even, or Scallop'd. Where these Inoculations are not made, there we have no Leaves, but only a company of Filaments; as in Fennel.

14. §. To the Formation of Leaves, the Fouldings immediately follow. And sometimes they have one Date, or are the contemporary works of Nature; each Leaf obtaining its distinct shape, and proper posture together; both being perfect, not only in the outer, but Central and minute Leaf, which are five hundred times smaller than the outer: both which in the Cautious opening of a Germe may be seen.

15. §. Nor is there greater Art in the Forms, than in the Foulds or Postures of Leaves; both answerably varying, as this or that way they may be most agreeable. Of the quadrangular postures, so amply instanc'd in by the Learned Sir Thomas Brown, I shall omit to speak. Others there are, which though not all so universal, yet equally necessary where they are, giving two general advantages to the Leaves, Elegancy and Security, so in taking up, so as their Forms will bear, the leaf room, and in being so conveniently couch'd, as to be capable of receiving protection from other Parts, or of giving it one to another; as for instance,

16. §. First, There is the Bow-Lap, where the Leaves are all laid somewhat convexly one over another, but not plaited; being to the length, breadth and number of Leaves most agreeable; as in the Buds of Pear-tree, Plum-tree, &c. But where the Leaves are not to thick felt, as to stand in the Bow-Lap, there we have the Plicature, or the Flat-Lap; as in Rais-Trees, Strawberry, Cinquefoyl, Burnet, &c. For the Leaves being here plaited, and so lying in half their breadth, and divers of them thus also collateral felt together; the thickness of them all, and half their breadth, are much alike dimensions; by which they stand more secure within themselves, and in better comfort with other Germs-Growths in the same Trunk. If the Leaves be much indented or jagged, now we have the Duplicature; wherein there are divers Plaits in one Leaf, or Labels of a Leaf, but in distinct Sets, a letter under a greater; as in Souchus, Tarney, &c. When the Leaves stand not collateral, but single; and are moreover very broad; then we have the Multiplicature; as in Gooseberries, Mallow, &c. The Plaits being not only divers in the same Leaf, but of the same Set continuant, and so each Leaf gather'd up in five, seven or more Foulds, in the same manner as our Gentlewomen's Fans. Where either the thickness of the Leaf will not permit a Flat-Lap, or the fewness of their number, or the smallness of their Fibers, will allow the Rowl, there This may be observed. Which is sometimes single, as in Bays-Leaf, Arum, Flammula, Jerusalem Cresspurp, &c. Sometimes double, the two Rows beginning at each edge of the Leaf; and meeting in the middle. Which again, is either the Fore-Rowl, or the Back-Rowl. If the Leaf be design'd to grow long, now we have the Back-Rowl, as in Docks, Sorrels, and the root of this Kindred: as also in Primrose, and other like Plants. For the main Fibers, and there with a considerable part of the Cortical Body standing prominent from the Back-side of the Leaf, they thus stand securely couch'd up betwixt.
twixt the two Rows: on whose security the growth of the Leaf in length depends. But those of Bears-Barb, Violet, Doves Foot, Warden, and many more, upon contrary respects, are rowed up inwards. Lastly, there is the Tre-Raw; as in Figs; the Leaves where of, though all rowed up to the main Stem, yet could not stand so firm and secure from the Injuries either of the Ground or Weather, unless to the Rows in breadth, that by the length were super-indued; the stalk or main Stem giving the same Protection here, which in other Plants by the Leaves, or some particular Mantling, is contrived. These, and other Foults, See in the Figures belonging to the First Part of the Fourth Book.

17. §. According to the Form and Foulding of every Leaf or Gramen, is its Protection order'd; about six ways whereof may be observ'd; so, by Leaves, Surfylts, Interstylts, Stalks, Hooks and Mantlings. To add to what we have above given, one or two Instances. Every Bud, besides its proper Leaves, is covered with divers Leafy Rambles or Surfylts; which, what the Leaves are to one another, are that to them all: For not opening except gradually, they admit not the Weather, Wet, Sun or Aer, to approach the Leaves, except by degrees respondent, and as they are gradually inured to bear them. Sometimes, besides Surfylts, there are also many Interstylts set between the Leaves, from the Circumference to the Center of the Bud: as in the Oak. For the Fibres of these Leave standing out so fix from a plain surface; they would, if not thus shelter'd, lie too much exposed and naked to the Severities of the Weather. Where none of all the Protections above-named, are convenient, there the Membranes of the Leave by continuation in their first forming (together with some Fibres of the Lignous Body:) are drawn out into so many Mantles or Veils; as in Docks, Snakeweed, &c. For the Leaves here being but few, yet each Leaf and its Stalk being both exceeding long; at the bottom whereof the next following Leaf still springs up; the form and posture of all is such, as supercedes all the other kinds of Protection, and so each Leaf apart is provided with a Veil to itself. These, and other Protections, See in the Figures belonging to the First Part of the Fourth Book.

18. §. The Uses of the Leaves, I mean in respect of their service to the Plant it self, are these: First, for Protection; which, besides what they give one to another, they afford also to the Flower and Fruit. To the Flower in their Foulds; that being, for the most part, born and usher'd into the open Aer by the Leave. To the Fruit, when afterwards they are display'd, as in Strawberries, Grapes, Raisps, Mulberries, &c. On which, and the like, should the Sun-Beams immediately strike, especially while they are young, they would quite shrivel them up; but being by the Leaves screen'd off, they impress the circumjacent Aer so far only as gently to warm the said Fruits, and so to promote their Fermentation and Growth. And accordingly we see, that the Leave above-named are exceeding large in proportion to the Fruits: whereas in Pear-trees, Apple-trees, &c. the Fruit being of a tender Parapheme, and so not needing the like protection, are usually equal with, and often wider in Diameter than the Leaves.
19. 8. Another use is for Augmentation; or, the capacity for the due spreading and ampliation of a Tree or other Plant, are its Leaves. For herein the Lignous Body being divided into small Fibres, and these running all along their lax and spongic Parenchyma; they are thus a Body fit for the imbibition of Sap, and safe Growth. Now the Sap having a free reception into the Leaves, it still gives way to the next succeeding in the Branches and Trunk, and the voyding of the Sap in these, for the mounting of that in the Root, and ingred of that in the Ground. But were there no Leaves to make a free reception of Sap, it must be needs be stagnant in all the Parts to the Root, and so the Root being clogg'd, its fermenting and other Offices will be voided, and so the due Growth of the whole. As in the motion of a Watch, although the original term thereof be the Spring, yet the capacity for its continuance in a due measure throughout all the Wheels, is the free and safe motion of the Balance.

20. 8. Lastly, As the Leaves subserve the more copious advancement, to the higher purity of the Sap. For this being well fermented both in the Root, and in its Ascent through the Trunk, and so its Parts prepar'd to a farther separation; the groffer ones are still depofited into the Leaves; the more elaborate and effential only thus supplied to the Flower, Fruit and Seed, as their convenient Aliment. Whence it is, that where the Flowers are many and large, into which the more odorous Particles are copiously receiv'd, the green Leaves have little or no smell; as thofe of Rose-tree, Carnations, French-Marigold, Wood-bind, Tulips, &c. But on the contrary, where the Flowers are none, or small, the green Leaves themfelve are likewife of a strong favour; as thofe of Wormwood, Tanfic, Bann, Mint, Rue, Geranium Moschatum, Angelica, and others.

An Appendix.

Of Thorns, Hairs and Globulets.

Thorns are of two kinds, Lignous and Cortical. Of the first are such as thofe of the Hawthorn, and are constituted of all the fame Substantial Parts whereof the Thorn or Bud it felf, and in a like proportion: which alfo in their Infancy are fet with the remembrances of divers minute Leaves. Of affinity with these are the Spines or Thorny Prickles upon the Edges and Tops of divers Leaves, as of Barberries, Holly, Thistle, Furze, and others; all which I think are the filamentous extremities of the Lignous Body incased in the Skin. But this principal difference between a Bud and thofe Lignous Thorns, is observable; That the Bud hath its Original from the Inner part of the Lignous Body, next the Pith: But thofe Thorns, from the outer, and lefs fecund Part; and fo produce no Leaves, but is, as it were, the Mote of a Bud.
2. §. Coastal Thorns are such as those of the Raspberry Bush, being not, unless in a most extraordinary small and invisible proportion propagated from the Lignous Body, but as it seems, wholly from the Cortical and Skin, or from the exterior part of the bark.

C. 2. §. 25.

3. §. The Growth of this Thorn may farther argue what in the Second Chapter we supposed; &c. That as the proper Tendency of the Lignous Body is to Ascend; so of the Cortical to Descend. For as the Lignous Thorn, like other Parts of the Trunk, in its Growth ascends; this, being almost wholly Cortical, pointeth downward. The use of

Hist. of the
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4. §. Upon the Leaves of divers Plants two Productions shew themselves, &c. Hairs and Globules. Of Hairs, only one kind is taken notice of; although they are various. Ordinarily they are of a Simple Figure; which when fine and thick set, as on most Hairy Buds, or fine and long, as on those of the Vine, we call them Down.

5. §. But sometimes they are Broached out, from the bottom to the top, reciprocally on every side, in some resemblance to a Stage Horns, as in Mullein. And sometimes they are Afrad, as upon Lavender, and some other Leaves, and especially those of Wild Olives, wherein every Hair rising in one round entire Buds a little way above the surface of the Leaf, is then aparted, Star-like, into several, four, five or six Points, all standing at right Angles with the said perpendicular Buds.

6. §. The Uses of Hairs are for Distinction and Protection. That of Distinction is but secondary, the Leaves being grown to a considerable size. That of Protection is the prime, for which they were originally form’d together with the Leaves themselves, and whole service they enjoy in their Infant-state: For the Hairs being then in form of a Down, always very thick set, thus, give that Protection to the Leaves, which their exceeding tenderness then requires; so that they seem to be vested with a Coat of Prize, or to be kept warm, like young and dainty Chickens, in Wool.

7. §. Globules are seen upon Orach, both Garden and Wild; and yet more plainly on Mercury or Bonum Henricus. In these, growing almost upon the whole Plant, and being very large, they are by all taken notice of.

8. §. But strict Observation discovers, that these Globules are the natural and constant Off-spring of very many other Plants. Both these Globules, and likewise the diversity of Hairs, I find that Mr. Hook hath also observed. I take notice, that they are of two kinds; Transparent, as upon the Leaves of Hyssop, Mint, Baume, and many more White, as upon those of Germander, Sage, and others. All which, though the naked Eye will discover, yet by the help of Glasses we may observe them most distinctly. The use of these we suppose the fame, in part, with those of the Flower, whereof we shall speak.

CHAP.
Book I. of Plants.

CHAP. V.

Of the FLOWER.

Next proceed to the Flower. The general Parts whereof are most commonly three; &c. the Empalement, the Foliation, and the Attire.

2. The Empalement, whether of one or more pieces, I call that which is the utmost Part of the Flower, encompassing the other two. This is composed of the three general Parts, the Skin, the Cortical and Lignous Bodies, each Empaler (where there are divers) being as another little Leaf; as in the case of a Quince-Flower, as oft as they happen to be overgrown, is well seen. As likewise in the Primrose, with the green Flower; commonly so call'd, though by a mistake: For that which seems to be the Flower, is only the more flourishing Empalement, the Flower itself being White. But the continuation of all the three aforesaid Parts into each Empaler, is discoverable, I think, no where better than in an Artichoke, which is a true Flower, and whose Empalers are of that amplitude, as fairly to shew them all: As also, that the Original of the skin of each Empaler or Leaf is not distinct from that of the rest; but to be all one piece, laid in so many Plaits or Duplicatures, as there are Leaves, from the outermost to the inner and most Central ones.

3. The Design of the Empalement, is to be Security and Bands to the other two Parts of the Flower: To be their Security before its opening, by intercepting all extremities of Weather: Afterwards to be their Bands, and firmly to contain all their Parts in their due and most decorous posture: so that a Flower without its Empalement, would hang as uncouth and taudry, as a Lady without her Bodees.

4. Hence we have the reason why it is various, and sometimes wanting. Some Flowers have none, as Tulips; for having a fat and firm Leaf; and each Leaf likewise standing on a broad and strong Basi, they are thus sufficient to themselves. Carnations, on the contrary, have not only an Empalement, but that (for more firmitude) of one piece: For otherwise, the Foot of each Leaf being very long and slender, most of them would be apt to break out of compass: yet is the top of the Empalement indented also; that the Indentments, by being lapp'd over the Leaves before their expansion, may then protect them; and by being spread under them afterwards, may better shoulde and prop them up. And if the Feet of the Leaves be both long and very tender too, here the Empalement is numerous, though consisting of several pieces; yet those in divers Rounds, and all with a counterchangeable respect to each other (which also the Learned Sir Thomas Brown observes) as in all Knapweeds, and other Flowers; whereby, how commodious they are for both the aforesaid ends, may easily be conceiv'd; and well enough exemplified by the Scales of Ficiss, whereunto, as to their position, they have not an unapt resemblance.
5. 6. THE FOLIATION also, is of the same substantial nature with the green Leaf; the Membrance, Pulp, and Fibres whereof, being, as there, so here, but the continuation of the Skin, the Cortical and Lignous Bodies.

6. 6. The Foulds of the Flower or Foliation are various, as those of the green Leaf; but some of them different. The molt general are, First, The Clof-Couch, as in Roses, and many other double Flowers. Then the Concave-Couch, as in Blattaria flore albo. Next the Plait, as in some of the Leaves of Pears-Blooms, in the Flowers of Coriander, &c. which is either fingle, as in those nam'd; or double, as in Blew-Bottle, Jacea, and more of that rank. Next, the Couch, and Plait together in the same Flower, as in Marigolds, Daffies, and all others of an agreeing form: where the first apparent Fould or Conformity of the Leaves is in Couch, but the Leaves being erect, each likewise may be seen to lie in a double Plait within itself. Then the Rowel, as in the Flowers of Ladies-Bower, the broad top of each Leaf being by a double Rowel fold'd up inwardly. Next, the Spire, which is the beginning of a Rowel; and may be seen in the Flowers of Mallow, and others. Lastly, the Plait and Spire together, where the Parts analogous to the Foliation, is of one piece, the Plaits being here laid, and so carry'd on by Spiral Lines to the top of the Flower, as is in divers, and I think, in Convolvulus Doronicus folio, more elegantly seen. These and other Foulds, See in the Figures belonging to the Second Part of the Fourth Book. The reason of all which varieties, a comparative consideration of the several Parts of the Flower may suggest. I have only mention, That no Flower, that I find, hath a Back-Rowel, as hath the green Leaf. For two Reasons; because its Leaves have not their Fibres standing out much on their Backside, as the green Leaves have; and because of its Attire, which it ever embosomes, and cannot so well do it by a Back-Rowel.

7. 6. The usual Protections of Flowers by the Precedents are expressive'd, so Green Leaves and Empalmations. Some have another more peculiar, that is a double Veil; as the Spring-Crocus. For having no Empalmation, and starting up early out of the Mould, even before its Green Leaves, and that upon the first opening of the Spring; left it should thus be quite barbed, 'tis born twath'd up in a double Blanket, or with a pair of Sheets upon its Back.

8. 6. The Leaves of divers Flowers at their Bases have a hairy Tuft; by which Tufts the Concave of the Empalament is fill'd up. That being very choice and tender, they may thus be kept in a gentle and constant Warmth, as most convenient for them.

9. 6. The Leaves of the Flower, though they are not hairy all over, yet in some particular parts they are often set with a fine Downy Velvet; that, being by their shape and posture in those parts contiguous to their delicate and tender Attires, they may thus give it a more soft and warmer touch. Thus in the Flower of Ladies-Bower, those parts of its Leaves which rowl inward, and lie contiguous to the Attire, are Downy; whereas the other Parts are smooth or bald. So the Flowers of Peaf, Spanifh Brown, Toad-Flax, and many others, where contiguous to their Attires, are deck'd with the like Hairy Velvet.
Book I.

of Plants.

10. 8. As upon the Green Leaves, so upon the Flowers are Globules sometimes seen; as upon the backside of that of Emula. On none more plainly than that kind of glatteria with the white Flower, where they are all transparent, and growing both on the Stalk, and Leaves of the Flower, each sheathing likewise its Peduncle whereon it is eroded.

11. 6. The use of the Flower, or the Foliation whereof we now speak, (that is, as to its private service) is for the protection of the Attire; This, as its under, and the Empalements as its upper Garments. As likewise of the Fruit: The necessity of which Service, in some Cases, by the different situation of the Flower and Fruit, with respect to each other, is evident; Apples, Pears, and several other Fruits, standing behind or under the Flower; but Cherries, Apricots, and divers others, within it. For these, being of a very tender and pulpy Body, and withal putting forth with the colder part of the Spring; could not weather it out against the Variations and Extremities of the Air, (as those of a more solid Parenchyma can,) except lodged up within their Flowers.

12. 8. And as the Flower is serviceable to the safety of the Fruit, so is it to its growth; for which purpose, as there is a Flower, so that Flower is greater or less, according as the nature of the Fruit to which it belongs, and the plenty of the Sap by which the Fruit is fed, doth require. Thus, where the young Fruit is of a tender Substance and the ascent of the Sap less copious, were there here no Flower to promote the said ascent thereof into the Fruit (in the manner as is effected by the Green Leaves) it must needs pine and die, or prove less kindly. On the contrary, should the Flower be over-large, it would not only promote the ascent of the Sap up to the Fruit, but being as yet over-proportionate to it, would likewise itself exhaust the same Sap, as fast as ascendent; like a greedy Nurse, that prepares the Meat for her Child, and then eats it up herself. Thus we see Apples and Pears, with a Flower of a moderate Size; like their Body, of a middle Constitution, and their Sap, of a middle quantity: But Quinces, being more solid, besides that they have as great a Flower, the Impalers of their Flower also thrive so far as to become handson Leaves; continuing also after the Flower is fallen, firm and verdant a great while; so long, till the Fruit be able to provide for it itself. On the other hand, Plums being more tender and Sappy than Apples and Pears, besides that their Impalers are much alike, their Flower is less; and Gooseberries and Currents, which are still more Pulpous, and the course of the Sap towards them more free, have yet a Flower far less. And Grapes, whose Sap is still of quicker Ascend, have scarce any Flower at all; only some small resemblance thereof, serving just upon the setting of the Fruit, and no longer.

13. 6. THE ATTIRE, I find to be of two kinds, Seminiforme, and Florid. That which I call Seminiforme, is made up of two general Parts, ChIVE and SEMETS, one upon each Chive. These SEMETS (as I take leave to call them) have the appearance, especially in many Flowers, of so many little seeds: but are quite another kind of Body. For, upon enquiry, we find, that these SEMETS, though they seem to
be solid, and for some time after their first formation, are entire; yet are they really hollow; and their side, or sides, which were at first entire, at length crack afunder: And that moreover the Conca
ces of each Semen is not a mere vacuity, but fill'd up with a number of minute
Particles, in form of a Powder. Which, though common to all Semens,
yet in some, and particularly those of a Tulip or a Lily, being larger,
is more distinctly observable.

14. §. These Semens are sometimes fastned so, as to stand erect
above their Chive, as those of Lark-beed. Sometimes, and I think usu-
ally, so as to hang a little down by the middle, in the manner and figure
of a Kidney; as in Marshalls. Their Cleft or Crack is sometimes single,
but for the most part double: At these Clefts it is that they disburse
their Powder; which as they start out, and stand between the two
Lips of each Cleft, have some resemblance to the common Sculpture
of a Pomegranate with its Seeds looking out at the Cleft of its Rind.
This must be observ'd when the Clefts are recently made, which usu-
ally is before the expansion of the Flower.

15. §. The Particles of these Powders, though like those of
Meal or other Duff, they appear not easily to have any regular shape;
yet upon strict observation, especially with the assistance of an indi-
ferent Glass, it doth appear, That they are a Congeries, usually, of so
many perfect Globes or Globules; Sometimes of other Figures, but
always regular. That which obserues their Figure is their being so
small: In Dogs-Mercury, Borage, and very many more Plants, they
are extremely so. In Marshalls, and some others, more fairly visible.

16. §. Some of these Powders, are yellow, as in Dogs-Mercury,
Goats-Rue, &c. and some of other Colours: But most of them I
think are white; and those of yellow Henbane very elegant; the dis-
bursed Powders whereof, to the naked eye, are white as snow; but each
Globe, through a Glass, transparent as Crystal; which is not a
fallacy from the Glass, but what we see in all transparent Bodies what-
soever, lying in a Powder or small Particles together The Parts of
this Attire, fee in Tab. 4. But especially, in the Figures belonging
to the Second Part of the Fourth Book.

17. §. The Florid Attire, is commonly known by the blind
and rude Name of Thrum; as in the Flowers of Marigold, Tanfie, &c.
How in adequate its imposition is, observation will determine. For the
several Thrums or rather Suits, whereof the Attire is made up, how-
ever else they may differ in various Flowers, in this agree, that they
are ever consistant of more than one, sometimes of Two, and for
the most part of Three Pieces ( for which I call them Suits ) and each
Piece of a different, but agreeable and comely form.

18. §. The outer Part of every Suit, is its Floret: whose Body
or Tube is divided at the top ( like that of the Conspic ) into five
different Leaves. So that a Floret, is the Epitome of a Flower: and
is all the Flower that many Plants, as Mugwort, Tanfie, and others,
have. What the Learned Sir Thomas Brown observeth of the
number Five, as to the Leaves of the Flower, is still more universally
holding in thee of the Floret.

19. §. Upon the Expansion of the Floret; the next Part of the
Suit is from within its Tube brought to light, which we may ( with re-
spect to that within it ) call the Sheath. For this also, like the Floret,
is a Concave Body; in its shape very well resembling the Fritulous Pouches of Wake-Robin, or of Dragon.

20. §. The Sheath, after some time, dividing at the top, from within its Concave the Third and innermost part of the Skirt, i.e. the Blade advanceth and displayes it self. This Part is not hollow, as the other two, but solid; yet at its Point, is commonly, divided into two halves.

21. §. About the said Point especially, there appears, Globulets, which are of the same nature with those of a Semen, though not so copious. So that all Flowers have their Powders or Globulets. The whole Attire may in After Per, Blew-bottle, &c. where the Skirts are large, be plainly observed without a Glass. The Parts of this Attire, See in Tab. 4. But especially in the Figures belonging to the Second Part of the Fourth Book.

22. §. The use of the Attire, how contemptibly soever we may look upon it, is certainly great. And though for our own use we value the Leaves of the Flower, or the Foliation, most; yet of all the three Parts, this in some respects is the choicer, as for whole fake and service the other two are made. The use hereof, as to Ornament and Distinction, is unquestionable; but is not all. As for Distinction, though, by the help of Glasses, we may make it to extend far, yet in a paffant view, which is all we usuallly make, we cannot so well. As for Ornament, and particularly in reference to the Semen, we may ask, If for that meerly these were meant, then why should they be so made as to break open, or to contain any thing within them? Since their Beauty would be as good if they were not hollow; and is better before they crack and burst open, than afterwards.

23. §. Other uses hereof therefore we must acknowledge, and may observe. One is, for food; for Ornament and Distinction to us, and for Food to other Animals. I will not say, but that it may serve even to thee for Distinction too, that they may be able to know one Plant from another, and in their flight or progresse fettle where they like best: and that therefore the varieties of these small parts are many, and well observed by them, which we take no notice of. Yet the crack out of Food is but in order to enjoy it: Which, that it is provided for a vast number of little Animals in the Attires of all Flowers, observation perforce we to believe. For why else are they evermore here found? Go from one Flower to another, great and small; you shall meet with none untaken up with these Guests. In some, and particularly the Sun-Flower, where the parts of the Attire, and the Animals for which they provide, are larger, the matter is more visible. We must not think, that God Almighty hath left any of the whole Family of his Creatures unprovided for; but as the Great Master, some where or other carveth out to all and that for a great number of these little Folk, He hath stored up their peculiar provisions in the Attires of Flowers; each Flower thus becoming their Lodging and their Dining-Room, both in one.

24. §. Wherein the particular parts of the Attire may be more distinctly servicable, this to one Animal, and that to another, I cannot say: Or, to the same Animal, as a Bee, whether this for the Honey, another for their Bread, a third for the Wax: Or whether all only faults...
from hence some "juice; or some may not also carry some of the Parts, as of the Globules, wholly away.

25. Or lastly, what may be the Primary and Private Use of the Attire (for even this above said, though great, yet is but Secondary) I now determine not.

CHAP. VI.

Of the FRUIT.

The general composition of all Fruits is one, that is, their Essential and truly Vital Parts, are in all the same, and but the continuation of those which in the other Parts of a Plant, we have already observed. Yet because by the different Constitutions and Tinctures of these Parts, divers considerably different Fruits result; I shall therefore take a particular view of the more known and principal of them, * namely, Apples, Pears, Plums, Nuts and Berries.

2. §. AN APPLE, if cut transverse, appears constituted of four distinct Parts, the Piling, the Parenchyma, Branchery, and Coarce. The Pilling is only the spreading and dilatation of the Skin, or utmost part of the Barque in the Branch. The Parenchyma, when full ripe, is a tender delicate Meat. Yet as the Pilling is but the Continuation of the utmost part of the Barque; so is this, but the continuance and ampliation, or (as I may call it) the swelth and superabundance of the Inner Part thereof; which upon observation of a young and Infant-Apple especially, is evident. Thus we see the Pith, which is often tough; in many Roots, as Parsnips, Turneps, &c. is tender and edible. So here, the Parenchyma, though originally no more than the Barque, yet the copiousness and purity of its Sap being likewise effectual to the largeness and fineness of its growth, it thus becomes a soft and tender meat. The Branchery is nothing else but the Ramifications of the Lignous Body throughout all the parts of the Parenchyma; the greater Branches being likewise by the Infolations of the leafs (as in the Leaf) united together. The main Branches are usually Twenty: Ten are spread and distributed through the Parenchyma, most of them enarching themselves towards the Cork or Stool of the Flower: The other Ten, running from the Stalk, in a direct Line, at last meet the former at the said Cork, and are there occluded with them. Of these latter, five are originated from one; which running along the Center of the Stalk, and part of the Parenchyma of the Fruit, is therein at last divided. To these the Coats of the Kernels are fastened. So that whereas most of these Branches were originally extended even beyond the Fruit, and infreted into the Flower for the due growth there-
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of the Flower, they full grow clofer, and there at last gather

(almost) into the firmeude of a Plum-flone it self. Within this lies

the Acetary; 'tis allways four, and by the bounding of the Calamary

of a Globular Figure. 'Tis a simple Body, having neither any of the

Lignow branched in it, nor any Calculous Knots. It is of the same sub-

stantial nature with the outer Parenchyma; but whether it be abso-

lutely one withit, or be derived immediately from the Pith, my En-

quiries yet made, determine nor.

4. §. The Original of the Calamary I feem to have neglected. But whereof we may here beft say, that whereas all the other Parts are Ef-

fential and truly Vital, the Calamary is not: but that the several Knots

whereof it consists, are only so many meer Conveions or Precipitations

out of the Sap, as in Urines, Wines, and other Liquors, we often see.

And that the Precipitation is made by the mixture and re-action of the Timitures of the Lignous and Cortical Bodies upon each other:

Even as all Vegetable Nutrition or Fixation of Parts is alfo made by the joint efficiency of the two fame Timitures, as hath been faid. Hence

we find, that as the Acetary hath no Branches of the Lignous Body, fo

neither hath it any Knots. Hence likewise it is, that we have so dif-

ferent and contrary a talt in the Parenchyma beyond the Calamary, from

that in the Acetary: For whereas this is four, that, wherein the said

Precipitations are made, is sweet; being much alike efrect to what we find

in mixing of Corals, &c with Vinegar or other acid Liquors. The

Parts of a Pear, See in Tab. 4. But efpecially in the Figures belonging
to the Third Part of the Fourth Book.
5. §. IN A PLUM (to which the Cherry, Apricot, Peach, Walnut, &c. ought to be refer'd) there are four distinct Parts, the Filling, the Parenchyma, Branchery and Stone. The Filling and Parenchyma are, as to their Original, with those of an Apple or Pear, both alike. As likewise the Branchery; but differently ramified. In Plums (I suppose all) there are five main Out-Branches, which run along the Surface of the Stone from the Bases to the point thereof, four of them by one Ridge, and one by the other opposite to it. In an Apricot there is the same number, but the single Branch runs not upon the Surface, but through the Body of the Stone. There are likewise two or three smaller Branches, which run in like manner under the other Ridge for some space, and then advancing into the Parenchyma, therein disperse themselves: These latter sort in Peaches are numerous throughout.

6. §. But notwithstanding the different disposition of the Branches of the Fruit aforefaid; yet is there one Branch disposed in one and the same manner in them all. The entrance hereof into the Stone is at its Basis; from whence running through its Body, and still inclining or arching it itself towards its Concave, it is at last, about its Cone, there-into emergent, where the Coats of the Seed are appendent to it. Of the Seed-branch 'tis therefore observable that after its entrance into the Fruit, it is always prolonged therein to a considerable length; as is seen not only in Apples, &c. where the Seed stands a good distance from the Stalk; but in Plums likewise, where it stands very near it; in that here the Seed-Branch, as is said, never strikes through the Stone into the Coats of the Seed directly, but runs through a Channel cut in the Stone, till it cliues, near the Cone, into the Concave thereof.

7. §. The Stone though it seem a simple Body, yet it is compounded of different ones. The Inner Part thereof, as it is by far the thinnest, so is it the most dense, white, smooth and simple. The Original is from the Fith; difficult, but curious to observe: For the Seed-Branch, not striking directly and immediately quite through the Bases of the Stone, but in the manner as is above described, carries a considerable Part of the Fith, now gather'd round about it, as its Parenchyma, along with it self; which upon its entrance into the concave of the Stone about its farther end, is there in part spread all over it, as the Lining thereof. The outer and very much thicker Part, consists partly of the like Precipitations or concrete Particles, as in a Pear's being gathered here much more closely, not only to a Contiguity, but a Coalition into one entire Stone; as we see in Pears themselves, especially towards the Cork, they gather into the like Stomines; or as a Stone, Mineral, or Animal, is oftentimes the product of accumulated Gravel. But as the Parenchyma is mixed with the Concretions in the Calcareous, so is it also, though not visibly, with that in the Stone, the ground of the Stone being indeed a perfect Parenchyma; but by the said Concretions so far alter'd, as to become dry, hard and undistinguishable from them. All which Particulars, are observable only in the several degrees of Growth in the young Fruit. And are represented in Tab. 4. But especially by the several Figures belonging to the Third and Fourth Parts of the Fourth Book.
8. 9. IN A NUT (to which an Akern is analogous) there are three general Parts, the Cap, Shell, and Pith. The Cap is constituted of a Pilling and Parenchyma, derived from the Barques; and Ramulets from the Lignous Body of the Branch. The Shell likewise is not one simple Body, but compounded. The Superficial Part thereof is originated from the Pilling or Skin of the Cap, from the inside whereof it is, in a Duplicate, produced and spread over the Shell. Which, if you look at the Baffs of the Shell, is farther evident; for that being continuous with the Parenchyma of the Cap, without the interpoZure of the Skin, the said superficial Part is there wanting. The thicker and inner Part of the Shell consists of the same Parenchyma as that of the Cap, with a Congeries of Precipitations filled up, as in a Stone. And as the Lignous Body is branched in a Stone, so, with some difference, in a Shell. The outer Branches or Ramulets are numerous, each issuing out of the Parenchyma of the Cap, and entering the Shell at the Circumference of its Baffs, and so running betwixt its superficial and inner Parts towards the Cone; round about. The Inner or Seed-Branch is single, entering in, as do the other, at the Baffs of the Shell, but at the Center thereof; from whence it runs, not through the Shell, as in Plants through the Stone; but through the Pith, as far as the Cone, where the Coats of the seed hang appendent to it. The Pith whether derived from the same part both in name and nature in the Branch and Stalk; or from the Cortical Body, I yet determine not. The Parts of a Nut, See in the Figures belonging to the Third Part of the Fourth Book.

9. 9. A BERRY, as a Gooseberry (to which Corinthi, Grapes Hips, &c. are to be referred) consists, besides the Seed, of the three general Parts, Pilling, Parenchyma and Branchery. The Pilling is originated as in the foregoing Fruits. The Parenchyma is double, as likewise in some other Berries. The outer is commonly, together with the Pilling, call'd the Skin, and is that part we spit out, being of a four taft. Now as the Pilling is originated from the outer, so this from the inner Part of the Barques; and accordingly the Pores thereof may be observed plainly of a like shape with those both of the Cortical Body and Pith. The Inner or Pulp is of a sweet taft, and is the Part we eat: It is of a Sub stance so lax and tender, as it would seem to be only a thicker or jellified Juice; although this likewise be a true Parenchyma, something like that of an Orange or Limon, with its Pores all filled up with Liquor. The Branchery is likewise double: The Exterior runs betwixt the Pilling and Outer Parenchyma in arched Lines, from the Stalk, to the Stool of the Flower. These outer Branches, though of various number at the Stalk, yet at the Cork are usually ten principal ones; five for the five Leaves of the Flower, and five for the Attire. The Inner main Branches are two, diametrically opposite to each other, and at the Cork with the other incozulated. From these two are branched other smaller, every one having a Seed appendent to it, whose Coats it enthrance by a double Filament, one at the Baffs, the other at the Cone. They are all very white and turgent, and by a flanct cut, may be obser'ved concave; thus representing themselves analogous to so many true spermatick Vessels. The
parts of a Gooseberry. See in the Figures belonging to the Third Part of the Fourth Book.

10. §. The Uses of Fruits are for Man, (sometimes also other Animals, as are Bees and Hogs) and for the Seed. For Man, they are so variously definable, that till our Orchards and Store-Chambers, Confectioners-Stoves and Apothecaries-Shops, our Ladies Closets, their Tables or Hands are empty of them, I shall not need to enquire for what. If it be asked, how the Fruit becomes, generally above all the other Parts, so pleasant a Meat? It is partly from the Sap, the groser portion thereof being deposited in the Leaves, and so the purer hereunto referred. Partly from the Globular Figure of the Fruit. For the Sap being thus in a greater quantity herein, and in all Parts equally diffus'd, the Conceivion hereof, as in a Vessel, is with greatest advantage favoured and promoted. Wherefore all Fruits, which we eat raw, how small soever, are of a Globular Form, or thereunto approaching; and the nearer, the delicater; amongst Apples, the Pippin; amongst Pears, the Burgundian; and amongst all Fruits, the Grapes; and amongst Grapes, the roundest, are of all, the most dainty.

11. §. The visible cause of this Globular Figure, is the Flower; or the Inosculata of all the main Branches at the Stool of the Flower; and upon the fall of the Flower, the obtutines, and with Wind and Sun, as it were the feaing of their several ends: For thus the Sap entering the Fruit, being not able to effcct, either a Difunction, or a Stilling forth of the said Branches, and so to carry on their Growth in length; they must of necessity be enarch'd; and with the Parenchyma more and more expand themselves. Whereas they were they disposed and qualified otherwise, than as is said; instead of forming a Fruit within bounds, they would run out into all extravagance, and even into another little Tree or Leafy Growth.

12. §. To the Seed, the Fruit is serviceable; First, in order to its being supply'd with a due and most convenient Sap, the greater part thereof; and that which is left elaborated, being, in its passage towards the Seed, thereinto received; the Fruit doing the same office to the Seed, which the Leaves do to the Fruit; the Sap in the Fruit being, in a large comparison, as the Wine; and that for the Seed, a small part of the highest Spirit rectified from it.

13. §. So likewise for its Protection, in order to the prosperous carrying on and perfecting of its generation, and security being perfected. Which protection it gives not only to the Seminal Sap and Seed it self, but ever also to its Seed-Branch. Thus we see an Apple, besides that it is itself of ample compass, for the sake of its Seed, hath likewise its Coar: as if it were not sufficient, that the Walls of their Room are so very thick, unless also mainfcoated. In a Pear again, where the Parenchyma is of less compass than that of an Apple; to what protection this affords, that of the Calcareus is super-added. But in a Plum, where the Parenchyma is exceeding tender, and in a Peach, which hangs late, and till Autumn Fruits approach, we have not only the Rubbish of a Calcareus, but flour Stone-Walls. Within which also, not only the Seed it self, but the Seed-Branch is evermore immured. Lastly, in a Nut, where the Shell being not surrounded with a Parenchyma, that protection is wanting without, 'tis answer'd by an ample Pith.
Of the Seed, in its State of Generation.

§ the Original, to the Ultimate end and Perfection of Vegetation is the Seed. How it is the former, and in its state apt for Vegetation, hath already been seen. How the latter, and in its state of Generation, we shall now lastly enquire. In doing which, what in the other state, was either not distinctly evident, or not so apparent, or not so intelligible, will occur.

2. §. The two general Parts of the Seed are its Covers and Body. The Covers in this estate are usually Four. The outermost, we may call the Cape. 'Tis of a very various form; sometimes a Pouch, as in Nasturtium, Cochlearia; a Cod, as in all Pulte, Galega; sometimes not entire, but parted, or otherwise open, as in Sorrel, Knottgrass; with many other forms: I think alwats more heterogeneous to that of the seed, by which it differs from the proper Coat. To this the Caps of Nuts, and the Parenchymas of other Fruits are analogous.

3. §. The two next are properly the Coats. In a Bean especially, and the like; from whence, to avoid Confusion, the denomination may run common to the responding Covers of other Seeds. The Colour of the outer, is of all degrees, from White to the Blackness of Jet. Its Figure sometimes kidney'd, as in Alceus, Beben, Poppy; Triangular, as in Polygonatum, Sorrel; Spherically triangular, in Menthe, Melisse; Circular, in Lencium, Amaranthus; Globular, in Napes, Asperula; Oval, in Speculum Venetis, Trithymum; half Globe, in Coriander; that which we take for one single round Seed, being a Conjugation of two half Oval, in Anise, Fennel; Haftal, in Latoeca; Cylindrical, as, if I mistake not, in Jacobe; Pyramidal, in Geranium Althoea globifol, with many other differences. But the Perfection of one or two of the said Figures lieth in the Cape. So that, as all Lives and Proportions are in the Leaf and Flower so to all Regular Solids in the Seed; or rather in its Covers.

4. §. 'Tis sometimes glittering, as in Speculum Venetis; Rough-cast, in Cananica; Studded, in Beben, Ballattias; Favous, in Papaver, Antirrhinum, Lepidum annuum, Alceus Vesicaria, Hysteranthus, and many more, before the Seeds have lain long by; Panniced, in Phalangium Crete, Lithospermum; Ramified, in Pentaphyllum fragiferum Erechthum majus, resembling...
The Anatomy

Book I.

refembling the Fibers of the Ears of the Heart; some just quinquenervial, as in Anitum, and many more, the Lignous Body being in five main Fibers branched therein. The Figures, and Surface, of These, and other Seeds, See in the Tables belonging to the Fourth Part of the Fourth Book.

5. The Covers of not only Quince-Seeds, and those of Pijllum (more usually taken notice of) but those also of Horumnum, Nasturtium, Bruna, Camelina, Ocyrum, and divers others, have a Macilage. Which, though it be not visible when the Seeds are thoroughly dry; yet lying a while in some warm Liquor, or only on the Tongue, it swells more or less, and upon them all fairly heels it self. On that of Oucyrum it appears grayish; on the other, transparent; and on that of Nasturtium Hortense very large; even emulous of the inner Pulp surrounding a Gooseberry-Seed. The putting of Clay-seed into the Eye, may have been brought into use from this Macilage, by which alone it may become Medicinal. And thus far of the Superficies.

6. The nature of the outer Coat is also various. Membranous, Cartilaginous and Stony; the like Precipitation being sometimes made herein, as in a Stone or Shell; as in that of the Seeds of Cardamum, Lithospermum and others. The Defigment hereof, being either with respect to the Seed in its state of Generation; as where the Cafe is either wanting, or at least insufficient of itself, there for its due protection and warmth. Or, in its state of Vegetation, for the better Fermenting of its Tinctures and Sap; the Fermentations of some Seeds not well proceeding, unless they lie in their Stony Cases in the Ground, like Bottled Liquors in Sand.

7. All Seeds have their outer Covers open; either by a particular Ferumen, as in Beans, and other Pulpe, as is said; or by the breaking off of the Seed from its Peduncle or Stool, as in the case in Cucumber, Cichory; or by the entering and passage of a Branch or Branches, not only into the Concave thereof near the Cone, but also through the Cone itself; as in Shells and Stones.

8. For the sake of this aperture it is, that Akerms, Nuts, Beans, Cucumbers, and most other Seeds, are in their formation so placed, that the Radicle still standeth next to it; That So, upon Vegetation, it may have a free and ready passage into the Mould.

9. The Original of the outer Coat, though from Parts of the same sublunary nature, yet is differenty made. In a Plum, the Seed-Branch which runs, as is described, through the Stone, is not naked, but, as is said, infeved with a thin Parenchyma, which it carries from the Stalk along with it; and which, by the Ramification of the said Branch within the Stone, is, in part, dilated into a Coat. That of a Bean is from the Parenchyma of the Seed; the superficial part of which Parenchyma, upon the large peduncle of the Bean becoming a thin Cuticle, and upon the Bean it self a Cartilaginous Coat.

10. The Original of the inner Coat of the Bean is likewise from the inner part of the said Parenchyma; which first is spred into a long Cake, or that which with the Seed-Branch maketh the Peduncle of the Bean, under which Cake, there is usuallly a black part or spot; by the length of which, the inner part of the Cake is next inferted into the outer Coat, and spred all over the Concave thereof, and so becomes the inner.
Book I.

Of Plants.

11. s. Of this Inner Coat, it is very observable, That although when the Seed is grown old and dry, ’tis shrunk up, and in most Seeds, so far, as scarcely to be discern’d, yet, in its first and juvenile Constitution, it is a very Spongy and Sappy Body; and is then likewise (as the Womb in a Pregnant Animal) in proportion, very thick and bulky. In a Bean, even as one of the Lobi itself: And in a Plum or Apricot, I think I may safely say, half an hundred times thicker than afterwards, when it is dried and shrunk up, and can scarcely be distinguished from the upper Coat. Upon which Accounts it is, in this Estate a true and firm Parenchyma. The Delineation hereof, See in the Figures belonging to the Fourth Part of the Fourth Book.

12. s. In this Inner Coat in a Bean, the Lignous Body or Seed-Branch is distributed: Sometimes, as in French-Beans, throughout the whole Coat, as it is in a Leaf. In the Great Garden-Bean, upon its first entrance, it is bipartite, and so in small Branches runs along the Circumference of the Coat, all meeting and making a kind of Reticulation against the Belly of the Bean. In the same manner the main Branches in the outer Coat of a Kernel, circling themselves on both hands from their first entrance, at last meet, and mutually insculpt; as the Veins in the Kidneys of a Man or any Quadruped; Or the Carotick Arteries in the Brain.

13. s. So that all the Parts of a Vegetable, the Root, Trunk, Branch, Leaf, Flower, Fruit and Seed, are still made up of Two Substantially different Bodies.

14. s. And as every Part hath Two, so the whole Vegetable taken together, is a composition of Two only; and no more: All properly Woody Parts, Strings and Fibres, are One Body: All simple Earsners, Pills, Parenchyma’s and Pulps, and as to their Substantial Nature, Pills and Skins likewise, all but One Body: the several Parts of a Vegetable all differing from each other, only by the various Proportions and Mixtures, and varied Form and Structure of these Two Bodies. What from these two General Observations might reasonably be inferred, I shall not now mention.

15. s. The Fourth or Innermost Cover we may call the Secondine. TheFight of which, by cutting off the Coats of an Infant-Bean, at the Cone thereof, in very thin Slices, and with great Caution, may be obtain’d. While unbroken, ’tis transparent; being torn and taken off, it gathers up into the likeness of a Jelly, or that we call the Tredle of an Egg, when raw-boy’d. This Membrane in larger or elder Beans, is not to be found distinct. But (as far as our Enquiries yet discover) it may in most other Seeds, even full grown, be distinctly seen; as in those of Cucumber, Colocynthis, Burdock, Carthamus, Gromwell, Endive, Mallows, &c. ’Tis usually so very thin, as in the above-nam’d, as Tab. 4. f. 16. very difficultly to be discover’d. But in some Kernels, as of Apricots, ’tis very thick; and most remarkably such, in some other Seeds. That all these have the Analogy of one and the same Cover, which I call the Secondine, is most probably argu’d from their unlike Natures; being all of them plain simple Membranes, with not the least Fibre of the Lignous Body, or Seed-Branch, visibly distributed in them: As also from their Texture, which is in all of them more close. See this Part in Tab. 4. As also amongst the Figures belonging to the Fourth Part of the Fourth Book.

16. s.
16. §. The Concave of this Membrane is filled with a most transparent Liquor, out of which the Seed is formed; as in cutting a petit and Infant-Beam, may be seen; and yet better in a young Walnut. In Beans I have observed it to turn, upon boiling, into a tender white Coagulum.

17. §. Through this Membrane, the Lignous Body or Seed-Branches distributed in the inner Coat, at last shoot downright two slender Fibres, like two Needle-Strings, one into each Lobe of the Bean.

Tab. 4. f. 18. The places where the said Fibres shoot into the Lobes, are near the Basis of the Radicle; and by their Blackness well enough remarked: but the Fibres themselves are so very small, as scarcely to be discern'd. Yet in a Lupine, of the larger kind, both the places where the Needle-Fibres shoot into the Lobes (which here from the base of the Radicle is more remote) and the Fibres themselves, are fairly visible. For the Seed-Branch, upon its entrance into the Coat of the Lupine, is presently divided into two main Branches; and those two into other leaves; whereas some underly, others aloft; run along the Coat, and towards its other end meet and are insculp't: where about, two opposite, shallow, round, and most minute Carotites, answerable to two Specks of a Cartilaginous globs, one in either Lobe, may be observed; which Specks are the ends of the said Needle-Fibres, upon the ripening of the Seed there broken off. These Fibres from the Superficies of each Lobe, defend a little way directly down: presently, each is divided into two Branches, one distributed into the Lobes, the other into the Radicle and Plane, in the manner as in the First Chapter is described. And thus far the History. I shall now only with a brief account of the Generation of the Seed, as hereupon dependent, conclude this Discourse.

An Account of the Generation of the Seed.

18. §. LET US say then, that the Sap having in the Root, Trunk and Leaves, passed divers Conceans and Separations, in the manner as they are said to be perform'd therein; 'tis now at last, in some good maturity, advanced towards the Seed.

19. §. The more copious and cruder part hereof is again separated by a free reception into the Fruits, or other Parts analogous to it; being either sufficiently ample to contain it; or at least laxe enough for its transpiration, and so its due discharge. The more Essential part is into the Seed-Branch or Branches entwined. Which, because they are evermore of a very considerable length, and of a Constitution very fine, the said Sap thus becomes in its Current therein as in the Spermatic Vessels, still more mature.

20. §. In this mature estate, from the Seed-Branch into the Coats of the Seed, as into the Womb, 'tis next delivered up. The meaner part hereof again, to the Outer, as Aliment good enough, is supplied. The finer part is transmitted to the Inner; which being, as is said, a Parenchymous and more spacious Body, the Sap therefore is not herein, as in the Outer, a meer Aliment; but in order to its being, by Fermentation, farther prepared.

21. §. Yet the Outer Coat, being on the contrary hard and dense; for that reason, as it admitteth not the Fermentation of the Sap so well within it self; so doth it the more promote and favour it in the Inner; being Bounds both to it and its Sap; and also quickeneth the process of the whole Work in the formation of the Seed.
22. §. Nor doth the Outer Coat, for the same reason, more promote, than declare the purity of the Sap now contained in the Inner: For being more hard and dense, and so not perspirable, must needs suppose the Parts of the Sap encompassed by it, since thus incapable of any evacuation, to be therefore all so choice, as not to need it.

23. §. The Sap being thus prepared in the Inner Coat, as a Liquor now apt to be the Substratum of the future Seed-Embryo; by fresh supplies, is thence discharged. Yet that it may not be over-copious, which, because of the laxity of the Inner Coat, from whence itissues, it might easily be: therefore, as the said Inner Coat is bounded without, by the upper Coat; so by the Secundine, is it bounded within. Through which Secundine the Sap being filtered, or, as it were, transpiring; the depositure hereof, answerable to the Colligamentum in an Egg, or to the Semen Maligne, into its Concave at last is made.

24. §. The other part of the purest Sap embofom'd in the Ramules of the Seed-Branch, runs a Circle, or some progress therein; and so becomes, as the Semen Magellanius, yet more elaborate.

25. §. Wherewith also, left its Current should be too copious or precipitant, by their co-arcture and diversication where they are inocoled, it is retarded; the noblest portion only obtaining a pass.

26. §. With this purest Sap, the said Ramules being supplied, from thence at last, the Navel-Fibres shoot (as the primitive Artery into the Colligamentum) through the Secundine into the aforesaid Liquor deposited therein.

27. §. Into which Liquor, being now hot, and its own proper Sap or Tinctures mixed therewith, it strikes it thus into a Coagulum; or of a Liquor, it becomes a Body conformable and truly Parenchymous. And the supply of the said Liquor still continued, and the shooting of the Navel-Fibres, as is above described, still carried on, the said Coagulation or Fixation is therewith likewise.

28. §. And in the Interim of the Coagulation, a gentle Fermentation being also made, the said Parenchyma or Coagulum becometh such, not of any Texture indifferently, but is thus raised (as we see Bread in Baking) into a Congerie of Bladders: For such is the Parenchyma of the whole Seed.

FINIS.
In this manner others, from the Seed-Branch into the Leaves of the Tree, are confluxed up. The recondite are excited again, to the Sinews, which are tangible: so the sinews are tributary to the Joints which being, as is said, more dense and more fibrous also, the Tree therefore is not injured. The Tree is a very strong body, to which it is being, by Nature.
THE ANATOMY OF ROOTS;

Presented to the Royal Society at several times, in the Years, 1672 & 1673.

With an Account of the VEGETATION OF ROOTS,

Grounded chiefly hereupon.

The SECOND BOOK.

By NEHEMJIH GREW M.D. Fellow of the Royal Society, and of the College of Physicians.


LONDON,

Printed by W. Rawlins, 1682.
THE ANATOMY OF ROOTS

Presented to the Royal Society by the Author,
in the Year 1761.

To the Reader.

An Account of the

DEGENERATION OF ROOTS.

By Nehemiah DREW, M.D., Fellow of the Royal Society, and of the College of Physicians.


LONDON.

Printed by N. Flesher, 1674.
TO THE
Right Honourable
WILLIAM
Lord Vi-Count BROWNCKER
THE
PRESIDENT
AND TO THE
Council and Fellows
OF THE
ROYAL SOCIETY.

MY LORD,

If the Dedication of Books were not in use; yet here, I think, I might have been a Precedent. The promotion of Phytological Science is one Part of Your Work; and 'tis You have called me to the management of this Part; for some time, have intrusted me herein; and by Your most favourable and candid acceptance of what I have performed thus far, have encouraged me hereunto: I therefore present but Your Own, into Your Hands.

The great Honour and Advantage of Your Fellowship, I first obtained, by Mediation of Dr. Wilkins, the late most Reverend Bishop of Chester, Whom I cannot name, without saying thus much of him, That He was a Per-
The Epistle Dedicatory.

son of that eminent and happy Worth, which, as it was too good, to fear envy; so is it too great, to need an Elogie.

With Him, it was, You were pleased to commit to Me, the further prosecution of this Work; the Beginnings whereof, were by Tour Order formerly made publick. Had I consulted my own Abilities altogether, I should scarcely have ventured upon it; seeing very little, for which I could think well of myself, saving, That I had learned, upon good grounds, to think of You with greatest Honour. But I also considered, That to insist hereon too much, might be a reflection upon Your Judgments, who had thought fit to make choice of Me. And, That You were not more the Patrons of Wit, than of Industry; and of All, who shall endeavour to find out, or to confirm the Truth of Things. Wherein, I looked upon Nature, as a Treasure so infinitely full; that as all Men together, cannot exhaust it; so no Man, but may find out somewhat therein, if he be resoluted to Try.

In compliance therefore with Your Commands, I have hereunto devoted a very considerable part of my Time. These adding force to my own Desires, of being somewhat instrumental to the Improvement of Medicinal, and other wholesome Knowledge: if peradventure, as we increase herein, we may become better, and more happy. As to which Improvement, though I could not hope; yet, I would not despair. I have already prepared the Soil, and made some Plantation: what remaineth behind, and the Vintage of the whole, will depend much upon the continued Influence of Your Beams: for how unpromising ever the Stock may be; yet the Fruit cannot but be somewhat matured, upon which Your are pleased to shine. I am also confident, that the fame Nobility and Goodness, which accept the endeavours, will likewise pardon the faults, of,

My Lord,

Your Lordships most humbly
and most sincerely
devoted Servant

Nehemiah Grew.

September 1,
1673.
THE

CONTENTS.

The FIRST PART.

CHAP. I.

Of the Original of Roots, § 1, 2, 3. Of their Figures, 4, to the end.

CHAP. II.

Of the Skin. Its external Accidents, and Original, § 1, 2. Compounding Parts. Whereof the one Parenchyma, 3. The other Lignous, 4, to the end.

CHAP. III.

Of the Barque. Its Original and external Accidents, § 1. Size, 2. Compounding Parts : Whereof the one Parenchyma, 3. The Bladders of the Parenchyma, 4, 5, 6. The Diametral Portions, 7, to 11. The other Part, Lignous, consisting of long Pipes or Vessels, 12, to 17. Of several Kinds, 18, to 23. In different Proportion, 24, 25. And in different and elegant Position, 26, to the end.

CHAP. IV.

The Contents.

CHAP. V.


The SECOND PART.

Theology, the Beginning and End of Philosophy, § 1, to 6. The Divine Wisdom seen in the Growth of Plants, 7. If we observe, How the Ground is Prepared, 8, to 14. How the Sap is Imbibed, and Distributed to the several Parts of the Root, 15, to 28. How the several Parts are Nourished and Formed, 29, to 35. How the several Parts receive their respective Situations, 36, to 40. How Roots receive their different Size and Shape, 41, to 47. How Roots receive their different Motions, 48, to 53. How Roots are differently Aged, 54, 55, 56. How the Liquors and other Contents of the several Parts are made 57 to 62. How the Odors of Roots are made, 63. How their Colours, 65, to 67. How their Tastes, 68, to the end.
THE ANATOMY OF ROOTS; PROSECUTED WITH THE BARE EYE, AND WITH THE MICROSCOPE.

PART I.

OF THE ORIGINAL, FIGURES, MOTIONS, AND AGES OF ROOTS.

BEING TO speak of Roots, it is requisite, for our better understanding of what follows, that some things, as to their Original, Figures, Motions and Ages, be premised.

1. It. Roots, taken altogether, have a Three-fold Original. Either from the Radicle: as all Roots which come of the Seed: or from the Trunk or Caulis, above ground: as in Strawberry, Chamomile, and many other Creepers: or from the Trunk or Caulis, after it is sunk under ground: as in Primrose, Bifort, and many others: and presently shall be shewed how.

2. In the Growth of a Bud, and of a Trunk-Root, there is this observable difference: That the former, carries along with it, some portion of every Part in the Trunk or Stalk; whereas it is a Compendium. The latter, always shoots forth, by making a Rupture in the Barque, which it leaves behind, and proceeds only from the inner part of the Stalk.
The Anatomy

Book II.

3. §. As also, That in a Bud, the Ligneous Part is spread abroad, so as to encompass a Pith. Whereas in a Trunk-Root, it makes a solid Thread standing in the Center. Which is the Cause of its descending into the Ground: as is already, in the First Book, and shall in this be further shewed.

4. §. ROOTS are generally distinguished, as to their Figures, in being more Enteric, as is that of Liquiritia; or Parted, as of St. Johnswort. Parted or Forked, either at the Bottom, as most Roots; or at the Top, as Dandelion, and some others. A thing very odd, and unintelligible, without the knowledge of the Motions of Roots; whereby presently.

5. §. Parted, again, are either Ramified, as that of Cumfrey; or Manifold, as of Crowfoot: both are Parted; but the former, by the subdivision of greater Branches, into lesser; and considerable Strings, have all their distinct original from one Head. Some are Straight, as a Radish; others Crooked, as Bajfors. Smooth, as Baglais; or Stringy, all round about, as Columbine. And to Carnations, this seems to be peculiar. That sometimes many of the Strings run parallel with the Wood of the great Root, through the Barque, or betwixt the Wood and the Barque.

6. §. Again, some are Thick, as Rhubarb; Slender, as the Vine. Long, as Fennel; Short, as a Turnep: which are distinct from Great and Little; in that these, are so called with respect to several Roots; these, with respect to the several Dimensions of one. Short, are Stubb'd, as Iris tuberosa; or Round, as Dractium. Round are Tubercous; or Simply Knobbled, as Rape-Crowfoot; Bulbous, that is Scaled, as some Lilies; or Shell'd, as an Onion. Where note, That all Bulbous Roots, are, as it were, Hermaphrodites, or Root and Trunk both together: for the Strings only, are absolute Roots; the Bulb, actually containing those Parts, which springing up, make the Leaves or Body; and is, as it were, a Great Bud under ground.

7. §. Roots, again, are Even or Uneven; Even, are Cylindrical, as Eryngo; or Pyramidal, as Barage. Growing smaller Downwards, as do most; or Upwards, as Shirets. Uneven, are Pitted, as Potato's, where the Eyes or Buds of the future Trunks lie inward; or Knotted, as Jerufalem-Artichoke, where they stand out. These Differences, are also Comounded: so some Roots are both Entire and Smooth, as Peony; others Entire, but Stringy, as Clary: that is, neither Ramified, nor yet Brufly, or divided at the Top into several small Strings; but a Single Root surrounded with many Harry Threads. Some both Plain in some parts, and Knobbled in others, as Filipendula, Lilium non bulbosum, and others.

8. §. Some also have two or more Roots; and those of one Kind: of which, some are distinctly fastened to the bottom of the Stalk, as in Dogflove: some stand one under another, so as only the uppermost is fasten'd to the Stalk, as in Dragon, Cress, and others. And there are some, which have not only two Roots, at the same time; but those of two distinct Kinds, as in Bajfort; one of them, a slender ftrait Cylindrick and horizontal Root; the other large and crooked, and bred of the Descending Trunk; as in speaking next of the Motions of Roots, will be understood, how. All which, with other Differences
9. THE MOTIONS of Roots are also divers. Sometimes Level, as are those of Hops, Ammi, Cinquefoyle; and all such as properly Creep. Sometimes Perpendicular, as that of Parsnip: Which is different from Straightness; for some Straight Roots, are Level. Both of them are either Shallow or Deep: some run Level; and near the Turf, as Woodbind, Wild Anemone; others lower, as Dogs-Grafs. Some strike down, but a little way, as Stramonium; others grow deep, as Horfe-Radifi: Which is different from being Long; for many long Roots, are Level, as Hops.

11. Some again Defcend, as Tulips, and other Bulbous Roots, which differs from growing only Downwards; in that here, the Head of the Root is Immoveable; but in Defcending, the whole Root obtaineth different Places, running deeper, time after time, into the Earth. Some also Ascend, sometimes, and in some part, appearing above ground, as Turnips.

11. These Motions are also Compounded; both in respect of the several Parts of the Root, and of several Times. So the main Root of Primrose, is Level; the Strings are Perpendicular. The Roots of most Seedlings, grow Downward and Upward, or shoot out in length at both Ends, at the same time. Thofe of Biffort, Iris, and some others, grow, in part, both Downward and Upward at several times: Whence it is, that Biffort is Crooked, with some refemblance to an S, according to its Name; And that some Parts of Iris-Root appear oftentimes above the ground.

12. There is alfo another Motion, in some Roots, not heed'd; and that is Contortion: whereby, without being moved out of their Place, they are Writhe or Twifted; as a piece of Cloath is, when the Water is wrung out of it; as in Cardamum, Sucebus, and others: whether always I cannot fay. This Motion cannot be noted, without tripping off the Barque; whereby the Veftels may be fecn, formerly, to make two or three Circumvolutions. This Motion seems to be governed by the winding of the Stalk; and therefore to begin at the Head, and terminate at the Poynt or lower End of the Root, which is immovable.

13. BUT ABOVE all the Motions of Roots, not obferved, the moft remarkable is that of DESCENT. Which, although it hath been noted, by fome Botanicks, of Bulbous Roots; yet of thefe only: Whereas it is the Property, of a great many more; and thofe, of very different Kinds; probably, of the far greater number of Perennial Roots of Hops; as of Ammi, Rape-Crowfoot, Valerian, Brownwort, Bearfoot, Tanfis, Lycitis, Sampier, Primrofe; Ammi, Avenus; Wood-forfel, Iris, and others. Of all which Plants, it is very obfervable, that their Root, is annually renewed, or repaired, out of the Trunk or Stalk, it felf. That is to fay, The Basis of the Stalk continually, and by inefitable Degrees, defcending below the Surface of the Earth, and hiding it felf therein: ifthus, both in Nature, Place, and Office chang'd into a true Root. Which Root, by the continuance of the said Motion.
Motion of the Stalk, also Descends; and so, according to the durableness of its Substance, becomes a shorter or longer Root; the Elder or Lower Portion thereof, Rotting off, by the same Degrees with the Generation of the Upper, out of the Stalk. So in Brownworts, the Bases of the Stalk sinking down by degrees, till it lies under Ground, becomes the upper part of the Root; and continually still to sink, the next year, becomes the lower Part; and the next after that, rots away; a new Addition being still yearly made out of the Stalk, as the elder Parts yearly rot away. So in Dragon, Crowes, and the like, where the Root is double; the Bases of the Stalk, this year; the next, becomes the Upper-Root; after that, the Lower-Root; and at the length dies and is consum'd.

14. §. The Demonstration hereof, is taken, more evidently, from some Roots, than from others; as from the Level and Knobed Roots of Wood-forrul, Primrose, &c. For the Leaves of those Plants rotting off successively, and the Bases of those Leaves gradually descending into the Ground; each Base is thus nourished with a more copious Sap, and so swelled into so many thick Knots. It may likewise be gather'd in some, from the like Position of the Vessels or Woody Parts, in the Root, as in the Trunk, as in Bares-foot. As also, from the Root of the Iris Tuberosa: where, although the Leaves fall off close to the Surface of the Stalk; yet after that is sunk down, and swelled into a Root, the Seats of the perilled Leaves, and the Ends of the Vessels belonging to them, are not so levelly visible as whereby the Root is wrought, as it were, with several Stems and Prick-Lines; the Stems flowing the setting on of the Leaves; and the Pricks, the Terminations or broken Ends of the Vessels: which ends, are still more apparent, upon the strifling off the Barque. I considered likewise, that as among Animals, there are many, which are not bred of Eggs, immediately; but are Transformed, one Animal into another: So, it is more than probable, That among Plants, there are not a few Instances of the like Transformations: whereof, this is one.

15. §. The Cause of this Defect, so far as it is dependent on the Inward Conformation of the Root, I shall shew in the following Part. But the Immediate Visible one, are the String-Roots, which this kind of Trunks frequently put forth: which, descending themselves directly into the Ground, like so many Ropes, hang the Trunk after them. Hence the Tuberosous-Roots of Iris upon the rotting or fading away of the String-Roots hanging at them, sometimes a little Re-ascend. Hence also the Shape of some Roots is inverted: For whereas most are parted downwards, into several Legs; some are parted upwards into divers Necks, as Dandelion, and others. For these Roots sending forth at the top several Trunk Buds, the said Buds successively put forth new, and call their old Leaves; and continually also making their Defect, are at length formed into so many Necks, of three, four, five, or more Inches long, under Ground.

16. §. HENCE Also we understand, in what particular way, some Roots become Perennial. Some are wholly so, as those of Trees, Shrubs, and divers other woody Plants. Others, in part, or by a new Progenies of Roots, from the old Head or Body, in the room of those that die yearly, or after a certain Time, as of Lilium non bulbo-

fuses,
Book II. of Roots.

som, Jerusalem Artichoke, Potato, Dog-flower, Monkey-hood, little-Celandine, and others. In which Plants, one or more of their Roots are firm, the other spongy and superannuated; and partly, by the ravine of the Trunk, and other younger Roots, reduced to a Consumption and Death.

17. With these, Tulips, and other Bulbous-Roots comfort: For the several Onion & shells, whereof chiefly, the Bulbs consist, successively perish and shrink up into so many thin and dry skins: between which, and in their Centre, other Leaves and Shells, being successively formed, the Bulb is thus perpetuated. In the same manner the String-Roots also succeed one another annually. So that at the end of divers Years, although it be still looked upon as the same indi-vidual Root, yet it is, in truth, another, as to every particle thereof.

18. Lastly, many other Roots are perpetuated by the aforesaid Defecion of the Trunk; out of which, it is still annually Repaired, as by the gradual perishing of its lower parts, it is Diminished: as hath been said. Whence also we see the reason of the Rugged and Blunt extremities of these, and some other Roots, as of that Plant superstitiously called Devil's-bit: because the end of it seems to be bitten off. Yet doth it not appear so originally: but the lower part thereof rotting off, as the Upper descends, the living remainder, becometh flumped, or seemeth bitten. Thus far of the Original, Shapes, Motions, and Ages of Roots.

CHAP. II.

Of the SKIN.

NEXT proceed to the several Parts whereof a Root is Compounded. The outer Part of all is the Skin, which is common to all Roots. This diversly Coloured: Whiter in Skirrets; Yellow, in Dock; Red, in Potato; Brown, in Louse-t; Black, in Bugloss. Its Surface, sometimes Smooth, as in Horse-radish; Rough, as in Scorzoner. And the Skin of the several Shells of a Tulip-Root, taken up fresh, look as if they were perforated with a great many small holes. This of various Size; very Thin, in Parsnip; somewhat Thick, in Bugloss; very Thick in Iris. Sometimes it is Opacous, as in Thistle; and sometimes Transparent, as in Madder.

2. All Every Root hath successively two kinds of Skins: the one, Coësaneous with the other Parts; and hath its original from that which involveth the Parts of the Seed itself. The other, Postnate, succeeding in the room of the former, as the Root ageth; and is or-tinated from the Bark. So in Dandelion, the old Skin, looked upon about the beginning of May, seems to have been one of those several Rings.
Rings, which the precedent year composed the Cortical Body of the Root: but by the Generation of a new Ring, next the Wood, is now thrust off and shrunk up into a skin. So also in the Roots of Bunglos and Horse-Radish, as far as the Bladders in the former, and the Vessels in the latter are Radiated; the Cortical Body seems either annually or oftener, to shrink up into another new skin, as, the old ones fall off. And sometimes, perhaps, as in Asparagus, the whole body of the Perpendicular Roots, except the woody Fibre in the Centre, becomes the second skin. So that the wearing away of the old skin, succeeds the derivation of the new one; as in Descending Roots, the Conspicuous of the Lower Parts, doth the Generation of the Upper. Because the Bark swells, and grows sometimes fatter than the skin can fall off, or give way to it; therefore are the Roots of many Herbs, Barque-bound, as well as the Trunks of Trees.

3. §. This Skin is usually, if not always, compounded of two Kinds of Bodies: which also is probable of the Coincident. The one, Parenchyma, and frequently constructed of exceeding little Cells or Bladders; which in some Roots, as of Asparagus, cut traverse, and viewed through a Microscope, are plainly visible. These Bladders are of different Sizes; in Bunglos, larger; in Asparagus lef; and sometimes they coincide and disappear. But in these, and all other Roots, even where these Bladders appear not, the Parenchyma of the Skin, is of the same Substantial Nature, with that other more vivid and bulky one of the Bark: As is manifest, from its being thence Originated; and alike Conformed, as shall be seen; and not only adjacent to it, as a Glove is to the Hand; but continuous therewith, as the parts of a piece of flesh, are one with another.

4. §. Of this Parenchymous Body, the skin consists chiefly, but not wholly; there being many Lignous Vessels which are Tubularly, mixed therewith: which, though hardly by the Microscope, yet otherwise, is demonstrable. For in tearing the skin, you shall do it more easily by the length, than breadth; because, by the first way, the continuity only of the Parenchyma, is dissolved: but by the latter, both of this, and of the Vessels, these being pointed by the length of the Root: So that, as by the finalis of the Bladders of the Parenchyma, the Skin is Denser; so by these Vessels, is it Tough.

5. §. Again, if you cut a Root traverse, and let it lie by for some time, all the parts, where there are no Vessels, shrink below the surface of the cut-end; but where-ever these are pointed, there is no shrinking; which oftentimes, evidently appears also in the Skin: because the said Vessels, though, as the Bladders, they may coincide; yet they cannot visibly shorten or shrink up in length; no more than a Strand, whose fibres may yet be easily crumpled together.

6. §. Further, the Root being cut traverse, if, near the cut-end, you very gently press the side of the Root with the edge of your Nail, the Sap will thereupon arise sometimes from the Skin; in the same manner, as from any other part of the Root, where the like Vessels are pointed. And although the Sap may likewise be extruded from the Pith; and other Parts where sometimes, there are none of these Vessels; yet not without a solution of there continuity; which here doth not follow; as appears, from the disappearing of the Sap, together with the intermission
termiflion of the pressure; the said Vessels then dilating themselves by
amotion of Reclination, and so fucking up the Sap again.
7. §. Hereunto may be added the Testimony of eight; the very
Vessels themselves, in many Roots, coming under an apparent view, and
standing in the utmost surface of the Root all round about, as in that of
Liquiritia, Columbine, Scorzonera, and others. Which Experi-
ments, I have here, once for all, more particularly set down; because
I shall have occasion, hereafter, to refer to them.

CHAP. III.

Of the Barque.

EXT WITHIN the Skin lieth the Barque. Tis sometimes Yellow, as in Dock; Red, in Bistort; but usually, and in Seed-Roots, I think, always White. It is derived from the Seed itself; being but the extension or prolongation of the Parenchy-
ma of the Radicle: One of the three Organical Parts of the Seed, described in the First Chap-
ter.

2. §. It is variously Sized; sometimes very Thin, as in Jerusalem
Artichoke, Goats-beard, and in most Trees; where it also retains the
Name of a Barque or Rind. Sometimes tis more Thick, and maketh up
the far greatest portion of the Root, as in the String-Roots of Asparagus,
in Dandelion, and others. The thinnest and the thickest are all ana-
logous, and obtain the same general Uses. The degrees of its Size,
amongst all Roots, may be well reckoned about Twenty, and seen in
the following examples, se. Beet, Dropwort, Jerusalem Artichoke, Tab. 7, 8, 9.

3. §. IT IS Compound of two Bodies. The one Parenchymous; Continuous throughout; yet somewhat Pliable without a solution of its Continuity. Exceeding Porous; as appeareth from its so much shrinking up, in drying. The Perer hereof are extended much alike both by the length and breadth of the Root; therefore it shrinks up,
by both those Dimensions, more equally. And they are very Dilative,
as is also manifest from its restorableness to its former bulk again, upon
its infusion in Water: that is to say, It is a most curious and exquisitely fine wrought Sponge. Thus much the Eye and Reason may discover.

4. §. The Microscope confirms the truth hereof, and more precisely shews, That these Pores are all, in a manner, Spherical, in most Plants; and this Part, an Infinite Mass of little Cells or Bladders. The sides of none of them, are visibly pervious from one into another; but each is bounded within itself. So that the Parenchyma of the Barque, is much the same thing, as to its Conformation, which the Froth of Beer or Eggs is, as a fluid, or a piece of fine Muschet, as a fixed Body. The Sides also of these Bladders are as transparent, as those of Water 3 or the Bodies of some Insects.

6. §. But their Size is usually much smaller; and their Posture more Regular than those in Bread or Water. In all Roots they are so small, as scarcely, without the Microscope, to be discerned: yet are they of different Size, both in the same, and in divers Roots; the varieties whereof, amongst all Roots, may be reduced to about Ten or Twelve according to the Standard, in Tab. 11. Some of those in Dandelion, being of the Smallest; and in Buglos, of the Greatest. They are pointed, for the most part, at an Equal Height; and piled evenly one over another: So that, oftentimes, they visibly run in Ranks or trains, both by the length and breadth of the Roots, as in the Root of Buglos, or of Dandelion, split through the middle, may be seen. Although they are usually Spherical, yet sometimes, and in some places, they are more oblonge, as in the outward part of the Barque of Buglos. These Bladders, are sometimes best seen, after the Root, being cut transversely, hath lain by a while, to dry.

6. §. They are the Receptacles of Liquor; which is ever Lucid; and I think, always more Thin or Watery. They are, in all Seed-Roots, filled herewith; and usually, in those also which are well grown, as of Borago, Radish, &c.

7. §. This Parenchymous Part, in many Roots, is of one Uniform Contexture; as in Asparagus, Horf-Radish, Peony, Potato, and others. In many others, it is, as it were, of a Diversified Wool; the Bladders being, though every where Regular, yet either in Shape, Size, or Situation, different in some Parts hereof, from what they are, in other intermediate ones. For these Parts, are like so many White Rays, streaming, by the Diameter of the Root, from the inward Edge toward the Circumference of the Barque; as in Lovage, Melilot, Parlpent, &c., cut transversely, is apparent. They are, though not in direct Lines, continued also by the length of the Root; so that they are, as it were, so many Membranes, by which the other Parts of the Barque are determined.

8. §. The Continuation of these Diametral Rays, or Portions, is divers: sometimes, but half through the Barque, or somewhat more, or less, as in Melilot. And it is probable, that to the Roots of all or most Trefoils, and also of the Leguminous Kind, this is proper. To have their Diametral Rays come short of the Circumference. Sometimes, they run quite through to the very Skin, as in Lovage. And I think, in the Roots of all Umbelliferous Plants: In which therefore, the Skin seems to have a closer Communion with the Diametral Rays, and to be originated especially therefrom. They usually stand at an Equal Distance in the same Root: But with respect to divers Roots, their Distance
fance varies; so les, in Parsnip, greater in Boglefs. They are commonly Tab. 7, 8.

Reclined, as in Lounge, but sometimes winding to and fro, as in a Carrot.

9, 4. They are not always of one Size: in a Carrot near the Inner Edge of the Barque, exceeding Slender, and scarcely discernable in others; Thicker, as in the Three greater ones of Melilot, and in common Clover. Both by their Distance, and Size, they are also les or more Numerous; some, only as they are nearer; some, as smaller others, as both. And 'tis proper, I think, to the Inlybou kind, either to have none, or but a few. Sometimes they are of the same Thickness quite, through the Barque from edge to edge, as in Marsh-

Mallow. And sometimes are considerably spread or dilated as they approach the Skin, wherewith they are joynd, and whereint they more visibly run, as in Parsley, or the smaller part of the Root of Lounge. And in some Roots, as of scorzonera, at some times of the year, when less succulent, almost the whole Parenchyma seems to be of the Nature of the Diametral Rays, in other Roots. The Bladders of these Diametral Portions, are sometimes, greater than those of the other Parenchymous Parts, as in Parsley: and I think sometimes les.

Yet as there, so here, variously sized; to about fix or eight Degrees; and those of Parsley about the third, fourth, and fifth. Their Figure is Sometimes more oblong; and their direction or respect more towards the Center of the Root.

11. 6. As the other Parenchymous Parts of the Barque, are the Receptacles of Liquor; so thfe, (where they are) of Aer. This is argued, From their being more White, and not Transparent, as such Roots and Parts use to be, which are more copiously and equally filled up with Liquor: as the Pith of Elder, which, in the old Stalks, is White; was once, and by being well soaked, will become, again Transparent. And from their being more dry and void of Liquor, and those of Parsley, which cannot be Vacuities, must be filled with more or les Aer, mixed with the Sap or the Vaporous parts there-

off. This is more observablc in thofe Diametral Portions, which terminate upon, and run into the Skin.

12. 6. THE BARQUE is not only of a divers Woof, but as is said, of a Compound Subftance; there being a certain number of Lignous Vessels, fewer or more, in some place or other, mixed with the Parenchymous Part above described, and some way or other, are demonstrable in all Roots. As by the Toughness of the Barque, when pulle by the length. By the visible Continuation of the faid Vessels through the length of the Barque, in the resemb lance of small Threads. And by the rising up of the Sap in the traverse cut of the Root, in such places of the Barque, where thefe Threads terminate; as the ex-istence of the fame Vessels in the Skin, was proved in the Precedent

Chapter.

13. Thefe Tubular Threads, run not through the Barque in di-

rect lines; but are frequently Baced together in the form of Net-

Work; The Parenchymous Parts every where filling up the spaces be-
twixt the Baced Threads; as in Burnet, Scorzonera, &c. the Barque being paired or striped off, is apparent.
14. §. They seem, at first, where they are Braced, to be Inoculated; so as to be pervious one into another. But a more accurate view, especially assifted by a Microscope, discovers the contrary. Neither are they wound any way one about another, as Threads are in a Rope: nor Implicated, as in ravled Yarn, or the Knots of a Net: but only contiguous or simply Tangent, as the several Chords in the Braces of a Drum: being thus joyned together by the Parenchymous Parts, as in speaking of the Fibro, will be understood how. Yet do not always the same Threads belong and keep entire to one Brace; but are frequently parted into several Threads, which are transfused from Brace to Brace. Nor do they always, in whole or in part, presently after their contingence, mutually fall off again; but, oftentimes, run along collateral ly joyned together for some space.

15. §. These Braces are of various number in divers Roots: more frequent in Jerusalem Artichoke, less in Scorzonera, more rare in Cynsmy. The Threads likewise are variously Divaricated; sometimes more where the Braces are frequent, as in Jerusalem Artichoke; and sometimes less, where the Braces are rare, as in Scorzonera, Dandelion: And in all Roots, more frequent towards the Inner Verge of the Bark.

16. §. By what is said, it is partly implied, That these Threads, are not Single Vessels; but a Cluster of them, Twenty, Thirty, or more or fewer of them together. Yet as the Threads are not Inoculated in the Brace; so neither are the Vessels in the Threads. Nor yet Twisted; but only stand collateral together; as the several Single Threads of the Silkworm, do in Sleeve-Silk. Neither are these Vessels pyramidal, so far as the Glass will discover; or, from probable Reason, may be conjectured. Nor Ramified, so as to be successively propagated one from another, after the manner of the Veins in Animals; but Cylindrical, and Difintly continued, throughout the length of the Root; as the several Fibres in a Tendon or Nerve.

17. §. THESE VESSELS are either themselves of divers kinds, or serve, at least, to confitute divers Kinds, in divers Roots: of the different Natures whereof, although there may be other ways whereby to judge; yet so far as by Inspection, we may do it, chiefly, by the Diversity of those Liquors, which they severally contain. Sometimes they yield a Lymph; and that Thin, as they do in a Parsnip; especially those that make a Ring, at the inward extremity of the Bark. See the Root it self. That this Clear Sap ascends only from these Vessels, is certain. Because no Liquor will do the like, from any Parenchymous Part, as Chap. 2. hath been said. And because it is of a different nature from the Sap contained in the Bladders of the Parenchyma; although of the same Colour, yet sensibly more Sweet.

18. §. Sometimes they yield a Thick and Mucilaginous Lymph, as in Cynsmy, as appeareth by its tenacity. From the Mucilaginous Content of these Vessels it is, I suppose, that the Sap contained in the Bladders is rendered of the like nature, so far as it approaches hereto, which sometimes is more; as in Marjoram; and sometimes but little as in Borage: For in pressling out the Liquor of this Plant, and then heating it over an indifferent fire; the greater part hereof remaineth thin; only some certain firings and little bits of a gelid Substance are mixed herewith; which as it seems, were originally the proper Liquor of these Mucilagins.

19. §.
Book II.

of Roots.

19. 6. Oftentimes these Succiferous Vessels yield a Milky or White Sap; and sometimes Yellow, and of other colours as in Senehus, and most Cichoraceous Plants; in Angelica, and most Umbelliferous; in Burdock; and divers Thistles, to which that is akin: in Scorzoneras, Common Bells, and many other Plants, not commonly taken notice of to be milky. The Milky Saps of all which, although they differ in Colour, Thicknes, and other Qualities; yet agree, in being more Oily than any of the Lymphous Saps. It being the mixture of the Oily parts with some other Limpid Liquor, but of a different Nature, which causeth them to be of a Milky, or other Opacous Colour, in the same manner as common Oyl, and a strong Liquamen of Tartar, shaked in a Bottle together, presently mix into a White Liquor. And although they will, for the greatest part, separate again; yet some of their parts, without any Boiling, or so much as the least Digestion with Heat, by Agitation only, or standing together for some time, incorporate in the form of a Thin Milky-Sapex, which will also dissolve in Water. I suppose, therefore, That it is the Volatile Salt, chiefly, of these Plants, which being mixed with their Oyl, renders this Liquor of a White or other Opacous Colour.

20. 6. Sometimes the Oyl will separate and discover it self: for if you cut a Fennel-Root traverse, after it hath layn some days out of the Ground; the same Vessels, which, in a fresh Root, yields Milk; will now, yield Oyl: the watery parts of the Milk, which in the drying of the Root are more evaporable, being spent.

21. 6. All Gums and Balsams are likewise to be reputed the proper Contents of these Vessels: for Thefe and Milks, are very near akin. So the Milk of Fennel, upon standing, turns to a Clear Balsam: of Scorzoneras, Dandelion, and others, to a Gum. In the dried Root of Angelica, &c. being split, the Milk, according to the Continuation of these Vessels, appeareth, as Blood clodders in the Veins, condensed to an hard and shining Rose. And the Root of Helianthus cut Tab. 9. tranversely, presently yields a curious Balsame of a Citrine Colour, and sometimes of the Colour of Balsame of Sulphur. I call it a Balsame; because it will not dissolve in Water. Yet not a Terebinth; because, nothing near so vivid or tenaceous as that is. But the Root of Common Wormwood, bleeds, from large Vessels, a true Terebinth, or a Tab. 10. E. Balsame with all the defining properties of a Terebinth; although that word be commonly used only for the Liquors of some Trees.

22. 6. There is yet another kind of Sap-Vessels, which may be called Vaporous-Vessels, as in Dockes, at least some of them. For by the Sap-Vessels it is, that the Barques of Roots do Bleed. Of which, some Bleed quick and plentifully, as the Umbelliferous and the Cichoraceous Kinds. Some, very slowly and scarce visibly, as all or most Trifoys, and of the Leguminous Kind. Some, which seem not to Bleed, as the Dock. Yet that this Root, hath also Vessels distinct from thoese that carry Aer: so doth partly appear, from the different Colour they produce where they stand: as will better be understood anon, in speaking of the Causes of the Colours of Roots. As also from the Toughnes of the Barque, in pulling it by the length; neither the Parenchymas, nor the Aer-Vessels, being of themselves Tough. But because the Succus or Sap they carry, seems to be a kind of Dewy Vapour, therefore, they may not improperly be called Reriferous or Vaporous-Vessels.
23. §. THE Sap-Vessels, are not only of divers Kinds, in divers Roots, but in the same. Whether in all, I doubt: but in some it is certain they are: For if you cut a Fenil-Root to traverse, both Milk and Lymph Sap, will presently ascend, and, upon accurate inspection, appear thereupon distinctfly. So the Roots, both of Trachelium and Emula, Bleed both a Lymph, and a Citrine Balsame: and Wormwood, both a Lympha, and a Terebinth, at the same time. So also the Root of Dandelion being cut in November, seems to bleed both a Milk and a Lymph: the latter being drowned by the former at another time when it is more copious. Whether all Roots have Lymphaduitis, is doubtful; but 'tis most probable, that they have, more or fewer; standing, for the most part, in a Ring, at the Inner Verge of the Barque: the Sap whereof, I suppose, is so far of common Nature in all Roots, as to be Clear, and left Only.

24. §. THE Quantity of these Vessels is very different: In Borage, Peony, Bifort, but few; in Asparagi, fewer: in Parsnip, Celendine, many; in Fenil, Marsh-mallow, many more: and between these extremas, there are many Degrees, as by comparing the Roots of Horfe-Radish, Turnep, Briony, Skirrets, Parsley, Gouts-Beard, and as many more as you please, may be seen. Amongst the severall Sorts of Docks, they seem in Patience, to be the fewest; in Red-Dock, the most numerous. There are two ways of judging of their Number: Either as their Extremities are visible upon the traverse cut of the Barque; or as the Barque is diversely Brittle or Tough; being so, from the various Number of these Vessels therein, as in the Second Chapter hath been said.

25. §. The Quantity of the ascending Sap, is a doubtful argument, whether of the Number, or Size of these Vessels. For it is common to most Milky-Roots, for the Milk to ascend more copiously; yet in some of them, the Vessels seem, in proportion with the Parenchyma Part, not to be so numerous, as in some other Roots, where the ascending Sap is least; as by comparing the Laticells of Dandelion, and the Lymphaduits of Fenil together, may appear: so that it should seem, that the bore of the Laticell Vessels, is greater than that of the Lymphaduits.

26. §. THE Situation of these Vessels, as they appear, even to the naked Eye, in the transverse Section, is Various and Elegant. Sometimes they are pointed only at the Inner Edg of the Barque, where they make a Ring, as in Asparagi. In which place and position, they stand in most, if not in all, Roots, how variously ever they are poſited alfo otherwife. The Common Crown-Root with numerous Roots, hath a Ring of sap-Vessels next the Skin. So the Barque of Monks-Hood, is encompassed with a transparent Ring of Sap-Vessels. The Ring is either more Entire, as in Brynna, brown-Wort, Valerian, Hop, Madder, &c. Or it is a Prick'd Ring, as in Butter-Bur. Sometimes they are chiefly pointed in a Prick-Ring, towards the outward part of the Barque, as in Peony: and some Roots are prick'd all over the Barque, as of Melilot. In others, they stand not so much in Pricks, as Portions or Columns, as in Cunspy.
27. §. In others, again, they all stand in more continued Lines, either Rays or Diametral, as in Borage; or Peripheral, as in Celan- 
dine. The Vascular Rays are not equally extended in all Roots: in
Parisip, towards the Circumference of the Barque; in Baglofs, about half way. In all Dockys, and Sorrels, the Rays are extended through about \( \frac{1}{4} \) of the thickness of the Barque, towards the Circumference, 
whereabout, divers of them are always arched in, two and two to- 
gether. In all or many Trifolys, and of the Leguminous Kind, they are 
extended through no more than \( \frac{3}{4} \) of the Barque. In the Umbellife- 
rous, they are Ralled in between the Diametral Portions of the Paren-
chyma. In Borage, the Rays are more Continuous; in a Carrot, more 
Pricked. Here also the Pricks stand in Even Lines; in Lovage, they 
are Divaricated. Of which, and those of some other Roots, it is al-
so Observable, That they are not all meer Pricks, but molt of them 
small, yet real Circles; which, after the Milk hath been frequently 
licked off, and caeafth to ascend, are visible, even without a Glass. 
And note, that in observing all Milk-Vessels, the Milk is to be taken 
on, not with the Finger but the Tongue; so often, till it rifieth no more, 
or but little. And some Roots may also be soaked in Water; where-
by the Position of the Milk=Vessels, will be visible by the darker Co-
colour of the Barque, where they stand.

18. §. The Rays sometimes, run more Parallel; and keep several, 
as in Monk-flood; and sometimes, towards the Circumference of the 
Barque, they are occurrent; as not only in Docke, but other Plants: 
In Eryng, in a termination more Circular; and in Bryony, angular, 
or in the form of a Glory, as also in Horfradisb, through a Microscope.
The Peripheral Lines are in some, more entire Circles, as in Dandelion; 
in others, made up of shorter Chords, as in Potato, Cam, and the 
smaller part of the Root of Monk-flood. In some, the Pricks are so 
exceeding small, and stand so close, that, to the bare eye, they seem 
to be continous Rings, which yet, through the Microscope, appear 
distinct, as in Marsh-marlow and Liquirifs.

29. §. Sometimes Columns and Chords are compounded, as in 
Burnet; Pricks and Chords, in Potato; Rays and Rings, in Monk-
flood; where the Ring is Single. In Fenn, there is a double or treple 
order both of Rays and Rings, the Lymphatic standing in Rays and the 
Laticals in Rings. And in Marsh-mallow, the Vessels are so politen 
so to make both those kinds of Lines at once.

30. §. In Celandine, they seem all, to the bare eye, to stand in 
numerous Rings lying even one within another. As also in Dandelion; 
in which yet, being viewed through a Microscope, there is an appear-
ance of very many small Rays; which streaming from the Inner Verge 
of the Barque, cross three or four of the smaller Rings, and are there 
terminated. Whence it should seem that Lymphatic Rays and Milky 
Rings, are in that Root, so far mixed together. Only the Lymph, be-
ing confounded with the Milk, cannot be discerned. And where the 
Milky-Vessels are evacuated, or at such Seafoos, wherein they are left 
full, divers Milky Roots will yield a clear Liquef at the Inner Verge of 
the Barque, where, at other times, they seem to yield only Milk. 
And this is the Description of the Barque.
CHAP. IV.

Of the WOOD.

HAT Portion of the Root which standeth next within the Bark, and in Trees, and Shrubby Plants, is the Wood; is also compounded of Two Substantially different Bodies, Parenchymous and Lignous. The Parenchymous, is of the same Substantial Nature with that of the Bark. And is originated from it; being not only adjacent to it, but all round about continuous therewith; even as that, is with the Skin; the Parenchyma of the Bark, being distributed, from time to time, partly outward into the Skin, and partly inward, into the Wood.

2. The Position of the several parts hereof, is different. For the most part it hath a Diametral Continuation, in several Portions, running betwixt as many more of the Lignous, from the Circumference towards the Center of the Root: all together, constituting that, which in the Second Chapter of the First Book, I call the Insertment. In the Roots of many Herbs, these Diametral or Inserted Portions are more observable, as in Cunfry, which leadeth to the notice of them in all others, both of Herbs and Trees. Sometimes part of this Parenchymous Body is disposed into Rings, as in Fenil. The Number and Size of which Rings differ: In Fenil, when the Root is grown large, they are in some places broader, but fewer; in Beet they are narrower, but more. The Diametral Portions are here, in like manner, much varied; in Cunfry, Celantds, larger; in Beet, Buglofs, meaner; in Borage, Parsnip, more, and smaller; and in most Woody Roots, streaming betwixt the Pith and the Bark, as to many small Rays. Their Continuation is also different; in some Roots, to the Centre, as in Columbian; in others, as in Parsnip, and sometimes different in the same Root, as in the Vine.

3. The Contexture of these Parenchymous Portions is sometimes Uniform, as in Buglofs, Peony; and sometimes also, as it is in the Bark, different; in part, more sappy, and transparent; in part, more white, dry, and airy, as in Carrot, Lovage, Scorzonera, and others; which yet cannot be observed without a wary view. But their general Texture is the same being all made up of many small Bladders. Which are here of different Sizes, like theohe of the Bark, but for the most part smaller. Their Shape likewise, is usually Round; but sometimes Oblong and Oval, as in Borage; or Oblong and Square, as in the Vine.

4. The Lignous Part, if not always, yet usually, is also compounded of Two Kinds of Bodies, seil. Succiferous or Lignous and Air- Vessels. The Lignous as far as discernable, are of the same Conformation and Nature with those of the Bark, and in the transverse cut of
Book II.

of the Root, do oftentimes, as those, emit a Liquor. They are also Braced; and many of them run in distinct Threads or Portions, collaterally together.

5. &. The Aer Vessels I so call, because they contain no Liquor, but an Aer Vapour. They are, more or less, visible in all Roots. They may be distinguished, to the bare Eye, from the Parenchymous Parts, by their Whiter Surface; and their standing more prominent, whereas those shrink below the transverse level of the Root, upon drying. They are frequently Conjugated divers of them together, sometimes fewer, and Tab. 10, for the most part single, as in Asparagus; sometimes many, as in Horf. & 15.

Radis. And their Conjugations are also Braced, as the Threads of the Sucefforous Vessels. But they are no where Inoculated: not Twisted one about another; but only Tangent or Collateral. Neither are they Ramified, the greater into less; but are all distinctly continued, as the Nerves in Animals, from one end of the Root to the other.

6. &. Their Braces, as those of the Sucefforous Vessels, are also of various number: in Jerusalem Artichoke, Cymfrey, Scorzoneræ, more rare; in Borage, Barnet, more frequent; as by stripping off the Barque of such Roots, where it is easily separable, may be seen. And they often vary in the same Root; so in Borage, Scorzoneræ, &c. they are more frequent in the Centre, and next the Barque, than in the Intermediate space, as by splitting those Roots down the middle doth appear. They also vary from those of the Sucefforous Vessels; those being usually more frequent, as in Jerusalem Artichoke, than those of the Aerial.

7. &. Betwixt these Braced Aer Vessels, and the rest, which make the true Wood, run the Parenchymous Parts above described; as they Tab. 6. do betwixt the Suceffores in the Barque: and so make up two Pieces of Net Work, whereof one is the filling up of the other.

8. &. The Position of both these Kinds of Vessels, is Various. The Suceffores or Lignous are sometimes posited in diametral lines or portions; as in the Vine, and most Trees. Sometimes, oppositely to the Aerial, as in Beet; each Ring herein being double, and made both of Tab. 8. Sap and Aer Vessels.

9. &. In Nettle the Position is very peculiar, from what it is in the Tab. 17. Roots of other Plants; being curiously mixed; the Suceffores running crof the Aerial, in several, viz. Five, Six, Seven, or more Rings. In Bryony the several Conjugations of the Aerial, are distinctly surrounded with the Suceffores. In Patience, the Suceffores are disposed, besides Rays, into many small Rings, of different Sizes, sprinkled up and down, and not, as in other Roots having one common Centre; within divers whereof, the Aer Vessels are included: especially within those which are drawn, not into Rings, but, as it were, into little stragling Hedges.

10. &. That also of the Aer Vessels, is Various and Elegant; especially in the upper part of the Root. In Ammi, Lilium non-bulbiferum, they make a Ring. In thfe, a Prick’d-Ring; in Peony, a Ring of Rays: in Valerian, a Ring of Pricks and Rays. In others, they make Tab. 7, 8; 9. not Rings, but longer Rays, extended either towards the Centre, as in Scorzoneræ; or meeting in it, as in Columbine. In the Common Dock, they stand more in single Rays: in the other Species of Docks, both in Rays, and collateral Conjugations between.
11. §. In Beet, they stand in several Rings; and every Ring, made of Rays. In Cunafry, the Rays and Rings are separate; those stand without, those next the Centre. In Dandelion, they stand together, and make a little Rope, in the Center itself. In Geranium, and others of that Kindred, they make a little Thred, in the same place. And in Skirret, they stand in two Threds, near the Centre.

Tab. 8, 9. In Celandine, they stand in almost parallel Lines. In Monk-hood, of a wedged Figure; divided in the smaller part of the Root, into Three little Wedges, with their poynets meeting exactly in the Centre. In Cinquefoil, and Strawberry, they are also poilter'd in three Conjugations, triangularly. In the young Roots of Oak, they stand neither in Radiated, nor otherwise strait, but Winding Lines. And in Borage the position, of many of them, is Spiral. As likewise, sometimes, in Mercury, or Lappathum unifolium. In Horfe-Radish, they stand more confused neither in Rings nor in Rays; yet their several Conjugations, are radiated: with very many other differences.

Tab. 8, 9. 12. §. The Quantity of these Vessels, as to the space they take up in the Root, is to be computed Two ways, by their Number, and Size. Their Number may, in some Roots, and in some measure, be judged of, by the bare Eye; having, frequently, a whiter surface than the other Parts. As also their Size; the Bore of these Vessels being greater than that of the Lignous in all Roots; especially in some. For if you take the Roots of Vine, Fenst, Dandelion, Plum-tree, Elder, Willow, &c. and lay them by, for some time, to dry; and then, having cut off a very thin Slices of each, tranversely; if you hold up those Slices before your Eye, so as the Light may be trajected through the said Vessels, they hereby become visible, as notably different, both in Number and Size.

Tab. 8, 9. 13. §. But undeceitful and accurate Observation of both their Number, and Size, must be made by the Microscope; and so they will appear to be much more various. In Bifort, Skirret, they are very few; in Beet, very many; betwixt which extremes there are all Degrees; as in Orpine, Venus Looking-Glass, Scorzonera, Great Celandine, Peony, Borage, Fenst, &c. may be seen. So their Size, in some is extreme small, as in Strawberry, Bifort, Valerian; in others very great, as in Asparagus, Bugloss, Vine. They are also of several Sizes in one and the same Numerical Root; but in some, are less varied, as in Lion Lions, Alum Root, Asparagus, Bugloss; in others, more, as in Bryony, Lovage. Amongst all Roots, they vary by about Twenty Degrees; as by comparing the Roots of Vine, Thorn-Apple, Bryony, Lovage, Fenst, Wild Carrot, Saxifrage, Parsley, Peony, Hoar-hound, Cinquefoil, Strawberry, &c. together, may be seen. Some of those in the Vine, being of the greatest Size; appearing through a good Glass, at least one Third of an Inch in Diameter: those in Strawberry, and that Kind, of the smallest; most of them appearing, in the same Glass, no bigger, than to admit the poynet of a small Pin, according to the Standard, in Tab. 12. See also the Figures of so many of them as are drawn.

Tab. 10. to the 17. 14. §.
15. 6. In some Roots, they are Small, and Few; as in Jerusalem Artichoke; in others Small, but Many, as in Horse-Radish: in Bugglas, Tab. 11, 14, they are Great, but Few; in the Vine, Great and Many. So that the 15, 17.

proportion, which those of a Vine, their Number and Size being taken together, bear to those of Jerusalem Artichoke, may be, at least, as Fifty, to One. Of the smallast Kinds, as those of Cinquefoil, Jerusalem Artichoke, and the like; it is to be noted, That they are scarce ever visible in the fresh Slices of these Roots: but after they have layn by a while, at last, by a good Glass, Clear Light, and freely View, are discernible.

16. 6. In some Roots, the greater of these Vessels stand in or next the Centre, as in Taraxacum, or Dandelion; in others next the circumference, as in Horseradish. Sometimes each of them is from one end of the Root to the other, of a more equal Size, or more Cylindrical; as in Marshmallow; but usually, they widen, more or less, from the Top, to the Bottom of the Root, as in Thorn-Apple: about the Top of which, they are, for the most part, but of the Sixth, Seventh, and Eighth, Magnitudes; some of the Fifth, but none of the Third; but about the Bottom, they are, of the Sixth, Seventh, and Fifth: whence it is manifest, That some of them are, in the manner of Veins, somewhat Pyramidal. Yet it is observable, That their amplification proceedeth not towards, but from their Original, as in Nerves.

17. 6. Of these Vessels Seignior Mistpghi hath observed; Composition (that he;) exposte fistulae Zona tenui & pellucidae, velut argentei coloris laminarum, parum latae; que, spiralis locata, & extremae lateribus unita, Tabulis, interius & exteriore aliquantulum &ponunt, efficit.

18. 5. To whose Observation I further add, That the Spiral Zone, or Laming, as he calls it, is not ever one Single Piece, but consisteth of Two or More round and true Fibres, although standing collaterally together, yet perfectly distinct. Neither are these Single Fibres themselves flat, like a Zone; but of a round forme, like a moat fine Thred. According as fewer or more of these Fibres happen to break off, from their Spiral location, together; the Zone is narrower, or broader: Usually, Narrower in the Trunk, and Broader in the Root.

19. 5. Of these Fibres I also Observe, That they are not Insensfated side to side; but are Knit together by other smaller Fibres; those being, as it were, the Warp, and thefe the Wof of the Aer-Vessels. Yet I think the several Fibres are not interwoven just as in a Web; but by a kind of Stitch, as the several Plates or Bredths of a Floor-Mat. A clear and elegant light of these Fibres, and of their Interaestifage, by splitting a Vine-Root, or a piece of Oak, may, with a good Glass in the fides of their Greater Aer-Vessels, be obtained; having much of the resemblance of Close Needle-work.

20. 5. The Spiration of the Fibres of these Vessels, may more easily be observed in the Trunk, than in the Root. And better in younger Plants, than other. And not fo well by Cutting as by Spitting, or by Tearing off some small Piece, through which they run: their Conformation being, by this means, not spoild. Yet this way, the Vessels are seen, chiefly, Unresolved.

21. 5. But in the Leaves and Tender Stalks of all such Plants, as those, upon breaking, a kind of Denue or Wood; they may be seen Resolved and Drawn out, and that some times even to the naked Eye,
an Inch or two Inches in length. This Wood being nothing else, but a
certain number of Fibres Resolved from their Spiral position in these
Vessels, and Drawn out in Length; and so clutched together as so many
Threads or little Ropes: appearing thus more or less, in the Lores and
some other Parts of most Plants; but more remarkably in some, as
in the Vine, Scabious, and others. As also in the Scales of a Squill. In
which last, for example, they are so easily separable, as further to
shew, what before was observed; viz. That the Plate or Zone, into
which the Aer-Vessels are usually Resolved, is not one Single Piece, or
more Plate; but made up of several Round Fibres all standing and
running parallel, and so knit together by other smaller ones, trans-
versely, in the form of a Zone. For if you break or cut a Leaf or Shell
of a fresh Squill, till you come to the Aer-Vessels, and having softly
drawn them out, for about an Inch or more (to the naked Eye) in
length, you then single out one or two of them from the rest, and
rowl them, as they hang at the Shell, eight or nine times round, each
Vessel will appear, through a Glass, to consist of 8, 10, or 12 small
Fibres; which, in the Unresolved Vessel, run parallel; but by this
means, are all separated one from another. See the Figures belonging
to the Third and Fourth Books.

22. §. The Process of their Spiration, is not, so far as I have ob-
erved, accidental, but constantly the same; \textit{sic}. In the Root, by
South, from West to East: But in the Trunk, contrarily, by South,
from East to West.

23. §. The Content of these Vessels, is, as hath already been inti-
imated, more Avery. The Arguments for which, are, That upon a
Transverse Cut of the Root, the Sap ascended not there, where
These stand. Being also viewed through a Microscope, they are never
observed to be filled with Liquor. Besides a Root cut and immersed in
Water, till the Water is in some part got into these Vessels, and then
the Root taken out and crumshed; the other Parts will yield Liquor,
but These, only Bubbles: which Bubbles are made, by some small
quantity of Liquor mixed with the Aer, before contained in the said
Vessels. To which, other Arguments will arise out of those Things
that follow in the Second Part. As also for this Content, its not be-
ing a pure or simple, but Vaporous Aer. Whether these Vessels may
not, in some Vegetables, and at some times, contain Liquor, is doubt-
ful. \textit{(a) Thus far of the Lignous Part.}

\textit{(a) See Book 3.}
Of the PITH.

I THIN the Lignous Part lyeth the Pith. This Part is not common to all Roots, for some have none, as Nicotian, Srtamonium, and others. Yet many which have none, or but little, throughout all their lower parts, have one fair enough about their tops, as Mallow, Borage, Dandelion, and the like. See the Roots. And in many others there are Parenchymous Parts, of the same substantial nature with the Pith, distributed betwixt the several Rings of Vessels, and every where visible, from the top to the bottom, as in Beet, Fenil, &c.

2. §. The Size of the Pith is varied by many Degrees, easily reckoned an Hundred; in Fenil, Dandelion, Asparagus, but small; in Horse-Radish, Valerian, Bistort, great. The Shape hereof, in the lower parts of most Roots, is Pyramidal; but at the tops, Various, according to the different Distribution of the Vessels, as in Carrot, Hyperbolick, in Parsley, Oval; as appeareth in cutting the Roots lengthways.

3. §. The Pith, for the most part, especially in Trees, is a simple Body: but sometimes, it is, as the Bark, compounded; some certain number of succiferous Vessels being mixed herewith; as in Jerusalem Artichoke, Tab. 6, 8. Horse-Radish, &c. upon a traverse cut, by a strict view, may be discerned. Their Position is sometimes Confused, as in a Carrot; and sometimes Regular, as in Parsley, appearing, by the traverse cut, in Rings, and in cutting by the length, in Arches. And sometimes the Pith is hollow, as in the Level-Roots of Bishop's-Weed: these Roots being made out of the Stalk, as in the First Chapter hath been shewed. §. 13, 14, 15.

4. §. As all the other Parts of the Root, are originated from the Seed; so, sometimes, is the Pith itself. But sometimes, it hath its more immediate Derivation from the Bark. Hence it is, that many Roots, which have no Pith in their lower parts, have one at their top, as Columbine, Louage, &c. For the Parenchymous Parts of the Bark being, by degrees, distributed into Diametral Portions, running betwixt those of the Lignous Body, and at length, meeting and uniting in the Centre, they thus constitute the Pith. In the same manner, at the top of some Roots, the Pith is either made or augmented, out of the Parenchymous Rings above described; these being gradually distributed to, and embodied in the Centre; as in Fenil, and some other Roots, their lower and upper parts compared together, may be seen. Even as in Animals, one Part, as the Dura Mater, is the original of divers others.
5. §. From hence, it also appears, That the Pith is of the same Substantial Nature with the Parenchyma of the Barque, and with the Diametral Portions; and that therefore they are all one body, differing in no Essential Property, but only in their Shape and Place. The same is also evident from the Continuity of the Pith with the Diametral Portions, as of Thefe, with the faid Parenchyma. And from their Contexture, which, by a Microfcope, appeareth to be of one and the fame general kind, in all Plants, both in the Parenchyma of the Barque, in the Infertment or Diametral Portions, and in the Pith, all being made up of Bladders.

6. §. The Bladders of the Pith, are of very different Sizes; seldom left, than in the Barque, as in Asparagus; ufually much bigger, as in Horse-Radifh. They may be well reckoned to about fifteen or twenty degrees; thofe in Jerusalem Artichoke, of the largest; in Valerian, Horse-Radifh, of the meaner; in Biflor, Peony, of the smallest. Their Position is rarely varied, as it is oftentimes, in the Barque; but more uniform, and in the tranverfe Cut, equally refeptive to all parts of the Root; yet being piled evenly, one over another, in the long cut, they feem to run, in Diect Trains, by the length of the Root. Their Shape also is, ufually more orbicular; but sometimes, somewhat angular, in the larger kinds, as in Jerusalem Artichoke.

7. §. Thus far the Contexture of the Pith is well discoverable in the Root. In the Trunk, farther, and more eafily. Whereof therefore, in the next Book, I fhall give a more particular Description and Draught. Yet fince I am speaking of it, I fhall not wholly omit here to obferve, That the Sides, by which the aforefaid Bladders of the Pith are circumfcribed, are not mere Paper-Skins, or rude Membranes; but fo many several Ranks or Piles of exceeding fmall Fibrous Threads; lying, for the moft part, eveny one over another, from the bottom to the top of every Bladder; and running crofs, as the Threads in the Weavers Warp, from one Bladder to another. Which is to fay, That the Pith is nothing efe but a Reft mirabile, or an Infinite Number of Fibres exquisitely fmall, and admirably Complicated together: as by cutting the Pith with a Razor, and fo viewing it with a good Glass, may be seen. See the Figures belonging to the Third Book.

8. §. All Plants exhibit this Speéable, not alike diftinfly; thofe bleft, with the largest Bladders. Nor the fame Pith, in any condition; but bleft, when dry: Because then, the Sap being voided, the spaces betwixt the Fibrous Threads, and fo the Threads themfelves, are more diftinfly difcernible. Yet is it not to be dried, after Cutting: Because its feferal parts, will thereupon coincide and become defformèd. But to be choopen, while the Plant is yet growing; at which time, it may be often found dry, yet undeformèd: as in the Trunks of Common Thiftle, Jerusalem Artichoke, &c.

9. §. Neither are thofe Threads, fo far as I can obferve, Single Fibres; but ufually, confift of feveral together. Nor are they fimplly Collateral, but by the weftage of other Fibres, in their natural Eflatc, knit together; much after the fame manner as the Spiral Fibres of the
Book II.

of Roots.

Aer-Vessels. This Connexion I have no where so well seen, as in the White Bottoms of the Bladders of a Bulrush, being cut traverse where in they have the appearance, of very fine and close Needle-work.

10. §. The Fibres by which the said Threads are knit together, I think are all Single: and are seldom and scarcely visible, except by obliquely Tearing the Pith; by which means, they will appear through the Glafs, broken off, sometimes, a quarter or half an Inch, or an Inch in Length; and as small as one Single Thread of a Spiders Webb.

In a Bulrush, they are sometimes discernible in cutting by the Length. These Fibres, and the Threads, they knit together, for the most part, are so pellucid, and closely tinate, that they frequently seem to make one entire Body, as a piece of Ice or a film of Water it self: or even as Animal Skins sometimes they, which yet are known to be Fibrous.

11. §. The Situation of these Threads, is contrary to that of the Vessels, as those by the Length, so these, chiefly, by the Breadth of the Root, or horizontally, from one edge of the Pith to the other. They are continued circularly: whereby, as oft as they keep within the compass of the several Bladders, the said Bladders are Round: But where they wind out of one Bladder, into another, they mutually Interfet a Chord of their several Circles; by which means, the Bladders become Angular.

12. §. The Contexture, likewise, both of the Parenchymous Part of the Barque, and of the Diametral Portions interferted between the Lignous; is the same with this of the Pith, now described; that is, Fibrous. Whence we understand, How the several Branches and Threads of the Vessels are made: For the Vessels running by the length of the Root, as the Warp; by the Parenchymous Fibres running crofs or horizontally; as the Woof; they are thus knit and as it were stitched up together. Yet their weifage seemeth not to be simple, as in Cloath; but that many of the Parenchymous Fibres are wound round about each Vessel; and, in the same manner, are continued from one Vessel to another; whereby knitting them altogether, more closely, into one Tubular Thread; and those Threads, again, into one Branch: much after the manner of the Needle work called Back-Stitch, or that used in Quilting of Balls. Some obscure things hereof, may be taken in a Thread of Cambrick, through a Microscope. But it is most visible, in the Leaves and Flowers of some Plants. The Delineation of these Things I shall therefore omit, till we come hereafter to speak of the other Parts.

13. §. From what hath been said, it may be conjectured; That the Aer Vessels successively appearing in the Barque, are formed, not out of any Fluid Matter, as are the original ones: But of the Parenchymous Fibres; so by changing them from a spherical to a Tubular Forme.

14. §. From the precedents, it is also manifest, That all the Parenchymous Parts of a Root, are Fibrous.

15. §. And lastly, That the whole Body of a Root, consists of Vessels and Fibres. And, That these Fibres themselves, are Tubulous, or,
or so many more vessels, is most probable: There only wanteth a greater perfection of Microscopes to determine.

16. §. The Contents of the Pith are, sometimes Liquor, and sometimes a Vaporous-Aer. The Liquor is always Diaphanous, as that of the Parenchymous Part of Barque; and in nature, not much differing from it. The Aer is sometimes lefs, and sometimes more Vaporous, than that of the Barque. By this Aer I mean, that which is contained in the Bladders. Within the Concaves of the Fibres which compe the Bladders, I suppose, there is another different Sort of Aer. So that as in the Bladders is contained a more Aqueous; and in the Vessels, a more Essential Liquor: So sometimes, in the same Bladders, is contained a more Vaporous; and in the Fibres, a more Simple and Essential Aer.
An Account of the

VEGETATION

OF

ROOTS

Grounded chiefly upon the foregoing

ANATOMY.

PART II.

To philosophize, is, To render the Causes and Ends Tbeology, the of Things. No man, therefore, that denieth God Beginning can do this. Truly. For the taking away of the and End of first Cause, maketh all things Contingent. Now, of that which is Contingent, although there may be an Event; yet there can be no Reason or End: so that Men should then study, That, which is not. So the Causes of Things, if they are Contingent, they cannot be Constant. For that which is the Cause of This, now; if it be fo Contingently, it may not be the Cause hereafter; and no Physical Proposition, grounded upon the Constancy and Certainty of Things, could have any foundation. He, therefore, that philosophizeth; and denieth God, playeth a childish Game.

2. 9. Wherefore Nature, and the Causes and Reasons of Things, duly contemplated, naturally lead us unto God, and is one way of securing our Veneration of Him; giving us, not only a general Demonstration of his Being; but a particular one, of most of the several Qualifications thereof. For all Goodness, Righteousness, Proportion, Order, Truth, or whatever else is Excellent and Amiable in the Creatures; it is the Demonstration of the like in God. For it is impossible, that God should
should ever make any thing, not like Himself, in some degree or other. These Things, and the very Notions which we have of them, are Conceptions flowing from the Word of the Divine Nature.

3. §. By the same means, we have a greater assurance of the Excellency of his Sacred Word. That He, who hath Done all things so transcendently well; must needs Speak as well, as he hath Done. That He, who in so admirable a manner, hath made Man; cannot but know best, What his true Principles and Faculties are; and what Actions are most agreeable thereunto: and, that having adorned him with such Beautiful and Lovely ones; it is impossible, He should ever put him upon the Exercise of those Faculties, in any way Deformed and Unlovely. That He should do all things, so well Himself; and yet require his Creatures, to do otherwise, is unconceivable.

4. §. And as we may come, hereby, to rectify our Apprehension of His Laws; so also, of His Misters. For there are many Things, of the Manner of whose Existence, we have no certain Knowledge. Yet, of their Existence, we are as sure, as our Senses can make us. But, we may as well deny, what God hath Made, To be; as, what he hath Spoken, To be true, because we understand not how. And the knowledge of Things being gradually attained, we have occasion to reflect; That some Things, we can now well conceive, which we once thought unintelligible. I know, therefore, what I understand not; but, I know not, what is unintelligible; what I know not now, I may hereafter; or if not I, another; or if no Man, or other Creature, it is sufficient, That God fully understandeth Himself. It is not, therefore, the Knowledge of Nature, but they are the images of Men's minds, that dispoze them, either to Forget God, or to Think unduly of Him.

5. §. Nor have we reason to fear going too far, in the Study of Nature; more, than the entering into it: Because, the higher we rise in the true Knowledge and due Contemplation of This; the nearer we come to the Divine Author hereof. Or to think, that there is any Contradiction, when Philosophy teaches that to be done by Nature; which Religion, and the sacred Scriptures, teach us to be done by God: no more, than to say, That the Balance of a Watch is moved by the next Wheel; is to deny that Wheel, and the rest, to be moved by the Spring; and that both the spring, and all the other Parts, are caus'd to move together by the Maker of them. So God may be truly the Cause of This Effect, although a Thousand other Causes should be suppos'd to intervene: For all Nature is as one Great Engine, made by, and held in His Hand. And as it is the Watch-makers Art, that the Hand moves regularly, from hour to hour, although he put not his Finger still to it: So is it the Demonstration of Divine Wisdom, that the Parts of Nature are so harmoniously contriv'd and set together; as to conceive all kinds of Natural Motions and Effects, without the Extraordinary and Immediate Influence of the Author of it.

6. §. Therefore, as the Original Being of all Things, is the most proper Demonstration of God's Power: So the successive Generations, and Operations of Things are the most proper Demonstration of his Wisdom. For if we should suppose, that God did not now make, or do any Thing, by any Thing; then, no Effect would be produced by a Natural Cause: and consequently, He would still be upon the Work of Creation; which yet Sacred Scripture affir'meth us, He reflects from. And we might expect the
the Formation of a Child, in an Egg, as well as in a Womb; or of a Chicken, out of a Stone, as an Egg: And all Sorts of Animals, as well as Plants, might propagate their Species, without Coition: and the like. For Infinite Power, needeth not make any difference in the Things it undertakes to manage. But in that, these Things are not only made, but so made, that is, according to such certain Natural Laws, as to produce their Natural Effects; here is the Sensible and Illustrious Evidence of his Wisdom. Wherefore as the Wisdom of Government, is not seen, by the King his interposing Himself in every Case; but in the contrivance of the Laws, and Constitution of Ministers in such sort, that it shall be as effectually determin'd, as if he did so indeed: So the more complicated and vastly Numerous, we allow the Natural Causes of Things to be; the more dulcely we conceive of that Wisdom, which thus dispofeth of them all, to their several Effects: All Things being thus, as Ministers in the Hands of God, conspiring together a Thousand Ways, towards a Thousand Effects and Ends, at one time; and that with the same certainty, as if he did prepose to each, the same Omnipotent Fiat, which he used at the Creation of the World.

7. §. THIS Universal Monarchy, as it is eminently Visible in all other Particular Economies; so is it, no less, in that of Vegetables. Infinite Occurrences, and secret Intrigues, 'tis made up of; of which we cannot skill, but by the help of manifold Means; and those, in the following Idea, have been lately proposed. Wherein, although some Experiments have been briefly touch'd: yet that which I have hitherto chiefly prosecuted, hath been the Anatomical Part; and that not thoroughly neither. Notwithstanding, so far as Observations already made will conduct us, I shall endeavour to go. And if, for the better clearing of the way, I have intermixed some Conjectures; I think they are not meehly such, but for which I have laid down some Grounds, and of which, the Series also of the following Discourse, may be some further proof.

8. §. LET US say then, that the Root of a Plant being lodged in some Soil, for its more convenient growth; 'tis necessary the Soil should be duly prepared for it. The Rain, therefore, falling and soaking into the Soil, somewhat dilutes the Dissoluble Principles there contained; and renders them more easily communicable to the Root: Being as a Menstruum, which extracteth those Principles, from the other more and more parts of the Soil.

9. §. And the warm Sun, joyned with the diluting Rain, by both, as it were a Distillation of the Soil, or a gentle Fermentation amongst its several Parts, will follow: whereby the Dissoluble Parts therein, will rot and mellow: that is, those Principles which as yet remained more fixed, will now be further resolved and unlocked, and most copiously and equally spread themselves through the Body of the Soil.
nate the Soil: Being thus, in part, out of their own Resolved Principles, annually Compounded again.

11. §. Many of these Principles, upon their Resolution, being by the Sun more attenuated and volatilized; continually ascend into the Aer, and are mixed therewith. Where, although they lose not their Vegetable Nature, yet being amongst other purer Principles; themselves also, depositing their Earthy feculencies, become more subtle, simple and Essential Bodies.

12. §. And the Aer being of an Elastic or Springy Nature, prefiguring, more or less, upon all Bodies; it thereby forceth and influenteth it self into the Soil, through all its permeable Pores. Upon its own entrance, it carries also many of the said Vegetable and Essential Principles along with it; which, together with the rest, are spread all over the Body of the Soil. By which means, though a leas Vehement, yet more Subtil Fermentation, and with the leaft advantage of warmth, continual, will be effected.

13. §. The Principles being thus farther resolved and sublizized, would presently exhale away, if the Rain, again, did not prevent. Which, therefore, falling upon and soaking through the Ground, is as a fresh Menfirnum, saturate or impregnate with many of them. And as it still sinketh lower, it carries them along with it self, from the Superficial, to the Deeper parts of the Ground: thus, not only maturing those parts also, which, otherwife, would be more lean and cold; but therein likewise, laying up and securing a Store, more gradually and thriftily to be bestowed upon the Upper parts again, as they need.

14. §. And Autumn having laid up the Store, Winter following therewith, doth, as it were, lock the doors upon it. In which time, some warmer Intervals, serve further and gradually to mature the stored Principles, without hazard of their being Exhaled. And the Spring returning, lets the doors open again, with warmer and more constant Sun, with gentle and frequent Rain, fully resolves the said Principles; and so furnisht a plentiful Diet, for all kinds of Vegetables; being a Composition of Water chiefly, wherein are resolved, some portions of Earth, Salt, Acid, Oyl, Spirit, and Aer; or other Bodies of Affinity herewith.

15. §. THE ROOT standing in the Ground thus prepared, and being always surrounded with a Barque, which confluxeth chiefly of a Parenchymous and Spongy Body: (a) it will thus, as Sponge do, naturally suck up the watery parts of the Soil impregnate with the said Principles. Which Principles notwithstanding, being in proportion with the watery parts, but few, and also more Essential; (b) therefore in this Parenchymous Part, are they never much discovered, either by Colour, Taste, or Smell. As it is probable, that some distilled Waters, which discover nothing, to Senfe, of the Plants from which they are distilled, may yet, in part, retain their Faculties. And it is known, that many Bodies; as Cressus Metallorum, convey many of their parts into the Menfirnum, without any sensible alteration thereof. So Frojfe and snow have neither Taste nor Smell; yet from their Figures, tis evident, that there are divers kinds of Saline Principles incorporated with them; or at leaft, such Principles as are common to them and divers kinds of Salts.

16. §.
Book II.

of Roots.

16. §. The entrance of this Impregnate Water or Sap is not without difference, but by the Regulation of the intervening Skin; being thereby strained and rendered more pure: the Skin, according to the thickness (a) or clofeness thereof, becoming sometimes only as a brown paper, sometimes as a Cotton, and sometimes as a Bag of Leather to the transient Sap, as the nature of it doth require. By which it is also moderated, left the Barque, being spongy, should suck it up too fast, and fo the Root should be, as it were, furcharged by a Plathora. And divers of the succorous Veffels being mixed herewith (b) and lying next the Soil, usually more or less mortified, and fo their Principles somewhat resolved: the Sap is hereby better specified, and further tintured; such parts of the Sap best entering, as are most agreeable to thefe Principles; which the Sap also carries off, in some part, as it paffeth into the Barque.

17. §. The Sap thus strained, though it be pure, and confifteth of Essential parts; yet being compounded of heterogeneous ones; and received into the Parenchyma of the Barque a laxe and spongy Body, they will now cafily and mildly ferment. Whereby they will be yet further prepared, and fo more efacily intimately themselves into all the Bladders of the faid Parenchyma; swelling and dilating it as far as the Continuity of its parts will bear. Whereupon, partly from the continued entrance of fresh Sap, and partly by a Motion or Pressure of Reftitution in the swollen and Tenfed Bladders of the Parenchyma, the Sap is forced thence into the other parts of the Root.

18. §. And because the Parenchyma is in no place openly and visibly Pervious, but is every where composed of an Infinite Number of small Bladders (c); the Sap, therefore, is not only fermented therein, and fitted for Separation; but, as it paffeth through it, is every part of it, strained an hundred times over, from Bladder to Bladder.

19. §. The Sap thus fermented, and strained, is distributed to the other Organical Parts, according as the feveral Principles of this, are agreeable to thofe whereof the faid Organical Parts confift. As the Sap therefore paffeth from Bladder to Bladder, fuch Principles as are agreeable to thofe of the Fibres of the faid Bladders, will adhere to, and infinate themselves into the Body of the Fibres; fo Water chiefly, next Acid, then Spirituous, Earthy, Aery, and Oleous. (d) And by its continual appallse and percolation, as it leaveth some parts upon the faid Fibres; fo as it is squeezed betwixt them from Bladder to Bladder, it licks and carries off fome others from them, in fome union together with it; and fo is Impregnate herewith: as Water, by paffing through a Mineral Vein, becomes tintured with that Mineral.

20. §. The Sap thus Impregnate with fome united Principles of the Parenchymous Fibres, paffeth on to the Lignous Veffels, whereunto their correfpondent Principles also enter; fo Water, Saline, Oleous and Earthy chiefly. (e) And becaufe the Parenchymous Principles mixed with them, are in fome degree united, and fo more ready to fix; fo of them, thefe therefore will likewife enter into the faid Veffels. Whereupon, the Alkali eleéturus of the one, and the Acidum SPIRITUOUS of the other, meeting together; Théfe, with the other Principles, all converge, and of divers fluids, become one fixed Body, and are gradually agglutinated to the Veffels; that is, The Veffels are now nourifhed.
22. §. The supply of the Sap still continued, the Principles thereof will not only enter into the Body of these Parts, but also their Contours.

And the Parenchymous Fibres being wrapped about the Vessels, (a) as often as the said Fibres are more surged with their own contained Fluid, they will thereby be somewhat floriunto, or contract in length; and so must needs bind upon the Vessels, and thereby, as it were, squeeze some part of the Fluid, contained both within themselves and the Vessels, back again into the Bladders.

23. §. And the Sap herein, being thus tinctured with some of the united Principles of the Vessels, divers of them will now also intimate themselves into the Parenchymous Fibres, and be incorporated with them: Whereby, the said Fibres, which before were only relaxed and dilated, are now also nourished, and not till now. Some portion of the united Principles both of the Parenchymous and Lignous Parts, being necessary to the true nutrition of Each: As the Confusion and joint affilience of both the Arterious and Nervous Fluids, is to the nourishment or coagulation of the Parts in Animals.

24. §. Some portion of the Sap thus doubly tinctured, is at the same time transmitted to, and enters the Body of the Aerial Vessels; consisting chiefly of Water, Air, and Acid; and, in like manner, as in the other Parts is herein agglutinated. And the appendage and pressure of the Sap still continued, some portion hereof is also projected into the Contours of the said Vessels; exsisting therein as a most compounded Fluid; par-taking, more or less, both of the Principles and Tinctures of the other Organical Parts, and of the Aerial Vessels themselves; being as it were, a Mixed Resolution from them all.

25. §. And the Parenchymous Fibres being wrapped about these, (b) P. 1. 6., as about the other Vessels, (b) and, in like manner, binding upon them; they thus frequently squeeze some part of the said contained Fluid out again: As necessary, though not to the immediate Nourishment of the Parts; yet the due Qualification of the Sap's being a Conitant Aerial Ferment, successively stored up within the Aerial Vessels, and thence trans-ferred to the Sap, in the other Organical Parts.

26. §. And that there may be a better Transition of the Sap thus tinctured, to the several Organical Parts; therefore, none of them are close set and compact within themselves, severally: For so, they would be inaccessible to the Sap, and their inward Portions, wanting a due supply of Aliment, would be starved. But the Vessels, both of Air and Sap, being every where divided into Braced Portions, and other Parenchymous Portions, filling up the spaces every where betwixt them (c) there is therefore a free and copious communication of the Sap, (and so of all the Tinctures successively transversed into it.) from Part to Part, and to every Portion of every Part. The Parenchymous Portions, running betwixt the Braces, as the smaller Vessels do throughout the Viscera, in Animals. Whereby, none of them want that Matter, which is necessary either for their Nutrition, or for the good Effate of their Contents, or for the due period of their Growth.

27. §. For the better Tempering of the several parts of the Sap, serve the Diometral Portions of the Parenchymous Body which run sometimes directly through the Barque, as in Looage, Parsley, &c. is described and figured (d) Which being, all or most of them, continued be twixt both the Succiferous and the Aerial Vessels, from the Circumference

(a) P. 1. 6.
(b) P. 1. 6.
(c) P. 1. 6.
(d) P. 1. 6.
Book II. of Roots.

85

to the Centre; they hereby carry off a more Copious and Aerial Ferment from the One, and communicate it unto the Other. For as the Sap enters the Bark, the more liquid part, still paleth into the succulent Portions thereof; the more Aery, is separated into those White and Dryer Diametral ones; and in its passage between the Portions of the Aery Vessels, is all along communicated to them. Yet is it not a pure or simple Aery, but such as carries a Tincture with it, from the Succiferous Vessels. And therefore it is observable, That when the Diametral Portions are more distant, the Sap-Vessels run not in a Straight Line between them, but are Reciprocally so inclined, as to touch upon them, as in Launch is visible: Thereby communicating their Tincture to the Aery, as it paleth by them, through the said Diametral Portions.

28. §. By the continual appulse of fresh Sap, some, both of the aery, and of all the other parts thereof, are transmitted into the Pith; where, finding more room, it will yet more kindly be digested. Especially having the advantage herein of some degree of Warmth; being herein remover from the Soil, and, as it were, Turn'd up within the Wood, or the Mas of surrounding Vessels. So that the Pith, is a Repository of better Aliment gradually supplied to those Succiferous Vessels, which are frequently scattered up and down therein, and which ascend into the Trunk. (e) But where no succiferous Vessels are mixed, herewith, it usually becomes Dryer, and is replenished with a more Aerial and Warmer Sap; whereby the growth of the Caulis is promoted, as by an Hot Bed set just under it. And in many Plants with divers knobbed Roots, the younger are more succulent, serving chiefly to feed the Stalk: the Elder are spongy and full'd with Aery, for the fermenting of the Sap, and more early growth of the Stalk: as in little Celadine, Dogstones and all of that Kindred. And thus all the Parts have a fit Aliment provided for their Nourishment.

29. §. IN THIS Nourishment, the Principles of the Sap are, as is How the said, concentrated and locked up one within another: (b) Whence it is, that the Organical Parts, being cleanse'd of their Contents, have none of them any Taste or Smell, as in the Piths of Plants, Paper and Linen Cloth is evident. (c) Because till by Digestion, violent Distillation, or other way, they are resolved, they cannot act upon the Organ of those Senses. For the same reason, they are never tintured, excepting by their Contents: and although, to the bare Eye, they frequently shew White, yet viewed through a Microscope, they all appear transparent. In like manner, as the Serous of Blood, Whites of Eggs, Tendons, Hairs and Horns themselves are transparent, and without much Smell or Taste, their Principles being, in all of them, more or less concentrated: But when ever these Principles, are forcibly resolved, they are ever variously invested with all those Qualities.

30. §. And as from the Concentration of the Principles, in every Organical Part, the said Parts do thus far, all agree: So, from the Predominion of the Principles of each Part, the rest are controled, not only to a Concentration, but an Assimilation also; whereby, the Specific Differences, of the several Organical Parts, are preferred. Hence the succiferous Vessels are always Tough and very Pliable; for so are all Barques, wherein these Vessels abound; so is a Handful of Flax, which is nothing else but a heap of the succiferous Vessels in the Barque of
that Plant. For besides Water, and Earth, an Alkaline Salt and Oyl are, as is said, the predominant Principles of these Vessels. (a) It is then the Oyl, chiefly, by which these Vessels are Touched: for being of a tenacious Nature, by taking hold of other Principles, it marries them together; and the Alkaline Salt and Earth, concurred with it, addeth to it more Strength. Hence the Caput Mortuum of most Bodies, especially those that abound with Oyl and a sal Alkali, is brittle and friable; those Principles, which were the Ligaments of the reft, being forced away from them. From the fame Cause, the Parenchymous Parts of a Root, even in their Natural State, are brittle and friable; for, because their Earthy, and especially Oleous and Saline Principles are, as is said, (b) so very few. Therefore all Plants and more simple Parenchymas, break short, so Corn, and the Roots of Potato's, and divers other Plants, being dry'd, will easily be rub'd to Meal; and many Apples, after Frosts, eat mealy; the Parenchymous Parts of all which, are not only by Analogy, but in Substance or Essence, the elfe fame Body. (c)

Lib. 1. c. 7. § 14. 31. § And as the Confluence of the several Organical Parts, is dependent on their Principles; so are their Figures. And first, the succederous Vessels, from their Alkaline Salt, (d) grow in Length. For by that Dimension, chiefly, This Salt always grows: And being a less moveable Principle than the reft, and so apt more speedily to fix, or root: It thus overrules them to its own Figure. And even as the Shape of a Button dependeth on the Mould, the Silk and other Materials wrought upon it, being always conformable therunto: so here; the salt is, as it were, the Mould; about which, the other more passive Principles gathering themselves, they all conform and fashion to it. Hence also the fame Sap-Vessels are not pyramidal, as the Vess of Animals; but of an equal bore, from end to end; the stalkings of the said Salt, being also figured more agreeably to that Dimension. And as by the Saline Principle, these Vessels are Long: so by the Oleous, (e) they are every where Round, or properly Cylindrical; without some joynct Efficacy of which Principle, the said Vessels would be Flat, or some way Edged and Angular, as all saline shoots, of themselves, are; as those of Alum, Vitriol, Sul Ammoniac, Sea Salt, Nitre, &c. And because the Spirituous and more Fluid part of the Principles, is leaft of all apt to fix; while therefore, the other parts fix round about, This will remain moveable in the Centre; from whence every Vessel is formed, not into a field, but hollow Cylinder; that is, becomes a Tube.

32. §. The Lactiferous Vessels are tubulary, as the Lymphaducts, but of a somewhat wider Concave or Bore. For being their Principles are less Earthy and Oleous, and also more loofely Concentrated; as from their eafe corruption or Resolution by the Air, it appears they are: they are therefore more tender, and so more eaily diflative, and yielding to the said Spirituous part in the Centre. And by this means, obtaining a wider Bore, they are more adapted to the free motion of the Milky Content: which being an Oleous and Thicker Liqueur, than that in the Lymphaducts; and having no advantage of pulsation, as the Blood hath in Animals; might sometimes be apt to stagnate, if the Vessels, through which it moves, were not somewhat wider.
33. 6. As the saline Principle is the Mould of the Succiferous, so is the Aerial of the Aer-Vessels. (a) Now the Particles of Aer strictly so called, at least of that part of it concerned in the Generation of the Aer-Vessels, I suppose, are crooked: and that by composition of many of those crooked ones together, some of them become Spiral, or of some other winding Figure: and that thereupon dependeth the Elastic Property of the Aer, or its being capable of Rarefaction and Condensation by force. Wherefore, the laid crooked Particles of the Aer, first flowing and setting together, as the Mould, the other Principle clinging and fixing conformably round about them. So that, as by force of the saline Principles, the rest of them are made to shoot out in Long continued Fibres so by force of the Aerial, those Fibres are still disposed into Spiral Lines, thus making up the Aer-Vessels. And according as there are fewer of these Aerial Particles, in proportion to the saline, the Concave of the Aer-Vessels is variously wider, or the Fibres continue their shooting by wider Rims; as those that come nearer to a right Line, and so are more com[pliment to the Figure and shooting of the saline parts. And whereas the lymphedalus, shooting out only in length, are never sensibly amplified beyond their original size: Those, on the contrary, always more or less, enlarge their Diameter; because their Fibres, being disposed into Spiral Lines, must needs therefore, as they continue their growth, be still dilated into greater and greater Rims. And being at the bottom of the Root more remote from the Aer, and so having somewhat fewer Particles purely Aerial, there ingredient to them, then at the top; they fall more under the government of the Saline, and so come nearer to a right Line, that is into greater Circles; and so the Aer-Vessels, made up of those Circles, are there generally wider. (b) (d) P. 167. 15.

34. 6. By mediation of their Principles, the Parenchymous Parts § 16. likewise of a Root have their proper Contexture. For from their Acid Salt they are Fibrous; from their Opf, the Fibres are Round, and in all parts even within themselves, and from their Spirit, it is most probable, that they are also hollow. But because the Spirit is, here, more copious than the Aer; and the saline Principle an Acid, (c) (e) § 19, and so, more under the government of the Spirit, than an Alkali; therefore are not the said Fibres continued in Straight Lines, as the Sap-Vessels; or by one uniform motion, into spiral lines, as the Fibres in the Aerial; but winding, in a circular manner, to and fro a thousand ways, agreeable to the like motions of the Spirit, that most abounds, and here most predominant Principle. And the Spiritual Parts being, as is said, here more copious and redundant, they will not only suffice to fill up the Concaves of the Fibres, but will also gather together into innumerable little spaces, without them: whence the Fibres cannot wind close together, as Thred, in a Bottom of Yarn; but are forced to keep at some distance, one parcel from another, and so are disposed, as Bread is in baking, into Bladders. (d) (d) § 16.

35. 6. And the under Fibre being first sift, as the Warp, the Spiritual parts next adjacent, will incline also to sift; and so govern an overwork of Fibres, wrapping, as the Woof, in still smaller Circles round the other: whereby they are all knit together. (b) For the same reason the Lymphedalus being first formed, the Parenchymous Fibres sift and wrap about these also. (f) And the Aer-Vessels being formed
formed in the Center, the succiforous run along those likewise (as volatile Salts shoot along the sides of a Glass, or Frost upon a Window) and so are, as it were, Incrustate about them in a Ring.

36. §. SOME OF THE more Etherial and Subtil parts of the Aer, as they stream through the Root, it should seem, by a certain Magnificence, do gradually dispoze the Aer-Vessels, where there are any store of them, into Rays. This Attraction (as I take leave to call it) or Magnetick power betwixt the Aer and these Vessels, may be argued, from the nature of the Principles common to them both: From the Electrical nature of divers other Bodies; the Load-stone being not the only one which is attractive: And from other Effects, both before (a) and hereafter mentioned. Wherefore in the inferior parts of the

(c) Lib. 1.

Book II.

2. §. The said Etherial parts of the Aer, have a Power over the Aer-Vessels not only thus to dispoze them; but also to sollicitate and spread them abroad from the Center towards the Circumference of the Root. By which means, those Roots which have no Pith in their lower parts, obtain one in their upper. (c) And the same Pith, which in the lower part, is ratably, small, in the upper, is more or less enlarged. (d)
Vessels, although they are joyned to the Aerial by the Parenchymous Fibres, (c) yet are not continuous with them; neither fall under (d) P.t. c.5. the like Attractive Power of the Aerial do; the Aerial §. 12. therefore, upon their spreading, do not always carry all the Succiforous along with them; but often, if not always, leave many of them behind them prinkled up and down the Pith; as in Parsley, Carrot, Jerusalem Artichoke, Turnip, &c. may be seen.

40. §. The spreading of the Aer-Vessels still continued, several of them, at length, break forth beyond the circumference of the Root; and so are distributed, either in the lower parts, into Branches and Strings; or at the top, into Leaves. And left they should all spread themselves into Leaves, and none be left for the Caulis; as where they are very small, or the Sap-Vessels to bound them, are but few, they might; therefore divers of them are, oftentimes, more frequently braced in the Centre; for which reason, they cannot so easily separate and spread themselves from thence, but run more inwardly up into the Caulis, as in Borage.

41. §. FROM THE various sizes, Proportions, and Dispositions of the Parts, Roots are variously fixed, shaped, moved and aged. Those which, by their Annual Growth, are large; have fewer, both Aerial, and Sap-Vessels, and a more copious Parenchyma. So that the Aer-Vessels, or rather, the Aery Ferment contained in them, volatilizing only a smaller portion of the Sap; the said Sap is less capable of advancement into the Trunk, and so must needs remain and fix more copiously in the Root, which is thereby more augmented. And where the Sap-Vessels alone, are but few, the Root is yet, ratably, somewhat large: but where they are numerous, it is never so, as to its Annual Growth, in any proportion to their Number: Because their Tincture, which is Alkaline, will go farther in setting the Parenchymous Parts; than the Tincture of these, which is Acidulate, will go, in setting them. (b)

42. §. When the Aer-Vessels are more pliable and frequent to the Attraction of the Aerial, and so spread themselves, and the Succiforous together with them, more abroad; in the manner as hath been said; the Root also will grow more in Breadth; the nutrition of the Parenchymous Parts, to which the Vessels are adjacent, being thus, by the same dimension, more augmented; as in Turnip, Jerusalem Artichoke, &c. But where these are not spread abroad; the Root is but slender; as in Asparagus, Dandelion, &c.

43. §. If the Aer-Vessels be contracted into, or near the Centre, and are somewhat Large or Numerous; and the Succiforous, also more copiously mixed with, or surrounding them; the Root grows very long; as do those of Fenil, vine, Liquorish, &c. For the Aer-Vessels containing a more copious Ferment, it will well digest and mature the Sap: Yet the Succiforous being over proportioned to them; the Sap will not therefore, be so far volatiliz'd, as to ascend chiefly into the Trunk; but only to subserve a fuller Growth of their Vessels: which being more numerous, and so more sturdy, and less frequent to the expansive motion of the Aerial; this their own Growth, and consequently, that of all the other Parts, cannot be so much in Breadth, as Length.

8 44. §.
44. §. Where the same Aerid Vessels are Fewer, or more Contractions, or sached in a Thicker and Closer Barque; the Root is smooth, and its Ramified, as in Asparagus, Peony, Danielson. But where more Numerous, sached in a Thinner Barque, Smaller, or more Dilated; the Root is more Ramified, or more Stringy, as in Cemane, Clay, Beet, Nicotiana. For being, as is said, by these means, more frequent to the Attraction of the Air; approaching still nearer the circumference of the Barque, they at last strike through it, into the Earth. And the Parenchymous Fibres being wrapped about them, and the Succisfors Vessels knit to them by those Fibres; (a) therefore they never break forth naked, but always invested with some quantity of these Parts as their Barque: where by, whatever Constitutive Part is in the main Body of the Root, the same is also in every Branch or String.

45. §. From the same Expansion and Pliability of the Aer-Vessels, the Root oftentimes putteth forth Root-Buds; which gradually shoot up and become so many Trunks. In the Formation of which Buds, they are pliable and receetive all kinds of ways; being not only invited Outward, toward the Circumference of the Root, as in Root-strings, but also spread more Aroad every way, so as to make a Root-Bud: Where as in the said Root-strings they are always more Contracted. Which, in respect of the Disposition of the Parts, is the principal difference between the Root and the Trunk, as hath been said. (b) Hence, those Roots, chiefly, have Root-Buds, which have the smallest Aer-Vessels; (c) these, as is said, being the most pliable and Expanfive.

46. §. But because the expansiveness of the Vessels, dependeth also, in part, upon the Fewness of their Brace; therefore the said Buds shoot forth differently, in divers Roots. Where the Brace are fewer, the Buds shoot forth beyond the Circumference of the Root, as in Jerusalem Artichoke; where more close, as in Potato's, the Buds lie a little asconded beneath it; the Aer-Vessels being here, by their Brace, somewhat check'd and curbed in, while the Barque continueeth to swell into a fuller Growth.

47. §. If the Aer-Vessels are all along more equally fix'd, the Root is so also, or Cydindrical; as are those of Eringo, Horse-Radish, Marshmallow, Liquiritia, &c. But if unequal, growing fully wider towards the bottom of the Root; then the Root is unequal also: But growtheth, as is observable, quite contrarily to the Aer-Vessels; not Greater, as They do; but still smaller, or pyramidal; as in Fennel, Borage, Nettle, Patience, Thorn-Apple, &c. is apparent. For the Aer-Vessels being considerably wider about the bottom of these Roots; they there contain a more Copious Ferment: Whereby the Sap is there also more volatilized, and plentifully advanced to the Upper Parts. Withal, thus receiving into themselves, and so transmitting to the upper Parts, a more plentiful Vapour, they hereby rob the Parenchymous Parts of their Aliment, and so limit them in their Growth.

How Roots. 48. §. FROM THE different Proportions and Situation of the are diffently Parts, the Motions of Roots are also various. For where the Aer-Vessels are spread abroad and invested with a thinner Barque; the Root runs or lies Level, as in the level-Roots of Primrose, Bishops-weed, Aconite, &c.
may be seen. So that these Roots, as by the Perpendicular Strings, which shoot from them into the Earth, and wherein the Aer-Vessels are contracted into their Center, they are Plucked down (a): So by (b) P.t.c.t. the Aer-Vessels, which stand nearer the Aer, and more under its Attractive Power (b) they are invited upwards; whereby they have (b) P. 2, neither ascent nor descent, but keep level, betwixt both.

49. §. But if these Vessels are Contracted, standing either in, or near the Centre, and are invested with a Barque proportionally Thick; the Root striketh down perpendicularly, as doth that of Delphin, Bugloss, Parsnip, &cc. And therefore the said Vessels, although Tab. 7, 8, they are spread abroad in the level Roots, yet in the perpendicular ones of the same Plant, they are always contracted; as by comparing the Level and Down-right Roots of Ammi, Primrose, Jerusalem Artichoke, Corn, &c., and others, is manifest.

50. §. If the Aer-Vessels are Contracted, and Environed with a greater number of Succiferous, the Root grows deep; that is, perpendicular and long. (c) Perpendicular, from the Contraction of the Aer-Vessels; (d) and long, from the Predominion of the Succiferous, which in their growth, are extended only by that Dimension, as in Liquiritia, Bryony, &c.

51. §. If the Succiferous are over proportioned to the Parenchymous Parts, but under to the Aer-Vessels; the Root is perpendicular still, but growth faltlow: The Succiferous being firmly enough to keep it perpendicular; But the Aer-Vessels having a predominion to keep it from growing deep; as in Stramonium, Nicotian, Beet, &c. Tab. 7.

52. §. If, on the contrary, the Parenchymous Parts are predominant to the Aer Vessels; and that, both in the Root and Trunk; then the whole Root changeth place, or descends. (e) For the said Aer-Vessels, (f) P. t. c.t. having neither in the Trunk, nor in the Root, a sufficient Power to. §. 10. Lib. 1. Draw it upwards; it therefore gradually yields to the Motion of its c. $a, b, e$, and String-Roots; which, as they strike into the Soil, Pluck it down after 4. Append. them. And because the old Strings annually rot off, and new ones §. 10. P. 2, successively shoot down into the Ground, it therefore annually fall descendeth lower; as in Tulip, Lily, &c., may be observed.

53. §. Where the Aer-Vessels are much spread abroad, and also numerous, the Root oftentimes, as to its several parts, descends and ascends both at once. So Radishes and Turnips, at the same time, in which their neither parts descend, and in the only which, the lower parts ascend, of their upper, (where the said Vessels are more loofely braced, and spread more abroad than in the lower parts) do Tab. 2: ascend, or make their Growth upward. Hence also, the upper part of most young Roots from Seed, ascends: Because the first Leaves, being proportionably large, and standing in a free Aer, the Aer-Vessels therein, have a dominion over the young Root, and so themselves yielding to the solicitation of the Aer, upwards; they draw the Root, in part, after them.

54. §. BY THE Situation and Proportions of the Parts, the Age How Root of the Root is also varied. For if the Sap-Vessels have the greatest proportion, the Root, is Perennial, and that to the farthest extent, as by Age. in Trees and Shrubs. Because these Vessels containing a more copious Ope; (f) and their several Principles being more closely Concentred (f.) P. 2, they are less subject to a Resolvent, that is, a Corruption or Mortification §. 21, on by the Aer.
55. §. If the Parenchymous Parts have much the greatest, the Root seldom liveth beyond Two Years; but afterwards perish both either in whole, or in part; as do divers bulbous, tuberous, and other Roots; whether they are more Porous and Succulent, or more Cloze and Dry. If Porous, all the Liquid Principles standing herein more abundant, either by a stronger Fermentation, or otherwise, Resolve the fixed ones of the Organical Parts; whence the whole Root, rots; as in Potato's. So also Parsnips, and some other Roots, which, in a hard and barren soil, will live several years, in another more rank, will quickly rot. If the Parenchyma be Cloze, then the Aer, chiefly, entering in and filling it up, thus mortifies the Root; nor by Rotting the Parts, but over Drying them; as in Satyrion, Rape-Crowfoot, Monkshood, &c. (a)

56. §. But if the Aer-Vessels have the greatest Proportion, and especially if they are more large, and withall, are spread more abroad: the Root is Annual, as in Thorn-Apple, Nicotian, Cardaus Ben. &c. And of the same Kindred, if any, those are Annual, which have the most Aer-Vessels. So Endive and Sonsbe, which have more of Aer-Vessels, are both Annual: whereas Chicory, in which they are fewer, is a Perennial Root. For hereby a more copious Aer being Transmitted into all the other Parts; (b) they are thus, by degrees, hardened, and become ficky; and so impervious to the Sap, which ought to have a free and universal Transition from Part to Part. As Bones, by Precipitations from the Blood, at length, cease to grow. Or the same more abundant Aer, so far volatilizeth the Liquors in the Root, that they are wholly advanced into the Trunk, and so the Root is starved. Whence also the Aer-Vessels of the Trunk, where they are numerous, and over proportioned to the Bulk of the Root, as in Corn, they do far promote the advance of the Sap, as to exhaust the Root, fucking it into a Consumption and Death.

57. §. FROM THE Principles of the Parts, their Contents and the several Qualities hereof are also various; (c) the Fluid of each Organical Part, being made, chiefly, by Filtration through the siles thereof; such of the Principles in the Sap, being admitted into, and transmitted through them, as are aptest thereunto. In the like manner, as when Oyl and Water, being poured upon a Paper, the Water paflieth through, the Oyl sticks; or as the Chyle is strained through the Coats of the Guts, into the Lactic Vessels: or as Water in Fugations, is strained through the Glands of the same Guts, from the Mecantical.

58. §. The Principles therefore of the Parenchymous Fibres being spiritual, acid, and aerial, they will also admit the like into them; excluding those chiefly which are Alkaline and Oleous. (d) And as by the Conjugation of such Principles in the Fibres, the like are capable of admittance into their Body: so the Proportion and Union of the same Principles, regulates the transmission hereof into their Concave. Wherefore, the predominant Principles of the Fibres being chiefly acid, next spiritual, and airy, the more airy ones will be transmitted. For if more of them should fix they must do so by similitude and adhesion: But where there are fewer fimilar parts to adhere to, fewer must adhere. The Fibres therefore contain so many parts of Aer, as to admit many

(a) P. 1, 4. 6. 13, 16, &c.
(b) P. 2, 5.
(c) P. 2. 5.
(d) P. 2.
§ 19.
many more into their Body; but not to fix them; which therefore must needs, upon admission, pass through into their Concave; where, together with some other more spirituous parts, they make an Aetherial Fluid. And because some aqueous or vaporous parts will also drain through with them; hence it is, that as more and more of these enter, they by degrees fill throut out the airy ones; which quitting the more succulent Fibres of the Parenchyma, are forced to betake themselves to the dryer ones, &c. all those, whereof the Diametral Portions do confit. For the time reason the Aery parts being gradually excluded the succulent Fibres of the Barque; they are forced to recede and transmigrate into those of the Pith. And the Fibres of the Pith themselves being filled, and the Aery parts fill forced into them; they at length also drain through the Fibres into the bladders: whence it comes to pass, that while the Barque is succulent, the Pith is often times filled with Aery.

59. §. The Lymphaduits being more earthy, Salinous; olaceous, and aqueous, will both admit and copiously fix the like Principles, as their proper Aliment. The Water being more plentiful than the reft, will therefore drain, with a lighter Tincture of them, into their Concave. Especially the Oleous parts of these being rampant, and leapt to fix and seize the aqueous, upon their entrance, than the saline.

60. §. The Lacticitious, appearing to be made, chiefly, by the Conspiritation of the Parenchymous Parts all round about their Sides; the Liquor contained in those Parts, although it may eafily enough be transfused into the Hollow of these Vessels; yet seems it not, with equal facility, to be refunded thence: So that the thinner and more aqueous Portion only, paffing off; the remainder, is, as it were, an Oleous Bixyr, or extract, in the form of a Milk.

61. §. The Fluid Ferment contained in the Aery-Veſſels, is alfo in part, dependent on the Principples of those Veſſels, being in their percolation tinchiured therewith. But because the percolation is not made through the Body of the Fibres whereof the Veſſels are compos'd, but only betwixt them; therefore the transient Principles more promiscually, yet with an over proportion of dryer Particles, pass into the Concave of these Veſſels, and are herein all immerfed in a Body of Aery. (a) The Fibres themselves, in the mean time, as thoſe of the Parenchyma, admitting and containing a more Aery and Aetherial 9. 24. Fluid.

62. §. The Contents are varied, not only by the Nature, but alfo the proportion and situation of the Parts, whereby the said Contents are with different Facility and Quantity, communicated one to another. Hence it is, partly, that a Pine, or that Corn, hath fo little Oyl: fo because their Aery-Veſſels, in proportion with the other Parts, are fo Great and Numerous: in Corn, the Stalk being alfo very hollow, and fo becoming as it were, one Great Aery-Veſſel. For the Oily parts of the Sap, are fo exceedingly attenuated (b) by the Aery Ferment contained in these Veſſels; that they are, for the moft part, fo far immerfed in the Spirit, or mixed therewith, as not, by being collected in any considerable Body, to be diftinguifhable from it. And the affinity that is betwixt Spirits and Oils, especially Effential, is manifest: Both are very inflammable; both will burn all away; The Oders, which we call the Spirits of Plants, are lodged in their effential Oyl; Both, being duly
duly Resolved, will mix as easily together, as Water and Wine. So
that, although Oyl, by the separation of its earthy and Saline parts,
which give it its feebly oleous Body, may not be so far attenuated, as to
produce a spirit; yet that it may so far be attenuated, and so be mixed
therewith, as not to be discerned from it, as in the forementioned Plants,
will be granted.

62. §. Hence it is, that the Lactiferous standing more remote
from the Aer-Vessels, and the succiferous interpolating; (a) the Liquor,
therefore, contained in them, is not so much under the government of the
Aerial Ferment, and is thence, partly, more Oily. For the same rea-
son, all Roots which are Milky, so far as I have observed, have an un-
der-proportion of Aer-Vessels; thence being either Fewer or Smaller.

How the Odours of Plants are made.

64. §. FROM what hath been said, we may receive some
information, likewise, of the Odoirs, Colours, and Tafes of
Plants. And for Odoirs, I suppose, That the chief Matter of them,
is the Aerial Ferment contained in the Aer-Vessels. Not but that
the other Parts do also yield their smell; but that these yield the
strongest and the best, and immediately perceptible in fresh, undried and
unbruised Plants. For the Aer entering into, and passing through the
Root, and carrying a Tincture, from the several Organical and Con-
tained Parts, along with it, and at last entering also the Concavities of
the Aer-Vessels; it there exists the most Compound and Volatile Fluid,
of all others in the Plant, and so the fittest matter of Odoir; and
such an Odoir, as answers to that of all the Odorous parts of the
Plants. (b) Wherefore the Organical Parts, being well cleaved of their
Contents, smell not at all; Because the Principles hereof are, as hath
been said, so far fixed and concentrated together. Hence also the Contained
Parts themselves, or any other Bodies, as their Principles are any way
more fixed, they are less Odorous: So is Rosin, less than Turpentine,
and Pich, than Tar; and many the self same Bodies, when they are
cognated, less than when they are melted. So also Musk, which is
not so liquid as Civet, is not so strong; nor Ambergriss, as Musk:
For although it hath a more excellent smell, than Musk hath, yet
yields it not so easily; since it is a more fixed Body, and requireth
some Art to be opened. Hence also the Leaves of many Plants lose
their Odoir upon rubbing: Because the Aer-Vessels being thereby bro-
ken, all their contained odorous Fluid vanisheth at once; which be-
fore, was only strained gradually through the Skin. Yet the fixed
Parts themselves, upon drying, are so far altered by the Sun and Aer,
as to become resoluble, and volatile, and thence odorous.

How their Colours.

65. §. SO ALSO of their Colours. As whence the Colours of the
Skins are varied. For divers of the Sap-Vessels, together with the
Parenchymous Parts successively falling off from the Barque into the
Skin; (c) by their proximity to the Earth and Aer, their Sulphurous or
Oleous Principle is more or less resolved, and so produceth divers Col-
ours. So thefe Roots which turn purple any where within, have
usually a blacker Skin; the one of those two Colours being by a refo-
lution and corruption of parts, easily convertible into the other, as
in Country, Thistle, &c, So the Milk of Scorzonera, contained in
the Vessels of the Barque, upon drying, turneth into a brown Col-
our:
Book II.

of Roots.

95

low: Wherefore the skin, in which there are divers of those Vessels, is of the same. So both the Milk and Skin of Looage is of a brownish yellow. But Parsely hath a clearer Sap in all its Vessels, and a whiter Skin. So Potato's, being cut traverse, after some time out of ground, have divers red specks up and down where the Vessels stand, and their skin is accordingly red.

66. 6. The reason, I say of these Colours, is the resolution or seperation of the Principles of the several Parts, chiefly, by the Air, and a lighter mixture of them consequent thereupon: whereby the Sulphurous or Oly Parts, which were before concentrated, are now more or less rampant, discovering themselves in divers Colours, according as they are diversely mixed with the other Principles. Hence these Colours are observable, according to the nature of the Parts wherein they are, or whereunto they are adjacent: So where the Lymphedulas doe run, there is a Red, or some other Sulphurous Colour; the Oleous Principles being, as is said, (a) more copious in these Vessels; as (a) P. 2. in the Bark of Peony, the inward parts of Potato's, &c. may be seen. But the Parenchymous Parts, where more remote from the said Vessels, they are usually White, or but Yellow: the Sulphurous Principle of these Parts, being, as hath been said, but sparing. (b) The fame is seen in those Roots which chew both Red and Yellow: tho' 9. 20. Parts, principally, where the Succiferous Vessels run, being Red; but those Parts, where only the Aer-Vessels are mixed with the Parenchymous, being Yellow: as in Patience. So likewise the pithy part of a Carrot, where the Aer-Vessels have very few Succiferous mixed with them, is Yellow: but the Barque, where the Succiferous are very numerous, is Red. For the same reason, many Roots, which are Whiter in their upper parts, are Purple or Reddish in their inferior, as Avena, Strawberry, &c. Because those lower parts, having lain longer (c) under ground (these being descending Roots) their (c) P. 6. Principles are, thereby, somewhat more resolved, and so the Oleous, their (n) F. 6. 13. and spread all over the rest in that Colour.

67. 5. And that the Resolution of the Sulphurous and other Principles is partly effected by the Air, appears in that, where the Air hath a free access to the Succiferous Vessels, the Colours are there, chiefly produced, or are more conspicuous. So in Potato's, where the Succiferous Vessels are either next to the external Air, as in the Skin; or contiguous with the Aer-Vessels, as in the Ring within the Barque; there, they produce a Red; but where more remote from both, as in the middle of the Barque, and Centre of the Root, there they produce none. Hence also it is, that the Leaves and Flowers of some Plants, as Bloodwort, Wood-Sorrel, Radish, Jacon, &c. although Green or White in the greatest portion of their Parenchymous Part; yet where the Succiferous and Aer-Vessels run together, they are of Red, Blue, and other Colours: the Oleous parts of the one, being unlocked and opened, by the air of the other.

68. 6. AND LASTLY, of their Taft. Most Roots which are How their acres or biting, have a very copious Parenchyma in proportion with the Succiferous Vessels, as of Arum, Dragon, and others: Because the Saline and other Principles are not so much hot, by any sufficient quantity of Sulphurous, from those Vessels, in which the Sulphur, as is said, is more abundant; (a) but rendered rather pungent, from some
some Spirit and Aër. But divers Umbelliferous Roots, especially which abound with Latifrons Vessels, are hot as Fennel, Lovage, Angelica, &c. Yet is it not their Oyl alone that makes them hot, but the combination thereof with the Saline Parts: as is manifest, from the nature of the Seed of these Plants; wherein, as the Oyl is most copious; so being held to a Candle till they burn, constantly spit; which cometh to pass, by the eruption of the Saline Parts: and is the very same effect, with that which followeth upon burning of Serum or Blood. And therefore, as these seeds are more hot, they also spit the more; so those of Cusine, which, though fmall, yet are not so hot, spit less; Fennel and Dill, which are bitter, more; there being a greater quantity of volatile Salt contained herein. Hence all Essentiel Oyls are hot, the Spirit and volatile Salt, being incorporated herewith. And some of them will fount, and crystallize as Sails do, as that of Anife, which argues a mixture of a considerable quantity of volatile Salt. As also both the Nature of these Oyls, in being amicable to the Stomach, Carminative, and sometimes Aodyne; fail, as they kill some feds, or corrosive Acid: for volatile Sals themselves will have the like operation in some cafes as these Oyls.

69. §. Many Latifrons Roots, as Taraxacum and others of that kind, are not so much hot, as bitter. For although by the Latifrons Vessels they are very Oly; yet those Vessels being pointed in rings, and not in Rays, and having no Diametral Portions running through their Barque to the Aër-Vessels; the Acid-Aerial Parts do hereby, although not mortife, yet so far refract the saline, lightly binding up the Oleous therewith, as to produce a bitter Taste. So, many sweet Bodies, upon burning, become bitter; the Acid Parts, now becoming rampant, and more copiously mixed with the Oleous.

70. The Roots, or other Parts, of many Umbelliferous Plants, have a sweetish Taste, as both the Sweet, and Common Chervils; both the Garden, and wild Carrot; Parsnip, Fennel, &c. The Saline Principles being concentrated in the Oly; and both of a moderate quantity with respect to the reft. For by the Oly, the Saline is rendered more smooth and amicable; and both being moderate, they are not therefore hot, as in some other Umbelliferous Roots; but by the predominance of the other Principles, made mild. Hence it is, that Sugar it felf is fweet, fail, because it is an Oleous Salt; as is manifest, from its being highly inflammable; its facile dissolution by a moderate, Fire, without the addition of Water; and in that, being melted with Turpentine, and other Oleys Bodies, it will mix together with them. So also the Acid Parts of Vinegar, being concentrated in the Salino-sulphurous of Lead, produce a Sugar. Hence Barley, which upon Distillation or Decotion yeildeth only an acid; being turned into Mault, becomes fweet. Because, being steeped, cooked, and fermented, the oleous parts are thereby unlocked, and becoming rampant, over the other Principles, altogether produce that Tafte. And the Bile it felf, which, next to Water and Earth, confifteth moft of oily parts, and of many both saline and acid is a bitter-sweet. Wherein, as some of the Saline and Acid parts, smoothed by the Oleous, produce a Sweet: So, some of the Oleous, impregnated with the saline, and the Acid, doe hereby produce a Bitter.
THE ANATOMY OF TRUNKS,

With an Account of their VEGETATION

Grounded thereupon.

The Figures hereunto belonging, Presented to the Royal Society in the Years, 1673 & 1674.

The THIRD BOOK.

By NEHEMIAH GREW M.D. Fellow of the Royal Society, and of the College of Physicians.


LONDON,

Printed by W. Rawlins, 1682.
THE

ANATOMY

OF

TRUNKS

WHEREON VARIOUS OBSERVATIONS

INVESTIGATION

Completed Perusing

The Report of the Proceedings of the Royal Institute in the Year 1763.

The Third Book

By Nehemiah Dronwn, M.D., Fellow of the Royal Society, and the Curator of the Museum.


London,

Printed by N. Rivington, 1764.
TO THE
Right Honourable
WILLIAM
Lord Vi-Count BROWNCKER
THE PRESIDENT;
AND TO THE
Council and Fellows
OF THE
ROYAL SOCIETY.

MY LORD,

THE Commands I received from Your Lordship, and the Royal Society, To prosecute the Subject treated of in the Two former Books; have produced This which follows. And I humbly submit the same to Your Lordships Judgment.

T. 2
The Epistle Dedicatory.

ment: which must needs be Candid and Benign, because it is Great. I have only this to say,

— Ἐκ Τεσσαρωνοί ἡρεμία το Αρχαδ;

Your Lordship will not disapprove the Enterprise, although it falls short of perfection. It being the result of Your Lordships manifold Virtues and Abilities. That You know how far to Encourage the meaneast Attempts; as well as rightly to Value and Assist the greatest Performances.

I am,

My Lord,

London, August 20. 1675.

Your Lordships most humble

and

most obsequious

Servant

NEHEMJAH GREW.
THE CONTENTS

The FIRST PART.

CHAP. I.

A Description of several Stalks or Trunks, as they appear to the Naked Eye.


CHAP. II.

Of the Barque, as it appears through a good Microscope.


CHAP. III.

Of the Wood.

The Contents.

CHAP. IV.

Of the Pith.

Description of the Pith, in General, 1. In the several Trunks or Branches aforesaid. As of the Size, 2, 3. Vessels, 4. Parenchyma and Bladders, 5, to 9. Apertures or Ruptures, 10. Some further Observations of the Pith, And of all the Pithy and Parenchymous Parts. And thence of the True Texture of a Plant, 11, to 15.

The SECOND PART.

CHAP. I.

Of the Motion and Course of the Sap.

CHAP. II.

Of the Motion and Course of the Air.

CHAP. III.

Of the Structure of the Parts.

CHAP. IV.

Of the Generation of Liquors.

CHAP. V.

Of the Figuration of Trunks.

CHAP. VI.

Of the Motions of Trunks.

CHAP. VII.

Of the Nature of Trunks, as variously fitted for Mechanical Use.
THE ANATOMY OF TRUNKS;
PROSECUTED
With the bare EYE,
And with the MICROSCOPE.

PART I.

CHAP. I.

The Descriptions of several Trunks, as they appear to the bare Eye.

1. O the end we may clearly understand, what the Trunk, Stalk, or Branch of a Plant, is; I shall by these Figures here before us, Describe the several Parts, whereof it is compounded.

2. And forexamples sake, I shall in the first place, Describe the Trunks of some Plants, as being cut tranversely, and accurately observ'd, they appear to the naked Eye. And some others, as by the length. Which having done,

I shall next proceed to a more particular Description of divers other Trunks and Branches as they appear through a good Microscope. In both thewings, not only what their several Parts are, as generally belonging to a Branch; but also, by a Comparative Prospect, in what respects they are specifically distinguished one from another; in the several Sorts of Branches.

3. 5.
2. § I SHALL begin where the Work of Nature appears least Diverfy'd: as in the Stalk of Maze or Indian Wheat. In which, although there are the fame Parenchyma, and Lignous Parts, as in all other Plants; yet is there neither Barque, nor Pith; the Vessels being dispersed, and mixed with the Parenchyma, from the Circumference to the Centre of the Stalk; Saving, that in and next the Skin, there seems to be no Aer-Vessels. Every where else, they run up, like fine Threads, through the length of the Stalk: Each Thread being also surrounded with Sap-Vessels; which in a Slice cut transversely, appear in very small and dark colour'd Rings. The like Structure may also be seen in the Sugar-Cane, and some other Plants.

3. § LET the next Trunk be that of Taraxacum, or Dandelion. In a Slice whereof, being cut transversely, is seen next the Skin, itself, a simple, white, and close Parenchyma or Barque: made up of Vessels; but such as are exceeding small; and hardly visible without a Glafs.

4. § Within this, fland Milk-Vessels in seven or eight distinct Columns, of different size: each Column being also made up of seven or eight Arched Lines. Between these Columns, run as many Diametral Portions, derived from the Barque, into or towards the Pith.

5. § Next within Thefe, fland the Aer-Vessels. Which are likewise divided, by the said Diametral Portions, into divers Arched Lines. The size of these Vessels, as well as their number, is small.

6. § Within Thefe, fland the Pith, confifting of very small Vessels or Bladders, as the Barque. 'Tis very small, the Diameter hereof, being scarce one fifth, of that of the Pith of Borage. But the Barque of Borago is not half so thick as this of Dandelion.

7. § FOR a Third stalk, we may take that of Borago; where-in there is some further Variety. For in a Slice hereof, cut transversely, there appears, first a Tough, yet Thin and Transparent Skin. Within this Skin, and Continous therewith, there is also a Thin Ring of Sap-Vessels: which, without being crufhed in the leaf, do yield a Lympba.

8. § Next flandeth the Parenchyma of the Barque. Which is made up of a great number of very small Vessels or Bladders. Upon the inner Verge of this Parenchyma, flandeth another Ring of Sap-Vessels: which also yield a Lympba; and that different, as is probable, from the Lympba in the utmost Ring. Hitherto goes the Barque.

9. § Adjacent to the Ring of Sap-Vessels, on the inner Verge of Barque, fland the Aer-Vessels on the outer Verge of the Pith. Not in a Ring; but in several Parcels; some Parcels or Conjunations, in the figure of little Specks; others, in little Arched Lines, almoft like an V Conjunct. And being viewed in a good Glafs, there appears to be within the compass of every larger Speck or Parcel, about 20 or 30 Aer-Vessels and within the smallest, about 8 or 10.

10. § The Pith, in a well grown stalk of this Plant, is always hollow. But originally, it is entire. It is likewise wholly made up of a great number of Vessels: of which, through a Glafs, some appear Pentangular, others Sexangular, and Septangular. Most of them are larger than those of the Barque; so as to be plainly visible to a naked Eye.

11. § A FOURTH Trunk, shall be that of Colewort, which seems likewise, to have at leaf, two Sorts of Lympba-dots. For being cut tranversely, as the former, we may observe, next the Skin, a very
very close Parenchyma, of a darkish Green. Wherewith are mixed some few Sap-Where, which give it that Colour.

12. §. Within This, stands a scalloped Parenchymous Ring, or a Ring of many short and slender white Arches. Which all round about the Barque, meeting together, run in so many white Diametral Portions, or extrem small Rays, into the Pith.

13. §. Betwixt these white Rays, and next of all to the solid white Arches, stand as many small Parcels of Sap-Vessels, like so many little Half-Ovals. Within each of which, is included a white Parenchyma.

14. §. On the inner Verrge of the Barque, stand another Sort of Sap-Vessels, in one slender and entire Ring. And so far goes the Barque.

15. §. Next within this Ring stand the Aer-Vessels, in several Parcels, diametrically opposite to the said white Parenchymous Parcels next without the Sap-Ring.

16. §. Last of all, and more within the Pith, stand the same kind of Sap-Vessels, as those of the Half-Ovals. Both these, by small lines, run one into another; thus, on both sides, hemming in the Aer-Vessels, and so making altogether, so many little Pyramids.

17. §. LET a Fifth be that of Holyoke. In which, the Curiosity of Nature, is still more copious: presenting us, as it seems, with Three sorts of Lymphadniti: Of which, two yield a Thin; the Third, a thick Lymph. For being cut, as before, next to the Skins, stands the Barque; somewhat close, and, in proportion, thick.

18. §. Towards the inner Verrge hereof, stand one sort of Sap-Vessels, postur'd like-wise in short Rays. These Vessels yield a Maculage. And on the inner Verrge of the Barque, stands a Thin Ring of other Sap-Vessels, which yield a thinner Liqueur. 

19. §. Next within the Barque stand the Aer-Vessels, postur'd like-wise in short Rays, diametrically opposite to those in the Barque. In every Ray, there are about twelve or sixteen Vessels.

20. §. Lastly, and more within the Pith, there stand other Sap-Vessels, all in very thin or slender Arched-Lines; thus hemming in the said Parcels of Aer-Vessels.

21. §. FOR a Sixth, I will take that of Wild Cucumber: Wherein is also found a Maculagnous Lymph. For first of all, next to the Skin, there is a Ring of Sap-Vessels. Which Ring is also radiated, the Rays, all pointing towards, and moist of them terminating on, the Skin.

22. §. Next of all, there is a thick, and simple Parenchymous Ring. On the inner verge whereof, there are other Sap-Vessels standing in Parcels, also in a Ring. So far goes the Barque.

23. §. Next within, stand the Aer-Vessels, in as many Parcels, contiguous to those of the Sap-Vessels aforesaid. To which likewise are adjointed as many more Parcels of Sap-Vessels within the Pith, opposite to the said Sap-Vessels within the Barque.

24. §. FOR a Seventh, we may, choose that of scorzonera. In which, the Vessels are both Lymphadna, and Lactiferous. All of them, with the Aer-Vessels, in a radiated posture. For first next the outer Edg of the Barque, stand the Lactiferous, in little Specks. Next to Tab. 18, these, on the inner Edg of the Barque, stand the Lymphadniti, in the same form.
Hereunto adjacent, on the outer Edg of the Pith, stand the Aer-Veisels, some in Specks, and some in extrem short Lines; hardly distinguish'd, without a very nice Inspection.

Within These, are placed other Lymphadeniti, opposite to those in the Barque. And within these Lymphadeniti, still in the same radiated Line, run more of the Milk-Veissel.

AN EIGHTH, may be that of sundock. Wherein first, there are a Sort of Lymphadeniti, which stand in Arched Parcells, round the Trunk, adjacent to the Skin.

Within thefe, about the middle of the Barque, run the Milk-Veissel, in the form of small round Specks.

Next to thefe on the inner Edg of the Barque are placed other Lymphadeniti. Which, together with more of the fame in the Pith, and the Aer-Veissel betwixt them, stand all in Radiated Lines, of several Lengths, and all sharpening towards the Centre.

LET the Ninth, be that of Endive; In which there is also much curious Work. Next to the Skin, there is, first, a thick and simple Parenchyma. Then there is a kind of Undulated Ring of Milk-Veissel, Within which stand a Sort of Lymphadeniti, in several Parcells; some, in Arched Half-Ovals; others, in short flender Rays. Betwixt these Parcells, many of the Milk-Veissel likewise stand.

Next there is an undulated Ring of other Lymphadeniti, parting as in most Trunks, betwixt the Barque and the Pith. Within which, are the Aer-Veissel. And within these, more Sap-Veissel. Both of them, in small Specks, answerable, or opposite to the Rays in the Barque.

I SHALL give also one or two Examples of Trees, or Arborescent Plants; the Vine and Common Sumach. In a Slice of the former cut transverse, next the Skin, there is a Thin Barque. In the inner part whereof, adjacent to the Wood, stand the Lymphadeniti in several Half-Oval Parcells, opposite to so many Radiated Pieces of the Wood.

The Wood is divided into the said Pieces, by as many Parenchymous Rays, inferted from the Barque, and so continuous therewith.

Within these Radiated Pieces of Wood, stand the Aer-Veissel; the largest of which, especially if held up against the light, are plainly visible to the bare Eye.

Within the hollow of the Wood, stands the Pith; in the young Growth always large. In the utmost Verge whereof, adjacent to the Wood, stand a few more Sap-Veissel of the same Sort with those in the Barque.

IN A like Slice of Common Sumach, contiguous to the hairy Skin, there is a Ring of Lymphadeniti. Next to this a Simple Parenchyma. Then several Arched Parcells of Lymphadeniti. Within these, a Ring of Milk-Veissel. And then a Ring of other Lymphadeniti. Thus far the Barque.

Within the Barque, stands the Wood, divided into several Portions, by the Diametral Infections divided from the Barque. In the Body of the Wood, stand the Aer-Veissel, very much smaller than in the Vine.
38. §. The hollow of the Wood is filled up with the Pith. In
the Circumference of which, stands a Ring of Lymphatics, of the
same fort with those next to the Wood without.
39. §. All the Parts of these Trunks, may, as I have now de-
scribed them, be observed without a Microscope: excepting the Bladders
and number of Aæ-Vessels. Yet Three things are hereunto necessary: viz. a good Eye, a clear Light, and a Razor, or very keen Knife,
wherewith to cut them with a smooth surface, and so, as not to Dislo-
care the Parts.
40. §. UPON Inspection also by the length, there are some parti-
culars, common, more or les, to most Plants, yet better observable in
some, than in others. As first, the Reticulation of the Vessels, (formerly
described) not only in the Wood, but in the Barque: which is evident
in a young Branch of Corin, upon the very Surface thereof, when some
of the Vessels begin to be cast off into the Skin. And so, by stripping
off the Skin, upon the Surface of the Wood.
41. §. In cutting by the length, as well as transversely, the young
Fibres, which grow within the Wood in the Edg of the Pith, are also
seen. As likewise the manner of the Derivation of the Parts of the Bud
from the Branch or Stalk: as in Senehus. There are also many Vari-
eties in the Pith, such as those hereafter mentioned {a} which fall un-
der observation only in cutting by the length.

C H A P. II.

Of the Barque, as it appears through a good Microscope.

NOW proceed to a more particular Description of several Trunks and Branches, as they appear through
good Glasses.

1. §. Now the Trunk, or Branch of every Tree, hath Three General Parts, to be described: 1st. the
Barque, the Wood, and the Pith. That likewise the manner of the Derivation of the Parts of the Bud
from the Branch or Stalk, as in Senehus. There are also many Vari-
eties in the Pith, such as those hereafter mentioned {a} which fall un-
der observation only in cutting by the length.

2. §. The Barque consisteth of two Parts, 1st. the outmost or Skin,
and the Main Body. The Skin is generally composed, in part, of very
small Vessels or Bladders, clutter'd together. That is, originally it is
fo; but as the plant grows, the Skin dries, and the said Bladders, do
very much shrink up and disappear.

3. §. Amongst these Bladders of the Skin, there are usually inter-
mixed a sort of Lignous Fibres, or Vessels, which run through the length Tab. 20:
of the Skin; as in Mallow, Nettle, Borago, Thistle, and most Herbs. Which
is argued not only from the Toughness of the Skin by means of the said
Vessels; but in some Plants, may be plainly seen, as in Taffe. In which,
4. Whether they are Aer-Vessels, or Sap-Vessels, is dubious. For, on the one hand, because they emit no Sap, or bleed not; and also stand adjacent to the Aer, 'tis probable that they are Aer-Vessels. On the other hand, they may be Sap-Vessels; notwithstanding that they bleed not. Because the non-emission of Sap is not an infallible and concluding argument of an Aer-Vessel. For there are some Plants which bleed not. Which yet are furnished with Sap-Vessels, as certainly as any others which bleed. (a)

5. The Skin of the Trunk is sometimes visibly porous. But no where more, than in the better sort of walking Cames; where the Pores are so big, as to be visible even to the naked Eye: like to those, which are observable in several parts of the Ball of the Hand, and upon the ends of the Fingers and Toes.

6. THE Main Body of the Barque consistslikewise of two Parts, 6c. Parenchyma, and Vessels. The Parenchyma is made up of an innumerable company of small bladders clutched together. Differing in nothing from those aforesaid in the Skin; saving, that they are much larger; and generally rounder.

7. This Parenchyma of the Barque is the same, as to its Substance, both in the Root and Trunk. Yet as to the Texture of its Parts, in the one, and in the other, there is this observable difference; viz. That in the Barque of the Root, cut tranversely, the said Parenchyma (as hath been shew'd) is usually, more or less, disposed into Diametral Rays: running through the Barque, after the same manner, as do the the Hour-Lines through the Margin of the Dial-plate of a Clock or Watch: as in Marsh-Mallow, Lovage, Melissa, and others. Whereas here in the Barque of the Trunk, the said Parenchyma is rarely thus disposed into Diametral Rays: Nor when it is, are those Rays continued to the Circumference of the Barque; as in the Barque of the Root they frequently are. So in Rhus or Sumach, although part of the Parenchyma be disposed into Diametral Rays: yet are those Rays extended not half way through the Barque. So also in Fig-tree, Worm-wood, Thistle, and others. What is further observable in the Texture of the Parenchyma, I shall shew in the description of the Pitt.

8. THE Vessels of the Barque, are, as I shall also shew, diversified many ways. But there are some Things, wherein, in all Sorts of Plants, they agree. First, in standing, most numerous, in or near, the inner Margin of the Barque. Secondly, in being always, and only Sap Vessels. I have viewed so many, that at least, I can securely affirm thus much, That if there be any Heteroclital Plants, wherein they are found otherwise, there is not One, in Five Hundred. Thirdly, in being always Conjugated or Braced together in the form of Net-work. Although the Number and Distances of the Branches, are very different: as I have already shewed in the Anatomy of Roots.

9. THE Properties, whereby the said Vessels of the Barque are specified and distinguished one from another, both in the same Plant, and in the several Species of Plants, are very many. Which Properties, are not Accidental, but such as the Conjoint and Universal Design of Nature. All which shall be demonstrated by the Description of several Quarters of the Slices, of so many Kinds of Branches.
Brances, cut Transverfly: and by the several Figures which represent them.

10. §. FIRST then, for the Eleven first Quarters, the Vessels of Tab. 22. &c. the Barque are only of Two Kinds. And these, in the first Eight, seem to be Rosiferous (described also in the Anatomy of Roots) (a) and (a) P. 1. tho' which are common to most, if not to all Plants, &c. the Lymphadnts. Yet in all the Eight, they are, in respect both of their Propor- tion, and Position, very different. So in Hazel and A§b they are but few. In Holly and Barberry more. In Apple, Pear, Plum, Elm, still more numerous. And of those three Fruits, in an Apple, or Plum, more than in a Pear.

11. §. Again, as their Proportion, so likewise their Position is divers. For in Holly, the Lymphadnts or inner Vessels next to the Wood, stand in Rays. Yet so numerous and close together, as to make one Tab. 22; Entire Ring. In Hazel, they stand more in Oblong Parcells. In Bar- 23, 24. berry, they stand likewise in Parcells, but they are far more Half-Ovals. The utmost Vessels or Rosiferous of all Three, make a Ring.

12. §. Again, in Apple, Pear, and Plum, the Lymphadnts are Radiated. The Rosiferous are neither Radiated, nor make an entire Ring; Tab. 25, to but stand in Peripheral Parcells. Much after the same manner, they 28, also stand in Elm. In A§b, the Vessels make Two Rings; but neither Tab. 29. of them Radiated: the inmost Ring or Lymphadnts, consisting of Arched Parcells, and the utmost or Rosiferous Vessels, of Round ones. And whereas in all the foregoing, the Lymphadnts are still contiguous to the Wood; and the Rosiferous more or less, distant from the Skin, here, on the contrary, the former are distant from the Wood, and the latter contiguous to the Skin.

13. §. And that these Vessels in each Barque of the said Eight Bran- ches, are of Two distinct Kinds, seems evident, as from some other reasons, so from hence: In that their Positions are altogether Heterogeneous: Yet in both Conflant, Regular and Uniform. I say, there seems to be no Reason, why the self same Kind or Species of Vessels, should have a different, yea a contrary Position in one and the same Plant: and that Contrariety, not Accidental, but Regular and Conflant.

14. §. FOR the Three next Quarters &c. the Ninth, Tenth and Tab: 30.

15. §. So for their Position. In Pine, the inmost make a Radiated Ring. The utmost stand thrashing up and down, without any certain order. In Wallnut the inmost make also a Radiated Ring; The ut- moft make a Double Ring; not Radiated, but of Round Parcells. In Fig, the inmost make also a Radiated Ring. But the utmost make a Double and sometimes Treble Ring, not of Radiated, nor Round, but Arched Parcells.

16. §. Thirdly, they are also different in Kind. Those, I think, of the two former, Wallnut and Fig, are thus different: those certainly, of the Fig, are so: being Lymphadnts and Läefels. The Lymphadnts make the inmost Radiated Ring. The utmost which make the other Rings in Arched Parcells, are the Läefers.

17. §. That they are distinct Kinds of Vessels, is evident for two Reafons. First, from their Position in the Barque; which is alto-
ther different, as hath been said. Secondly, from the most apparent
Diversity of the Liquors or Saps, which they contain, and which, upon
cutting the branch transversely, do distinctly bleed from them. Which
is one way, whereby we do distinguish the Vessels of Animals themselves.
As in the Liver, it were hard to say, which is a Blood-Vessel, and which
is a Bile-Vessel, where they are very small, if it were not for the Con-
tents of them both.
18. §. Those in the Barque of Pine, are likewise of Two Kinds.
The inmost are Lympheadults, as in the two former. The utmost are
not Milk-Vessels, but Gum-Vessels, or Resiniferous; which stand fragon-
ing, and finely, about the middle of the Barque. Out of these Vessels
all the clear Turpentine, that drops from the Tree, doth issue.
19. §. Few, but very great. So that besides the difference of their
Number and Position, and of the Liquors which they contain, and bleed;
there is yet a Fourth, and that is, their Size. Most of these
Turpentine-Vessels, being of to wide a bore, as to be apparent to the naked Eye:
and, through a good Glass, above 4 of an Inch in Diameter.
Whereas that of the Lymphedults, can hardly be discovered by the belt
Microscope.
20. §. The same Turpentine-Vessels of Pine, are likewise remarkably
bigger, not only than the Lymphedults, but many times, than the
Milk-Vessels themselves: as those of the Fig, which, in comparison, are
exceeding small; every Arch, not being a single Vessel, but a Parcel or
Cluster of Vessels; Whereas one single Gum-Vessel in Pine, is sometimes
as big as two whole Arched Clusters, that is, as some Scores of the Milk
Vessels in a Fig-tree. And the said Gum-Vessels of Pine, being compared
with the Lymphedults of the same Tree, one Gum-Vessel, by a moder-
ate estimate, may be reckoned three or four hundred times wider
than a Lymphedult. The like prodigious difference may be observed in the
Size of the several Kinds of Vessels of many other Plants.
21. §. THE Three next Quarters of Branches, are of Oak, Common
Sumach, and Common Wormwood. In the Barque-Vessels whereof,
there is observable some further Variety. For in all or in most of the
above named, there are only Two Kinds of Vessels in the Barque. But
in Each of these, there are, at least, Three Kinds.
22. §. And first, in that of Oak there are Lymphedults, Rosin-
ferous, and a Sort of Resiniferous. The inmost or Lymphedults, make a
Radiated Ring, contiguous to the Wood. The utmost or the Rosin-
ferous make also a Ring, but not Radiated. Those which are a fort of
Rosin-Vessels, stand in Round Parcels; the greater Parcels betwixt the
Two Rings of Rosiniferous and Lymphedults; and the lesser, betwixt the
Rosiniferous and the Skin.
23. §. That these last are different Vessels from both the other, seems
evident, from the difference of their Position, as aforesaid. And that
they are a fort of Resiniferous, is argued from hence; In that, not
only Galls are very full of Rosin, but that the Barque of Oak it self is
also somewhat Resinous. For the conveyance of whose Resinous parts, it
is most unlikely, that any other Vessels should subserve, but a peculiar
Kind, which may therefore be properly called Resiniferous.
24. §. The next is a Branch of Common Sumach. In the Barque
whereof, there are likewise Three Kinds of Vessels. First of all, there
is a thick Radiated Ring of Lymphedults; standing on the inner Merv

Tab. 32.
gin of the Barque, contiguous with the Wood. These Vessels exhibit their Lymph very apparently. A second kind of Vessels, i.e. Roriferous, are situate towards the outer Margin of the Barque, and are compos'd into distinct Arched Parcels, all standing in a Ring.

25. §. Betwixt these Two Kinds stand the Milk-Vessels. Every single Milk-Vessel being compass'd or hemm'd in with an Arch of Roriferous. The Milk-Vessels are extraordinary large, almost as the Gum-Vessels of Pine; so as distinctly to be observ'd without a Microscope; after they are evacuated of their Milk; and without difficulty will admit a Virginial Water; being two or three hundred times as big as a Lymphaditus. Besides these Three forts of Vessels, there is also a Ring, adjacent to the Skin; which seems to be another fort of Roriferous.

26. §. The Lait, is a branch of Common Wormwood. In the Tab. 35, Barque whereof, there are likewise Three Kinds of Vessels. First of all, there is a thin Radiated Ring of Lymphaditus, contiguous with the Wood or on the inner Margin of the Barque. Yet the Ring is not entire, but made up of several Parcels; which are intercepted by as many Parenchymous inferted into the Pith.

27. §. A Second Sort of Vessels, which seem to be Roriferous, are situate about the middle of the Barque; and are compos'd into Arched Vessels, which likewise stand all even in a Ring.

28. §. Beyond these Arches, and towards the outer Margin of the Barque, stand a Third Sort of Vessels. Different from the Milk-Vessels in Salmach, both as to their Situation, Size and Content. For in Salmach, the Milk-Vessels stand within the Arched Lymphaditus; whereas these in Wormwood, stand without them. Likewise, being the Vessels of an Herb, they are far less; i.e. about the compass or width of a small Wheat-straw. Their Content, is not a Milk, but a liquid, most Olesious and oifid Gum. Or which, for its pleasant Eavour may be call'd an Aromaticall Balmom. For it perfectly yieldeth whatever is in the Smell and Taffe of Wormwood: being the Essence of the whole Plant, which nature treatieth up in these Vessels. So that they are, in all respects, analogous to the Tarpentine Vessels in Pine. There are divers other Herbs and Trees, which in the like Vessels, contain a Tarpentine, or rather Aromaticall Balmom; as Angelica, Helium and others; the Vessels being so very large, that they may be easily traced with a knife, in cutting by the length of a Branch or Salk.

29. §. Whether in some Plants, there are not more Sorts of Vessels, in the Barque, than have been now mention'd, I cannot say: Though we have not much reason to doubt of it. Because we fee, there is so great variety in the Viseria of Animals. For what the Viseria are in Animals, the vesseles themselves are in Plants.

30. §. CONCERNING the Form and Texture of the Lymphaditus, there are some things, which though they be not observable in the Wood, yet in regard I am now describing the said Vessels, I shall here therefore add. I have already said, and liewed, in the former Books, That the Lignous and Tomy Parts of all Plants, are Tubulare. And that the Lymph is convey'd, by the length of a Plant, through an innumerable company of small Tubes or Pipes.

31. §. The Question may be yet further put: If the Tomy Parts of the Barque are made of Tubes, What are these Tubes themselves made up of? I answer, That these Tubes or Lymphaditus, are not only themselves
themselves Organical; but their very Sides also, seem to be compos'd
of other Parts, which are Organical, i.e. of Lignous or Tony Fibres,
Which Fibres, standing close or contiguous in a round Figure, they
make one Tubular Body, which I call the Lymphaduct of a Plant. And
it is probable, That these Fibres themselves, are also Tubular. That
is, that a Lymphaduct, is a small Tube, made up or compos'd of
other, yet much smaller Tubes, set round together in a Cylindrick Fi-
gure. As if we should imagine a company of Straws, which are so
many small Pipes, to be joyned and set round together, so as to make
another greater Pipe, answerable to a hollow Cave. The Cave, I say,
is as the Lymphaduct; and the Straws are as the Fibres whereof it is
compos'd. By which also appears, the admirable smallnes of these
Fibres. For there are some Lymphaducts, which may be reckon'd fifty
times smaller than a Horse-Hair. Allowing therefore but Twenty of
the aforesaid Fibres to make a Thread so big as one Lymphaduct; then
one of the said Fibres, must be a Thousand times smaller than a Horse-
Hair. That these Fibres, whereof the Lymphaducts are made, are
themselves compos'd of other Fibres, is not altogether improbable.

33. §. These Fibres, although parallel; yet are they not confus'd,
but only contiguous; being compos'd together in a Tubular Figure,
by the Weflage of the Cortical Fibres, as in Chapter the Fourth will
better be understand'd.

34. §. The first notice I took of the Composition and Texture of
these Vessels, so far as the best Glassest yet known, will admit; was in
a very white and clear piece of Afb-wood torn, with some care, by the
length of the Tree, and object'd to a proper Light. They seem also
sometimes discernable in some other clear Woods, as in very white Fir,
&c. And having formerly demonstrat'd, that the Lignous Part of a
Plant, is annually made or augment'd out of the inner part of the
Barque, wherein the Lymphaducts always stand: we may reasonably
suppose the same Lymphaducts to have the like Conformation in the
Barque, as in the Wood.

35. §. And I am the rather induc'd to believe, that I am not mis-
taken in this Description, upon these two Considerations. First, that
herein the Analogy between the Vessels of an Animal and a Plant, is the
more clear and proper. For as the Sanguineous Vessels in an Animal
are compos'd of a number of Fibres, set round, in a Tubular Figure,
together: so are these Lymphaducts of a Plant. Secondly, in that here-
in, there is a more genuine Correspondence betwixt these, and the other
Vessels of a Plant it self; i.e. the Aer-Vessels; which are made up of a
certain number of Round Fibres, standing collaterally, or fide to fide
as I have already observ'd in the Anatomy of Roots. So that it is the
less strange, that the Lymphaducts should be compos'd of Fibres, since
the Aer-Vessels are evidenc'd so made. Only with this difference, that
whereas in the Aer-Vessels, the Fibres are postured or continued Spi-
rally; here, in the Lymphaducts, they stand and are continued only
in straight Lines.

36. §. THE STRUCTURE of the Lachisperous and Gum-Vessels, which
have a very ample Bore, is more apparent. And, by the best Glassest
I have yet us'd, they seem to be compos'd, chiefly, by the Configuration
of the Bladders of the Barque. That is to say, That they are so many
Chapter, not made or bounded by any walls or sides proper to themselves, as a Quant into a Cork, and as the Aer-Vessels are in the Wood: but only by the Bladders of the Parenchyma; which are so postured and crowded up together, as to leave certain cylindrical Spaces, which are continued by the length of the Bark.

36. One difference between the Vessels or Channels now described, and the Tubular Hollows and other Apertures in the Pith, is this: That these never exist originally with the Piths, but are so many Ruptures supervening to it in its Growth. Caused, partly, by the Stretch or Tenter it suffers from the Dilatation of the Wood; and partly, the drying, and so the Shrinking up of its Bladders, and of the Fibres whereof they are composed. Whereas the said Vessels in the Bark, are many of them originally formed therewith. And those which are post-nate, not made by any Rupture, but only such a Disposition of the Parenchymous Fibres, and Confinement of the Bladders, as is thereunto convenient.

37. In paring the Bark of a Branch of Pine, Sumach, &c. they appear, neither parallel, nor any where Inscripted: but run, with some little obliquities, distinct one from another, through the length of the Branch: and so, we may believe, through the length of the Tree.

Chapter III.

Of the Wood.

The next general Part of a Branch, is the Wood, which lyeth betwixt the Bark and the Pith. And this likewise evermore confineth of Two General Parts, &c. of a Parenchymous Part, and that more properly called Lignous. The Parenchymous Part of the Wood, though much diversified, yet in the Trunks of all Trees whatsoever, hath this property, To be disposed into many Rays, or Diametral Inscriptions, running betwixt so many Lignous Portions, from the Bark, to the Pith, as in any of the Quarters here before us may appear.

2. But these Inscriptions are much diversified, according to the several Sorts of Plants. So in Barberry, A&; Pome, Worm-wood, they Tab. 322, are few numerous. In Elm, Wallnut, Fig, Sumach, they are more new. And in Holly, Pear, Plum, Apple, Oak, Hazel, are most numerous.

3. The same Inscriptions, in Barberry, Wormwood, and some in Oak, are very thick. In Pine, Fig, A&, of a middle Size. In Pear, Holly, and most of them in Oak, are exceeding small. Again, in Bar

berries, Elm, A&, Sumach, Fig, they are of an equal Size. In Holly, Hazel, Pear, Plum, Oak, they are very unequal: some of those in Holly, being Four or Five times thicker than the rest; in Plum, Six or Seven times; and in Oak, Ten times at least.
4. §. In some Plants, they are Equidistant; in others, not: in some, the Great ones are Equidistant; in others, the Lesser in others, both in some, neither. Which Varieties are not accidental, but constant to the Species in which they are severally found.

5. §. They are not always visibly continued from the Circumference to the Centre of the Wood: but in some Branches, as of Sumach, and in most Trunks of many years growth, declining, in some places, under or over, from a Level, are thereby, upon a Transverse Section, in part cut away.

6. §. They have yet one more Diversity, which is, That in divers of the aforesaid Branches, they run not only through the Wood, but also shoot out beyond it, into some Part of the Barque, as in Elm, Sumach, Wormwood, &c. Whereas in Pine, and some of the rest they either keep not distinct from the other parts of the Parenchyma of the Barque, or are so small, as not to be distinguished there form.

7. §. The Texture likewise of these Infections is somewhat various.

For in Wormwood, and most Herbs, they are manifestly composed of small Bladders; differing in nothing from those of the Barque or Pitth, saving, in their being much less. Yet in Herbs, they are much larger than they are in Trees. And in many Trees, as Apple, Pear, Plum, Pine, &c. they are either quite lost, or so squeezed and pressed together by the hard Wood standing on both sides, as to be almost undiscernable.

8. §. So that although the Parenchyma of the Barque or Pitth, and the Infections in the Wood, are of the same specific Nature or Substance: yet there is this difference betwixt them: That the Fibres of the former, are so Netted together, as to leave several round Vacuities; or to make a great many little Bladders, whereas, in the latter, they are usually so far crowded up, as to run (as when a Net is stretched out) like a Shein of Parallel Threads.

9. §. Of these Infections in the Wood, it is further observable, That they do not only run betwixt the Lignous Portions; but that many of their Fibres are likewise all along distributed to the several Fibres, of which the Lignous Portions consist, and are interwoven with them; both together thus making a piece of Linny-Woolly Work, or like many other Manufactures in which the Warp and the Woof are of different Sorts of Stuff: as in the end of the Fourth Chapter is further explained.

10. §. THE WOOD is likewise compounded of Two Sorts of Bodies: That which is strictly Woody, and the Aer-Vessels mixed here-with. The true Wood is nothing else but a mafs of antiquated Lymphaducts, viz. those which were originally placed on the inner Margin of the Barque. For in that place, there grows, every year, a new Ring of Lymphaducts. Which losing its original softness by degrees, at the latter end of the year, is turned into a dry and hard Ring of perfect Wood.

11. §. So that every year, the Barque 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. In like manner, as hath been observed of the Skin of the Root. Or as the Cuticle in Animals, is but the efflorescence of the Cutis. I say, that the elder skin of a Tree, is not originally made a skin; but was once, some of the middle part of the Barque it self, which is annually cast off,
and dried into a Skin: even as the very skin of an Adder, upon the gradual growth of a new one underneath, in time, becomes a Slough.

The innermost portion of the Barque, is annually distributed and added to the Wood: the Parenchymous Part thereof: making a new addition to the Infections within the Wood; and the Lymphedulcis: a new addition to the Ligamentous pieces betwixt which the Infections stand. So that a Ring of Lymphedulcis in the Barque this year, will be a Ring of Wood in the next; and fo another Ring of Lymphedulcis, and of Wood, successively, from year to year. So the Table, for an Apple-Barque, sheweth a quarter of a Slice of a Branch cut tranversely, of Three years growth: That of Barbery, of Two; That of Sumach, of One only; That of Elm, of Five.

12. Hereby two things may be the better noted. First, the difference betwixt the degrees of the annual growths of several Trees: three years growth in an Oak, being as thick as five in an Elm. Secondly, the difference betwixt the Annual growths of the same Tree; being, not of a constant proportion, but varying in thickness, as it should seem, according to the season of the year: whereby it may appear, what season, or kind of year, doth most of all favour, the latitudinal growth, or the thickening of any Tree.

13. The Lymphedulcis thus antiquated or turned into Wood, do rarely, if ever, bleed: but only transmit a kind of Dewy or Vaporous Sap. And some of them, as in the Heart of some Trees, it is probable, that they transmit not any Sap, either in the form of a Liquor, or a Vapour: and so being gradually deprived of their Watery Parts, become the Heart.

14. There is this further variety in the Wood; represented in Walnut, Fig and Oak. That some certain parcels hereof, make either several small and white Rings, as in Oak; or else divers white and crooked Parcels, tranversely, to the Infections, as in Wallnut and Fig. For it feemeth, that, at least in many Trees, some portion of all the Kinds of Vessels in the Barque, are not only annually distributed to the Wood, but do likewise therein retain the name, or somewhat like Position, which they originally had in the Barque. So that all these bigger and darker Portions of the Wood, were originally, the Radiated Lymphedulcis of the Tree: so the little white Circles, or Parcels of Circles, in the same Wood, were originally another sort of Sap-Vessels in the Barque, those which have a circular Position therein.

15. In the branches of Fir, Pine, and others of the same Kindred, there are some few Turpentine-Vessels scattered up and down the Wood; and represented by the larger Black Spots. Which Vessels are cæsium numero, the self same, which did once appertain to the Barque; and do even here also in the Wood, contain and yield a liquid Turpentine. Only, being pinched up by the Wood, they are become much smaller Pipes.

16. THE Aer-Vessels, with the Infections, and true Wood, altogether make up That, which is commonly called, The Wood of a Tree. The Aer-Vessels I do call, not in that they never contain any Liquor; but, because all the principal time of the growth of a Plant, when the Vessels of the Barque are filled with Liquor, there are filled only with a Vegetable Air.

17. In almost all Plants, not one in some hundreds excepted, this is proper to the Aer-Vessels; To have a much more ample Bore or Ca-
viety, than any other in the wood. In the wood, I say, for in the Barque, there are many Sap Vessels bigger than the biggest Aer-Vessels that be.

18. §. The Vessels hereof are very many; in respect both of their Number, Size, and Position; being, as to thefe, the fame, in no two Sorts of Plants whatsoever. First in respect of their Number. So in Hazel, Apple, Pear, they are very numerous; but in different degrees: and are reprezentcd in the Figures already referred to, by all the black spots in the Wood. In Holly, Plum, Barberry somewhat numerous. In Oak, A[bb], Walnut fewer. In Pine, and others of that Kindred, very few; fe. fewer than in any other kind of Plant.

19. §. Secondly, in respect of their Size; which from the first or greatest, to the leaff, may be computed easily to about Twenty Degrees. Thus, many of those in Elm, A[bb], Wallnut, Fig, Oak, are very large. In Barberry, Plum, not fo large. In Hazel, Sumach, smaller. In Holly, Pear, of a still smaller Size. So that many of those in Elm, or Oak, are Twenty times bigger, than those in Holly or Pear.

20. §. In an ordinary jointed Cane, they are fo wide, that if you take one yard, or a yard and ½ long, and putting one end into a Basin of Water, you blow strongly at the other; your Breath will immediately, pafs, through the Aer-Vessels, the length of the Cane, fo as to raise up the Water into a great many Bubbles.

21. §. And as they have a different Size in divers Kinds of Plants; so likewife, according to the place where they stand, in the felf fame. So in Holly, Hazel, Apple, their Size is more equal throughout the breadth of the Tree. But in Barberry, Elm, Oak, A[bb], very different:

22. §. Thirdly, thefe Aer-Vessels are also different in their Situation. So in Apple, Wallnut, Fig, they are spread all abroad in every annual Ring; not being pointed in any one certain Line. In others, they keep more within the compass of some Line or Lines; either Diagonal, or Peripheral. So in Holly they are Radiated, or run in even Diametral Lines between the Pith and the Barque. So also are some of them in Hazels; and some few in Wallnut.

23. §. Whether they stand Irregularly, or are Radiated, it is to be noted, That Nature, for the moft part, do dispo[fit]h of them, that many of them may ftand very near the Infections. So in Apple, she will rather decline making an even Line; or in Holly, will rather break that Line into Parcels, than that the Aer-Vessels shall stand removed from the Infections. To what end this is done, shall be said hereafter.

24. §. Again, in A[bb], the Aer-Vessels are none of them Radiated, but most of them stand in Circles on the inner Margin of every annual Ring. Which Circle is sometimes very thick, as in A[bb] and Barberry. In others but thin, the Vessels standing, for the moft part, single throughout the Circles; as in Elm. Sometimes again, they both make a Circle, and are also spread abroad; as in Pear and Plum.

25. §. Those likewise which are spread abroad, are sometimes Regularly pointed. So in Barberry, besides those larger, that make the Circle, there are other smaller ones, that stand, in oblique Lines, athwart
Book III. of Trunks.

117

athwart one another; almost like a Bend, or sometimes, an entire or broken Silly in an Escentcheon. In Oak, they make rather certain Tab. 33. Columns, in the posture of the Tale. And in Elm, they make, as it were, many cross Parcels, in the posture of the Effs.

26. §. This great difference in the size and position of the Aer-Vessels, in the same individual Plant, is one ground, for which, I think it probable, that there are divers Kinds of Aer-Vessels, as well as of Sap-Vessels. Even as in Animals, there are divers Kinds of Organs for Spiration, and the separation of Aer: Fibers having their Branches; Land-Animals their Lungs; and those in Freggs: &c. being of a somewhat peculiar Kind.

27. §. THE Form and Texture of these Vessels, and the various ways whereby they may be best observed, I have already described and dwelt in my Anatomical of Roots. As to their Form, one thing remarqued was this: That they are never Ramified, but distinctly continued from one end of a Plant, small or great, to the other; as the Nerves are in Animals. A further and efficacious proof whereof, may be made, only by holding up a piece of an ordinary Cane, about 1 foot long, cut very smooth at both ends, against a full light: whereupon, if you keep it in a straight Line betwixt the Light, and the cast of your Eye, and then look steadily, you may see quite through it, that is, through the Aer-Vessels, which run straight along the Cane from end to end.

28. §. As to their Texture; whereas, oftentimes, the Aer-Vessels appear to be unroaved in the form of a very small Plate, it is to be noted, that it is not only of different breadth, in divers Plants, and usually much broader in the Root, than in the Trunk: but also, that in the Trunk, many times, the said Vessels are unroaved or resolved, not in the form of a Plate, but of a Round-Thred. The Causes of which Diversitie, are principally Three: 1st. The Woflage of the Fibres of which the Aer-Vessels consist; The difference betwixt the said Fibres; or betwixt the Warp and the Woof; And the different Kinds of Woof.

29. §. By the Woflage of the Fibres, it is, That the Vessels, oftentimes, unroave in the form of a Plate. As if we should imagine a piece of fine narrow Ribband, to be wound spirally, and Edg to Edg, round about a Stick; and so, the Stick being drawn out, the Ribband to be left in the Figure of a Tube, answerable to an Aer-Vessel. For that which, upon the unroaving of the Vessel, seems to be a Plate, Tab. 39: or one single Piece, is, as it were, a Natural Ribband, consisting of several Pieces, that is, a certain number of Threads or Round Fibres, standing parallel, as the Threads do in an Artificial Ribband. And as in a Ribband, so here, the Fibres which make the Warp, and which are Spirally continued; although they run parallel, yet are not coalescent; but continued together, by other Transverse Fibres in the place of a Woof.

30. §. And as the said Fibres are transversely continued, thereby making a Warp and Woof: So are they (as in divers woven Manufacturers) of very different Bolk; those of the Former, being much bigger, and therefore much stronger, than those of the Latter. By which means, as Cloth or Silk will often Tear one way, and not another; so here, while the Warp or those Fibres which are Spirally continued;
The Anatomy

Book III.

31. And because the Fibres of the Woof, are themselves also of different bulk, therefore it is, That where they are more sturdy, as usually in the Root, they require a greater quantity of Warp, that is, a broader plate, to overmatch them. Whereas, where they are more extream small, as in the Trunk and Leaves, one Thread of the Warp, that is, one Spiral Fibre, will be strong enough of it self, and so, sometimes, be finely unroaved.

32. §. From the extream Tenuity of these Fibres, it is, That they are very rarely discern'd, and not without the greatest difficulty. As also, from their great Tenderness; whereby not enduring to be drawn out, they all break off close to the Sides of the spiral ones. In the Pith, the like Transverse Fibres are a little more visible; which first conducted Me to the notice of them here also.

33. §. All the Fibres of the Aer-Vessels, both the Warp and the Woof, are of the same Substantial Nature with the Pith and the other Parenchymous Parts of a Plant. From whence it is, That whereas the Tomy Parts of a Plant, whereof all Linen Manufactures are made, are very strong and tough; these, as is above said, are extream Tender and brittle, like those of the Pith and all the Pithy Parts. To which therefore, the Aer-Vessels are to be refer'd. And the Content of both, is oftentimes the same.

34. §. From whence, we have a further proof of what I have formerly asserted; which is, That in all plants, there are Two Substantially different Parts, and no more than Two, viz. the Pithy, and the Tomy or Lignous Parts.

35. §. From hence also we have some ground to conjecture, That so many of the Aer-Vessels, at least, which are not formed with the seed, but post-nate, are originated from the Parenchymous Parts; which seem by some alteration in the Quality, Position and Texture of the Fibres, to be transformed into Aer-Vessels, as Caterpillars are into Flies. And as the Pith itself, by the Rupture and Shrinking up of several Rows of Bladders, doth oftentimes become Tubulary; So is it also probable, that in the other Parenchymous Parts, one single Row or File of Bladders evenly and perpendicularly piled; may sometimes, by the Shrinking up of their Horizontal Fibres, all regularly break one into another and so make one continued Cavity; or a Tube, whose Diameter is the same with that of the Bladders, whereof it is composed. All which, will appear more probable, and what hath been said, be yet better understood, when we come, in the next Chapter, to the Description of the Pith.

B. i. c. 7.
§ 13, 14.

C H A P.
CHAP. IV.

Of the PITH.

The Third General Part of a Branch is the Pith. Which though it have a different name from the Parenchyma in the Barque, and the Infections in the Wood; yet, as to its Substance, it is the very same with them both. Whereof there is a double evidence, from their Continuity, and the sameness of their Texture. Their Texture shall be shewed presently.

As to their Continuity, it is to be noted, That as the Skin is continuous with the Parenchyma of the Barque; and this Parenchyma likewise, with the Infections in the Wood; so these Infections again, running through the Wood, are also continuous with the Pith. So that the Skin, Parenchyma, Infections, and Pith, are all One entire piece of Work; being only filled up, in divers manners, with the Vessels.

2. 8. The Size of the Pith is various, being not the same in any two Branches here represented. In Wormwood, Sumach, Fig, Barbery, Tab. 24, 'tis very large; 5, 6, 7 Inches Diameter, as it appears 31, 34, 35; through the Microscope. In Pine, Afs, Holly, Walnut, not so large; 22, 29, from 3 Inches Diameter to 4. In Oak, Apple, Pear, Hazel, laller, scarce 30, 32, from 2, to 3. In Damascene, not above an Inch and half. And in Elm, 23, 25, scarce an Inch Diameter. Note also, that of all Plants, both Herbs, 26, 35, and Shrubs, have generally the largest Piths, in proportion to the other Parts of the same Branch, as in Sumach, Fig, Barbery, is manifest.

3. 8. It is also worth the noting, That whereas, in most Plants, the Barque and Wood do both grow thicker every year: the Pith, on the contrary, grows more slender; So that in a Branch of one years growth, it is apparently more ample, than in one of two; and in a Branch of two, than in one of three; and so on.

4. 8. The Pith, for the most part, if not always, in the Branches, as well as the Root, is furnished with a certain number of sap-vessels. They are here usually so postur'd, as to make a Ring on the Margin of the Pith. Where they are more numerous, or large, they are more evident; as in Walnut, Fig, Pine, and others. They are also of divers Kinds, answerable to thole in the Barque: as in Walnut, Lymnebedulæ; in Fig, Lacteals; in Pine, Ruminiferous.

Tab. 30.

31, 32.

5. 8. The Parenchyma of the Pith is composed of Bladders. Which are the very same with thole in the Barque, and oftentimes in the Infections within the Wood. Only thos in the Pith, are of the largest Size; thole in the Barque, of a lesser; and thos of the Infections least of all: for which reason they are less obvious than in the Pith.

6. 8. The Bladders of the Pith, though always comparatively Great; yet are of very different Sizes. Being easily distinguished, even as to their Horizontal Area, to Twenty Degrees. Thos of Fig, Barberry, and some others, are somewhat large. And of many Herbs, as
of Thistle, Borage, and others, three times as big again; appearing in the Microscope, like to the largest Cells of an Hony-comb. Those of Plum, Worm-wood, Sumach, &c. Of Elm, Apple, Pear, &c. Of Holly and Oak, still less. So that the Bladders of the Pith in Borage or Common Thistle, are of that Size, as to contain, within the compass only of their Horizontal Area, about twenty Bladders of the Pith of Oak. Wherefore one whole Bladder in Thistle, is, at least an hundred times bigger, than another in Oak.

7. §. Of the Size of these Bladders of the Pith, 'tis also to be noted, That it doth not at all follow the Size of the Pith of either: but is still varied, according as Nature designeth the Pith for various use. Thus, whereas the Pith of Sumach is larger than that of Barberry, it might be thought, that the Bladders, whereof it is composed, should be likewise larger: Yet are they Three times as Small again in Sumach, as they are in Barberry. So the Pith of Plum, is far less than that of Pear; yet the Bladders of the former are Four or Five times as big, as those of the latter. So the Pith of Hazel is almost Three times as Little again, as that of Holly; yet the Bladders in Hazel, are Ten times bigger, than in Holly.

8. §. The Shape of the Bladders hath also some Variety. For although, for the most part, they are more round; yet oftentimes they are angular: as in Reed-grass, a Water-plant; where they are Cubic, and in Borage, Thistle, and many others, where they are pentagonal, sextangular and septangular.

9. §. Of the Texture of the Bladders, 'tis also to be noted, that many times, the Sides of the greater Bladders are composed of lefser; as is often seen in those of Borage, Balsam, and some other Plants. In the same manner, as the Sap-Vessels, are but greater Fibres made up of lefser.

10. §. The Pith, though always originally composed of Bladders, and so One Entire Piece; yet in process, as the Plant grows up, it hath divers openings or Ruptures made in it; oftentimes very regularly, and always for good use, and with constancy observed in the same Species of Plants. In Sharp-pointed Dock, many of the Pores are considerably prolonged by the length, like small Pipes. In Walnut it shrinketh up into transverse Fibres or Membranes; as likewise sometimes in Spanish-Broom. Sometimes the Pith is hollow or Tubulary; either through the Trunk, as in Thistle, Endive, Scorzoner, Marshmallow, or so, as to remain entire at every Joint; as in Sycamore, Nettle, Teasle; in which it is divided as it were into several Stories; and divers other ways.

11. §. I shall conclude this discourse with a further illustration of the Texture of the Pith, and of the whole Plant, as consequent thereupon. I say therefore, (and have given some account hereof in the Anatomy of Roots) That as the Vessels of a Plant, so the Aer-Vessels and the Linpheafts are made up of Fibres; according to what I have in this Discourse above said; so the Pith of a Plant, or the Bladders whereof the Pith consists are likewise made up of Fibres, which is true also of the Parenchyma of the Trunk, and also of the Infections in the Wood. Yea, and of the Fruit, and all other Parenchymous Parts of a Plant. I say, that the very Pulp of an Apple, Pear, Cucumber, Plum, or any other Fruit, is nothing else but a Ball of most extraneous transparent Threads or Fibres, all wrapped in...
of Trunks.

12. The Fibrousity of the Parenchyma is also visible in some Woods, in which, it is apparently mixed with the Lignous Parts, not only by Infections, but peraminimas partes organicas. That is to say, The Parenchymous Fibres, like smaller Threads, are either wrapped round about both the Lignous and the Aer-Vessels, or at least interwoven with them, and with every Fiber of every Vessel: as in very white Ash or Fir-Wood, Tab. 39.

13. Where it follows, that the whole Substance, or all the Parts of a Plant, so far as organical, they also consist of Fibres. Of all which Fibres those of the Lymphatica, run only by the Length of the Plant: those of the Pith, Infections, and Parenchyma of the Barque, run by the breadth or horizontally: those of the Aer-Vessels, fetch their Circuit by the Breadth, and continue it by the Length.

14. By which means, the said Parenchymous Fibres, in fetching their horizontal Circles, do thus weave, and make up the Bladders of the Pith, in Open-Work. And the same Fibres being thence continued: they also weave and make up the Infections, but in Close-Work. Betwixt which Infections, the Vessels being likewise transversely interjected, some of the same Fibres wrap themselves also about these; thus tying many of them together, and so making those several Conjugations and branches of the Vessels, which I have formerly described. And as some of these Horizontal Fibres are wrapped about the Vessels: so also about the Fibres, whereof the Vessels are composed. By which means it is, that all the Fibres of the Vessels are Tacked or Stitched up close together into One Coherent Piece. Much after the same manner, as the perpendicular Splinters or Twigs of a Basket, are, by those that run in and out Horizontally. And the same Horizontal Fibres, being still further produced into the Barque: they there compose the same work over again (only not so open) as in the Pith.

15. So that the most unsigned and proper resemblance we can at present, make of the whole Body of a Plant, is, To a piece of fine Bone-Lace, when the Women are working it upon the Cusion. For the Pith, Infections, and Parenchyma of the Barque, are all extream Fine and Perfect Lace-Work: the Fibres of the Pith running Horizontally, as do the Threads in a Piece of Lace; and bounding the several Bladders of the Pith and Barque, as the Threads do the several Holes of the Lace; and making up the Infections without Bladders, or with very small ones, as the same Threads likewise do the close Parts of it. But as to the
the Lace, which they call the Cloth-Work. And lastly, both the Lig- 
nows and Acrobats, stand all Perpendicular, and so cross to the Horiz- 
ontal Fibres of all the said Parenchymous Parts; even as in a Piece of 
Lace upon the Cloth, the Pins do to the Threads. The Pins being 
also conceived to be Tubular, and prolonged to any length; and the 
fame Lace-Work to be wrought many Thousands of times over and 
over again, to any thickens or bight, according to the height of any 
Plant. And this is the true Texture of a Plant: and the general com- 
position, not only of a Branch, but of all other Parts from the Seed 
to the Seed.
An Account of the

VEGETATION

OF

TRUNKS

Grounded upon the foregoing

ANATOMY.

PART II

HAVING before given the Anatomy of Trunks; I shall next proceed to see, what Use may be made thereof; and principally, to explicate the manner of their Vegetation. In doing which, that former Method, which I used in shewing the manner of the Growth of Roots, I shall not exactly follow. For so, in regard the Organical Parts of the Root and Trunk are the same, and consequently their Nutrition and Conformation are effected in the same way; I should hereby be obliged to a nauseous and unprofitable repetition of many things already said. The Explication therefore of all those Particulars, which more especially belong to the Trunk, or are more apparent therein, and not spoken of, or not so fully, in the former Books, will be my present Task. The chief Heads whereof, shall be thefe Seven following, viz. 

FIRST, the Motion and Course of the Sap. 
SECONDLY, The Motion and Course of the Air. 
THIRDLY, The Structure of the Parts. 
FOURTHLY, The Generation of Liquors. 
FIFTHLY, The Figuration of Trunks. 
SIXTHLY, The Motion of Trunks. 
SEVENTHLY, And lastly the Nature of Trunks as variously fitted for Mechanical Use.
CHAP. I.

Of the Motion and Course of the Sap.

I R S T, as to the Course of the sap, there are Three Parts in which it moveth; 1. the Pith, the Wood, and the Barque. First the Pith, in which the Sap moveth the First year, and only the First year. Or, it is Proprimum quarto modo, to the Pith of every Annual Growth, and to the Pith of such a Growth only. To be succulent. That is, whether of a Sprout from a Seed, or of a Sucker from a Root, or of a Cynor from a Branch: The Pith is always found the First year full of Sap. But the Second year, the same individual Pith, always becomes dry, and so it continues ever after.

2. §. One cause whereof is, that the Lymphadulis in the Barque, being the first year adjacent to the Pith; they do all that time, transfix and part of their Sap into it; and so keep it always Succulent. But the same Lymphadulis, the year following, are turned into Wood; and the Vessels which are then generated, and carry the Sap, stand beyond them, in the Barque. So that the Sap being now more remote from the Pith, and intercepted by the new Wood, it cannot be transferred, with that sufficient force and plenty as before, into the Pith; which therefore, from the first year, always continues dry.

3. §. THE SECOND Part in which the Sap moves, sub forma liquoris, is the Wood. Which yet, it doth not in all Plants, but only in some; and visibly, in very few; as in the Vine: In a Vine, I say, the Sap doth visibly ascend by the Wood. And this it doth, not only the first year, but every year, so long as the Vine continues to grow. But although this ascend, in or through the Wood, be every year; yet it is only in the Spring, for about the space of a Month; 1st in March and April.

4. §. There are many other Trees, besides the Vine, wherein, about the same time of the year, the Sap ascends; though not so copiously, yet chiefly, in the Wood. For if we take a Branch of two or three years growth, supposing of Sallow, and having first cut the same transversely; if the Barque be then also transversely, and with some force, pricked with the back of the knife, near the newly cut end; the Sap will very plainly rise up out of the utmost Ring of Wood. And if it be pricked in the same manner, or a little more strongly, about an Inch lower, the Sap will ascend out of every Ring of Wood to the Center. Yet at the same time, which is to be noted, there is not no Sap at all out of the Barque.

5. §. Whence appears the Error of that so Common Opinion, That the Sap always riseth betwixt the Wood and the Barque. The contrary whereunto is most true, That it never doth. For the greater part of the year, it riseth in the Barque, 1st, in the inner Margin adjacent
6. §. THE THIRD Part in which the Sap ascends, is the Barque, as was above hinted, and may be observ'd in almost any Branch, if cut cross, in the late Spring and in Summer; either as the Sap insinuates spontaneously, or upon pressing, as aforesaid. So that when the Sap ceaseth to ascend, sub forma liqueuris, by the Wood, then it begins to ascend by the Barque.

7. §. Beside the difference of Time, the Organised Parts likewise, in which these two Saps ascend, are divers. For in the Barque, it ascends visibly, only in the Succiferous, whereas in the Wood, it ascends only by the Aer-Vessels.

8. §. FROM what hath been said, we may understand, what is meant by the Bleeding of Plants. If we take it generally, it properly enough expresseth, The eruption of the Sap out of any Vessels. And so, almost all Plants, in Summer time, do Bleed, that is, from sap-Vessels, either in the Barque, or in the Margin of the Pith: the Saps they Bleed, having either a Sower, Sweet, Hot, Bitter, or other Tale. At which time, the Vessels also, in the Barque of a Vine-Branch, do Bleed a Sower Sap.

9. §. But that which is vulgarly called Bleeding, as in a Vine, is quite another thing; both as to the Liquor which insinueth, and the Place where it insinueth: that is to say, it is neither a Sweet, nor Sower, but Tasteful Sap; insinueth, not from any Vessels in the Barque, but from the Aer-Vessels in the Wood. So that there is as much difference betwixt bleeding in a Vine, or the Rising of the Sap in any other Tree, in March, and in July; as there is betwixt Salivation and an Hemorrhage, or betwixt the Course of the Chyle in the Succiferous Vessels, and the Circulation of the Blood in the Arteries and Veins.

10. §. NOW the Cause from whence it comes to pass, that the early Spring-Sap of a Vine, and other Trees, ascends by the Wood, is, that the Generation of the young sap-Vessels in the Barque, by which the Sap ascends all the Summer; is, in the beginning of Spring, but newly attempted. So that the Sap having not yet these Vessels to receive it, it therefore (pro buo vice) runs up the Aer-Vessels in the Wood. But so soon as the said Vessels in the Barque begin to be considerably encreased, the Sap, declining the Aer-Vessels, betakes it self to Thes, as its most proper Receptacles.

11. §. THE CAUSE also, why the Vessels of almost all Plants, upon cutting, do yield Sap, or Bleed; is the Prefigure which the Parenchyma makes upon them. For the Pith and other Parenchymatous Parts of a Plant, upon the reception of Liquor, have always a Conatus to dilate themselves. As is manifest from sponges, which are a Substance of the same Nature, and have a somewhat like Structure. As also from Cork, which is but the Parenchyma of Barque of a Tree. I say therefore, that the Parenchyma being fill'd and swell'd with Sap, hath thereby a continual Conatus to dilate it self; and in the same degree, to press together or contract the Vessels which it surroundeth. And the Said Vessels being cut, their actual Contraion and the Eruption of the Sap, do both immediately follow.

12. §. IT may be also noted, That the Trunk or Branch of any Plant being cut, it always bleeds at both ends, or upwards and downwards, alike
The Vegetation

Book III.

alike freely. Which, as well as divers other Experiments plainly shews, That in the Sap-Vessels of a Plant, there are no values.

13. §. FROM what we have now above, and elsewhere formerly said, we may also understand the manner of the Ascent of the Sap. As to which, I say, Fir: That considering to what heighth and plenty, the Sap sometimes ascends; it is not intelligible, how it should thus ascend, by virtue of any one part of a Plant, alone; that is neither by virtue of the Parenchyma, nor by virtue of the Vessels, alone. Not by the Parenchyma alone. For this, as it hath the Nature of a Sponge or Filter, to suck up the Sap; so likewise, to suck it up but to a certain heighth, as perhaps, about an Inch, or two, and no more.

14. §. Nor by the Vessels alone, for the same reason. For although we see, that small Glass-Pipes immersed in Water, will give it an ascent for some Inches; yet there is a certain period, according to the bore of the Pipe, beyond which it will not rise. We must therefore joyn the Vessels and the Parenchyma both together in this Service; which we may conceive performed by them in the manner following.

15. §. Let A B be the Vessel of a Plant. Let C D E F be the Bladders of the Parenchyma, wherewith, as with so many little Cisterns, it is surrounded. I say then, that the Sap, in the Pipe B A, would, of itself, rise but a few Inches; as suppos'd, from D to L. But the Bladders D P, which surround it, being swelled up and turgid with Sap, do hereby press upon it; and so not only a little contract its bore, but also transfuse or strain some Portion of their Sap thereto: by both which means, the Sap will be forced to rise higher therein. And the said Pipe or Vessel being all along surrounded by the like Bladders; the Sap therein, is still forced higher and higher: the Bladders of the Parenchyma being, as is said, so many Cisterns of Liquor, which transfuse their repeated Supplies throughout the length of the Pipe. So that by the supply and pressure of the Cisterns or Bladders F D, the Stap rises to L; by the Bladders Q, L, it rises to M; by the Bladders N M, it rises to I; by the Bladders O I, it rises to K; by the Bladders P K, it rises to E; and so to the top of the Tree. And thus far of the Motion of the Sap.

TAB. 39.
CHAP. II.

Of the Motion and Course of the Air.

The next enquiry to be made, is, into the Motion and Course of the Air. Where this question will first of all be asked: i.e. Which way the Air first enters the Plant; whether at the Trunk, Leaves, and other parts above ground; or at the Root? Answer, That it enters in part, at them all. For the Reception, as well as Transmission whereof, the pores are so very large, in the Trunks of some Plants, as in the better sort of thick walking Canes, that they are visible, to a good Eye, without a Glass; but with a Glass, the Cane seems, as if it were stuck to the root, full of holes with great Pits: being so large, as very well to resemble the Fingers of the Skin in the end of the Fingers and Ball of the Hand.

2. In the Leaves of Pine, they are likewise through a Glass, a very Elegant Show, standing all most exactly, in rank and file, throughout the length of the Leave. The Figure whereof shall be given hereafter, when we come to the Anatomy of the Leaf.

3. But although the Air enters, in part, at the Trunk and other Parts, especially in some Plants; yet its chief entrance is at the Root. Even as some Parts of Air may continually pass into the Body and Blood, by the Habits, or Pores of the Skin; but the chief entrance hereof, is at the Mouth. And what the Mouth is, to an Animal; that the Root is to a Plant.

4. Again, if the chief entrance of the Air were at the Trunk; then, before it could be mixed with the Sap in the Root, it must descend; and so move not only contrary to its own Nature, but likewise in a contrary Course to the Sap, throughout the Plant. Whereas, by its Reception at the Root, and to its Transition from thence; it hath a more natural and easy motion of Ascent. For while the Sap ascends, that the Air, in the same Plant, should continually descend, cannot reasonably be supposed.

5. The same is further argued, From the fewness and smallness of the Dia meter Portions in the Trunk, in comparison with those in the Root. In which Nature hath plainly designed the same, for the Separation of the Air from the Sap, after they are both together received therein. So that the Reception and Course of the Air, is made on this manner following.

6. THE Air being a Springy Body, it insinuates into all the Holes and Crevices of the Earth; and so is plentifully mixed therewith. Whereupon, as the Sap enters the Root, more or less Air still intrudes it self together with it. The Liquid Portion of the Sap, swells and fills up the Succulent Parts of the Bark. The Airy Part, is, as was said, separated from the Liquid, into the Diametrical Portions. Which running,
running from the Barque towards the Centre of the Root, and so passing along betwixt the Aer-Vessels; do hereby convey the Airy Part of the Sap from the Barque, into the fame.

7. And being thus received into the Aer-Vessels, and the Reception thereof, by the fame means continued, it is by them advanced into the Trunk. In which advance, it is again, more or les, disbursed into all the Parts of the Trunk; as it goes. Partly, inwards to the Pith. From whence, the Pith is always, at length, filled with Aer. Partly, into the Injections; by which it is conveyed outward into the Barque. Wherein, it is in some part, transfused through the Sap: and so the rest, with part of the Sap, remitted, in perspirations, back again into the Aer.

8. So that, whereas the Diametral Portions in the Root, do serve to convey the Aer from the Sap in the Barque, into the Aer-Vessels, in the Wood: on the contrary, the Injections here in the Trunk, serve to convey the Aer from the Aer-Vessels in the Wood, into the Sap, in the Barque. Wherefore, as the Aer-Vessels advance the Aer, or the Airy Part of the Sap, and so convey it by the length of the Trunk; so the Injections flow it, and convey it by the breadth.

9. And that the Injections have this Office or Subservience unto both Kinds of Vessels; doth yet further appear, if we consider, that the Aer-Vessels are always so polished, as to touch upon the said Injections, or at least to stand very near them. For either they are large, and so do frequently touch upon them on both sides; as in Elm, Ald, Walnut, &c. Or if they be small, they either run along in even lines collateral and oftentimes contiguous with the said Injections, as in Holly: or at least, are reciprocally, some on one side, and some on another, inclined to them; as in Apple. By all which means, the Aer is more readily conveyed from the Vessels into the Injections.

10. A further evidence hereof is this. That generally, the bigger and the more numerous the Aer-Vessels be; the bigger, or at least, the more numerous alo are the Injections: Especially, if the comparison be made (as in all other cases it ought to be, as well as here) betwixt the severall Species of the same Kind. So Corin, which hath small Aer-Vessels, hath also very small Injections. But the Vine, hath both very large; and so for others.

11. Wherefore, the Injections minister betwixt the Aer-Vessels, and the Suceiferous; in the fame manner, as the Vesicle of the Lungs, do betwixt the Bronchiae and the Arteries. That is to say, as in an Animal, the Bronchiae depoit the Aer into the Vesicle of the Lungs; which administer it to the Arteries: so in a Plant, the Aer-Vessels depoit the Aer into the Vesicle of the Injections; by which it is gradually filtered off into the Barque and the Sap-Vessels therein.
Book III.

of Trunks.

I29

CHAP. III.

Of the Structure of the Parts.

Third enquiry, is into the Generation and Structure of Parts. The manner whereof I have already endeavoured to explicate (a) from the Anatomy of the Root, throughout all particulars. P. 2.

Some whereof I shall yet further clear.

1. §. As first, the Union of the Barque to the Body of the Tree. Contrary to the common Opinion, That they are not continuous; but that the Barque only surrounds the Body, as a Scabbard does a Sword, or a Glove the Hand. As also seemeth to be proved, by the easy slipping of the Barque of Willow, and most other Trees, when full of Sap, from the Wood.

2. §. But, notwithstanding this, they are as truly continuous, as the Skin of the Body is with the Fle&; that, by means of the Parenchyma; which is one entire Body, running from the Barque into the Wood, and so uniting both together; as in a Branch of Vine or Corin-Tree, when the Barque is strippèd off, is apparent; the Spaces between the several Parts of the Wood, being filled up with the Parenchymous, inserted from the Barque.

3. §. Now the reason why the Barque nevertheless slips so easily from the Wood, is plain, viz. Because most of the young Vessels and Parenchymous Parts, are there every year successively formed; that is, twixt the Wood and Barque: where the said Parts newly formed, are as tender, as the tenderest Vessels in Animals. And we may imagine, how eafe it were at once to tear or break a thousand Vessels or Fibres of an Embryo, of a Womb or Egg.

4. §. The same Vessels of the Barque being always braced, and gradually falling off, together with the Parenchyma, into the utmost Rind: Hence it is, that the Barques of many Trees, are as it were, in large tilted with several Cracks of diverse Sizes; and sometimes in the Figure of Rombs: the said Fibres representing the Position and Tract of the Vessels in their Braces. Hence also it is, that the Barque of some Trees, as of Corin, Cherry, &c. falleth off in Rings, &c. because the Sap-Vessels are polish'd in the same manner in the Barque.

5. §. The Sap-Vessels, as they are generated at the inner Verge of the Barque; so likewise, in a small quantity, at the utmost Verge of the Pith. Thence being not only fed with a more vigorous Sap, but with great caution, secured within the Wood, for the propagation of the succeeding Buds.

6. §. Hence also it is, that is, by the annual accretion of these Vessels, that the Pith is sometimes less in the Trunk, than in the Branches: Tab. 18; and left in the elder Branches, than in the younger; and sometimes is altogether wholly filled up. By which means, as the Branches carry every year a greater burthen, so they become still more sturdy the better to support it.

7. §. Sometimes also the Pith breaks and shrinks up, thus making the Trunk a Pipe. The cause whereof, is either the Largeness of its Pores, or the Thinness of the Sides of the said Pores; upon both of which

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The Vegetation

Book III

which accounts, the Pith doth more easily tear, and upon tearing shrink up, and so become hollow: as in Cichory, Lampiana, Sonchus, Teasel, Brownport, and others; wherein the Pores of the Pith are large, and the Sides of the Pores, thin. Whereas, upon contrary accounts, the Piths of most Trees, remain perpetually entire.

8. §. T H E Reason why Plants are made thus to become hollow, is partly, for the ripening of the Fruit or Seed; which is the better effected by a more plentiful supply of Air continually received into their hollow Trunks. For by means of that Air, part of the Sap, is dried up, and the remaining part of it made warmer, and so sooner matured.

9. §. Partly, for the better determining the due Age of the Plant. Hence it is, that the greater part of Annual Trunks, are hollow: the Air contained in that hollows, drying up the Sap, and shrinking up the Sap-Vessels so far, as to hinder the free motion of the Sap therein: from whence the Plant must needs perish. So that as the Content of the Acr-Vessels, is a kind of Vegetable Air, whose Office is to Attenuate, and Ferment the Juices of Plants: so the Content of these Cavities, cometh nearer to a more common Air, designed chiefly, so soon as it is convenient, to dry them up.

10. §. A G A I N, as to the Acr-Vessels, divers questions may be asked. As how it comes to pass, that they are generally less in the Trunk of the same Plant, than in the Root? The Cause whereof is, that here in the Trunk they are more under the power of the Air; both that which entreath in at the Trunk, and that which of its own Nature ascendeth up into it from the Root. For the Air, as we have elsewhere said, is the Medium of the Acr-Vessels; to whose crooked or at least, Acrid Parts, the Saline, and other Principles concuring to their generation, do conform. To which they do best, the smaller they are: the Fibres of the larger Acr-Vessels making greater Circles, and so coming nearer to a right Line, answerable to the Figure of the Particles, not of the Aerial, but of the Saline Principle.

11. §. Wherefore as the Acr-Vessels may be observed full to be dilated or widened towards the lower parts of the Roots; the Aerial Principle being there less predominant, and the Saline more: So towards the upper part of the Trunk, to be contracted or grow smaller, the Aerial Principle being here more predominant, and the Saline less.

12. §. F O R the same cause it may be observed, That the Acr-Vessels of the Second years Growth, and the several years succeeding, are usually nearer of one Size, than those of the Second and First; all being under a less power of the Air, than the First. For the first year the Pith being full of Liquor, the Acr-Vessels themselves, are the only Repositories of the Air. Whereas after the first year, the Pith becoming dry, or another great Repository for the Air, the Acr-Vessels are henceforth filled with a moister or more Vaporous and Saline Air, and so made to grow wider.

13. §. Hence the very Size of the Pith, hath much influence upon the Acr-Vessels, and the manner of Nutrition, and the Generation of Liquors in Plants.

14. §. B U T for the most part, the Acr-Vessels are somewhat, more or less, amplified in every new Annual Ring; or at least to a certain number of years. Probably, because in the elder Branches, the Spiral Fibres, of which the Vessels confit, are more bulky; and so make a
Vessel of a wider, as a more agreeable bore. Nature obtaining here-
by, that the Quantity of Air, shall always be answerable to the
Growth of the Plant, or at least, be sufficient to maintain its Vegetable
Life and Vigour.

15. §. And therefore, as is above hinted, it seems likely, That after
a certain number of years, the Air-Vessels are no longer ampli-fied, but
stand at a stay, and perhaps may grow smaller, according as the Tree is
less or more Longeved; and that after this period, it is some way or other
in its Declining State.

16. §. LASTLY, from the Content and Governing Principle of the
Air-Vessels, the Time, when they begin every year to be formed, or
to appear, is always later; at least with respect to the season of the
Tree. So that whereas the Sap-Vessels begin to be formed in Spring:
these, not till the latter end of Summer, or there about; at least not
till about that time to appear. That is, when the Sap begins to de-
crease, and to grow more Airy; and so more fit matter for the Gen-
eration of the said Air-Vessels.

C H A P. IV.

Of the Generation of Liquors.

PON the Structure and Formation of the Parts, de-
pendeth the Generation of Liquors, as was lately in-
timated. The manner whereof I have formerly
flewed, in discoursing of the Root. Yet some things
I shall here further explicate. And First, what we
have formerly afferted, &c. That the concurrence of
two specifically distinct Fluids, is as necessary to
Nutrition in Plants, as in Animals. Which appears, as from divers
other considerations, so from the very Structure of a Plant: where in
all the Organical Parts, or the Parenchyme and the Vessels, are every
where mixed together per minima, that is, per minimas partes organ-
cean, or Fiber with Fiber of several Kinds. Every small part of a
Tree, or of the Barque of a Tree, being as I may say, a sort of Lins-
Woolsey. So that there is not the least part of the Sap, which is not
impregnate with divers Essentiel Tinctures, as it is continually fil-
tered from the Fibres of one Kind, to those of another; standing every
where wound and stitched up together for the same purpose.

2. §. FROM the special Nature and Structure of the Parts, the
Liquors of Plants are likewise specified. The Vessels being the chief
Visceræ of a Plant. For all Liquors in a Plant, are certainly made by
that Plant. And since the Plant hath no Visceræ (so called) I would
then know, what its several Liquors are made by? If in the Paren-
chyme, surely by that Parenchyme. If in the Vessels, by the Vessels.
And if of divers Kinds by divers Kinds of Vessels. So that what the
Visceræ are in Animals, the Vessels themselves are in Plants. That is
to say, as the Visceræ of an Animal, are but Vessels conglomerated: so
to the Vessels of a Plant, are Visceræ drawn out at length.
3. 6. **AGAIN**, as the specifying of the Sap dependeth chiefly on the special Nature of the Parts: lo partly, upon the Structure of the Whole. Whereby every Part is still better accommodated with its own Juice. Thus the Aer-Vessels are necessary, not only and barely for a supply of Aer; but also by their Name, Size, and Position to adjust the quantity of that Aer, to the government of Nutrition, and the Generation of the Specific Liquors of every Plant. Which is evident from hence, in that they do not follow the Size of the Plants; but are great and many, in some small Plants; and small and few, in some others that are large. So Vines, and Corn, as we have formerly observed, have proportionally a great number of Aer-Vessels, and those very large. By which means the Sap is attenuated and left Oyl, and more copiously impregnated with a Subtle, Volatile and Winy Spirit.

4. 6. For the same reason, the Stalk of Maze or of Indian Wheat; which when it is Green yieldeth a very sweet Juice; and the Cane; whereof Sugar (which aboundeth with a volatile and inflammable Spirit) is made; these, I say, obtain the like proportion of Aer-Vessels, to what we see in most other Plants. Hence also it is, that none of the said Plants have any considerable Barque; that so the attenuating and futilizing Aer, may have a more easie and plentiful admission at the Trunk, also. For which reason likewise the Pores of the Skin of some Cane are, as hath been said, remarkably wide.

5. 6. Hence also it is observable, that of the same Species or Kindred, those Plants which have the most, and especially the largest Aer-Vessels; have also the greatest abundance either of a sweet, or of a winy Liquor. So in Apple; they are larger than in Crab. In Warden, larger than in Quince; and in Pear-Tree, larger than in Warden. So also in Corin, larger than in Gooseberry; and in Vine, larger than in Corin; and so in others.

6. 6. AND as the Aer-Vessels, by their Multitude and Largeness, are accommodated to the better making of a Winy sap: so by their fewness and smallness, of an Oyl. As is remarkably seen in Fir, and other Resiniferous Trees: these having, if not the smalllest, yet the fewest Aer-Vessels of all other Trees.

7. 6. IF it be asked, how a Plant comes to have any Oyl at all in any Part? Since we see, that the Sap by which the Root is fed, schemeth to be nothing else but Water; and that many Plants which yield a great deal of Stillitations Oyl, as Mint, Rue, and others, will yet grow in Water: I say, if it be enquired how this Water, is made Wine or Oyl? I answer, that there is no such matter. But that the Oyl, and all other Vegetable Principles are actually existent in, and mixed per minima, though in an extraordinary small proportion, with the Water. Even as we see the distilled Waters of Anise Seeds, Penyroyal, and the like to be impregnated with their own Oyls, which give the Taste and Smell to such Waters.

8. 6. Wherefore, as a certain quantity of any Salt may be disdissed in Water; beyond which, it will not mix therewith, but remains under its own Form: So is there a certain proportion of Oyl, though far less, which may also be perfectly mixed with Water; and is certainly so, more or less, with all the Water in the world. But if that proportion, or degree of impregnation be once exceeded; the particles of Oyl do then, and not till then, gather into a body, and appear under their own Form.
9. §. I say therefore, that all kinds of Vegetable Principles, are either in or together with the Water, with less difference first received into a Plant. But when they are once therein; they are then separated, that is to say, filtered, some from others, in very different Proportions and Conjunctions by the several Parts; the Watery by one Part, the Aery by another, the Oily by another, and so the rest: and so every Part is the Receptacle of a Liquor, become peculiar, not by any Transformation, but only the Percolation of Parts out of the common Mass or Stock of Sap. And so all those parts of the Sap, which are superficial to any kind of Plant, are at the same time, discharged back by Perpirations, into the Aery.

To. §. AND, that Nature, in the various Percolations and Separations of the Sap, may fill the better answer her end; hence, it is, that she carefully leeth, not only to the special Nature and Proportion of the Organs, by which the doth her work: but likewise to their very Position. Thus it is observable, That whereas the Lympheducts, which carry a more Watery Liquor, are still placed on the inner Verge of the Barque, next to the Aery-Vessels: the Lacticera and Resinous Vessels of Plants, to whose Oily Liquor a mixture of much Aery is incongruous; do usually stand, neither on the inner, nor the outer verge of the Barque; but in the middle. By which means, they are at the greatest distance, and so most secure, from the Aery; either that which enters the Barque at the Circumference, or from the Wood and Pith.

11. §. AND; because the Resinous Liquors of Plants are more Oily, than the Watery, their security therefore, from the approach of the Aery, is yet further contrived. In that in Pine, and other Resinous Trees, the Diametrical Inserions are never found, or at least, not visible: which yet in other Trees, are conspicuous, being those Parts, whose office it is, to introduce the Aery from the Aery-Vessels into the Barque.

12. §. AGAIN, the Milky Liquors of Plants being thinner than the Resinous, and having a considerable quantity of Water mixed with their Oyl; hence it is, that in Milky Plants, as in Rhus, there are a greater number of Lympheducts; and those standing nearer to the Milky Vessels, than they do in Pine and the like, to the Resinous. By which means they are better fitted to affline their Aqueous Parts more plentifully to the said Milky Liquor.

13. §. FROM the Mixture of Watery Parts with the Oyle, it comes to pafs, that whereas all Lymph's, Mucilages, and Resins are transparent; the Aqueous Liquors of Plants are Milky or white, or otherwise Opacous. For the same thing is the cause of the Whiteness of Vegetable, as of Animal-Milk: that is to say, a more copious mixture of Watery and Oily Parts per minim, or into one Body. For even the Scrous and Oyle Parts of Animal Milk, when thoroughly separated one from the other, they become very transparent. So the Stillations Oyl of Anise Seeds, is most transparent and limpid, even as Water it self: yet there is a known sort of White Anise-Seed Water, as it is commonly called: that is to say, wherein the Oyl, in distillation, ariseth and is mixed more plentifully with the Water. And the Water, wherein the Stillations Oyl of any Vegetable is dissolved, becomes a perfect white Milk; as in this Honourable and Learned Presence, I have formerly had occasion to shew the Experiment. (a)
The Vegetation

14. §. AND that the Milky Liquors of all Vegetables whatsoever, are more Oylie than their Lymphas, is most certain. For all those Gums, which dissolve either in Oyl or in Water, as Gallanum, and the like, are originally the Milky Juices of Plants. And if you take the Milk of any Plant, as for instance, the Milk of common Sumach, or of any Tasteful, Bitter, Astringent, Hot, Cold, or any other whatsoever; and having well dried it, and then fired it at a candle; it will thereupon burn with a very bright and durable flame, even like that of Tar or Tarapentine it self.

15. §. FROM what hath been said, we may likewise gather the most genuine import of the word Gum, and the distinction thereof both from a Rosin and a Mucilage. First, a Rosin, is originally a Tarapentine, or Acidoleous Liquor, having an exceeding small quantity of Watery Parts mixed therewith; and which, for that reason, will not be dissolv'd in Water, but only in Oyl. Of this kind are Mastick, Benzoin, Taccamahaca, and divers others, commonly, in our Bills to Apothecaries, called Gums. Yet in strict speaking they are all so many Rosins.

16. §. Secondly, a Gum, and every Oylie Gum, is originally a Milky Liquor, having a greater quantity of Water mixed with its Oily Parts; and which for that reason, will be made to dissolve either in Water or Oyl. Of this kind are Sage, Opoponax, Ammoniac, and others.

17. §. The third sort of Gum, is that which is Unguette, and which therefore dissolveth only in Water, as Gum-arabick, the Gum of Cherry-Tree, and others such like. This Gum, though commonly so call'd, yet is properly but a dried Mucilage; being originally nothing else but the Mucilaginous Lympha issuing from the Vessels of the Tree. In like manner, as it doth from Comfrey, Mallow, and divers other Plants: and even from the Cucumber. The Vessels whereof, upon cutting cross, yield a Lympha, which is plainly Mucilaginous, and which being well dry'd, at length becomes a kind of Gum, or rather a hardened Mucilage. In like manner, the Gums of Plum-tree, Cherry-tree and the like, are nothing else but dryed Mucilages. Or, if we will take the word in its widest sense, then all Gums are originally, either a Terebinth, or a Milk, or a Mucilage.

18. §. I have likewise made divers Observations of the Tastes, Smells, and Colours of Plants, and of their Contents, since th'o/ I last published; and that both for the finding out the true Causes of their Generation, and also the applying of them unto Medical and other U5es. Of which hereafter.
HE Fifth Head, shall be, of the Figuration of Trunks. Which also, as well as the making of Lagers, dependeth upon the Structure of the Parts. As First, almost all Shrubs (caeret paribus) have a greater number of Aer-Vessels; and those of a smaller Size; and consequently much spread abroad, as most easily yielding to the magnetick Power of the Aer, according as we have more fully demonstrated, in speaking of the Vegetation of Roots: as in Elder, Hazel, Fig, Sumach, and the like. By which spreading, the said Aer-Vessels do sooner, and more easily strike into the Bark, and so produce collateral Buds and Branches, and that upon the first rising of the Body from the Root: that is, the Plant becomes a Shrub.

2. **B U T** if the said Aer-Vessels are very large, they will not yield so easily to shoot out collaterally; and so the Trunk grows up taller and more entire: as in Oak, Wallnut, Elm, Cc. wherein they are exceeding large, is seen. Hence also the Fir, if supported, will grow to a prodigious length. And Hops and Bryony are some of the tallest, amongst all Annual Grows: the Aer-Vessels of all which, are very large. Whereas Borage, and many other like Plants, although the Pores of their Parenchyma, are vastly wide, and filled with Sap; yet because their Aer-Vessels are small, they are therefore but Dwarf-Plants. Wherefore the tallest, or advancement of a Plant or Tree, dependeth not upon the Plenty of Sap, how great soever, but on the Largeness of the Aer-Vessels.

3. **A G A I N**, as a Plant or Tree grows either Shubby, or Tall and Entire, according to the Size of the said Vessels: so from their Position, both it grow slender or Thick, So, where they keep more within the compass of a Ring, as in Elm, and Abb, the Tree, in proportion, usually grows taller, and lets thick. But where the said Vessels are spread more abroad, and especially are portured in Rays, as they are in Oak, the Tree grows very thick. Because the said Vessels thus standing all along nearer to the Infections, there is a more ready and copious pallage of the Aer out of the one into the other; and so the Diametral growth of the Wood is more promoted.

4. **L A S T L Y**, from the same general cause it is, That the Trunks of Vegetables are either Round or Angular. Those of all Trees are Round. Because the Barque, being here thicker, and the Aer-Vessels bound up with a greater quantity of Wood, the Aer hath not sufficient Power to move them, and the Barque with them, into those various Positions or Figurations, as the Trunks of Herbs do yield to.

5. Yet the cause of the various shapes of the Trunk, is not the Aer alone; but partly, the Principles of the Plants themselves, in conjunction therewith; according to the predominition whereof, and chiefly of some certain kind of Salt or Salts, as I shall hereafter (a) more particularly explicate. the Trunk is Square, Triangular, Pentangular, or otherwise Figured. And thus much in general of the Figuration of Trunks.

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(a) B.A.P.
HE Motions also of Trunks are various. Principally Four; Ascending, Descending, Horizontal, and Spiral. The cause of the Ascent of a Plant, is a certain Magnetick Correspondence between the Air and the Aer-Vessels of a Plant; the Motion and Tendency whereof, the whole Plant follows. This I have asserted, and I think, clearly demonstrated in my First and Second Books of the Anatomy of Plants. I will here add this plain Experiment.

2. §. Take a Box of Moulds, with a hole bored in the bottom, wide enough to admit the Stalk of a Plant, and let it upon fells half a yard or more above ground. Then lodge in the Mould some Plant, for Example a Bean, in such sort, that the Root of the Bean standing in the Moulds may point upwards, the Stalk towards the ground. As the Plant grows, it will follow, that at length the Stalk will rise upward, and the Root, on the contrary, arch itself downward. Which evidently shews, That it is not sufficient, that the Root hath Earth to shoot into, or that its Motion is only an Appetite of being therein lodged, which way soever that be: but that its nature is, though within the Earth already, yet to change its Position, and to move Downwards. And so likewise of the Trunk, that it rises, when a Seed sprouts, out of the Ground, not merely because it hath an Appetite of being in the open Air; for in this Experiment it is so already; yet now makes a new Motion upwards.

3. §. But although the Natural Motion of the Trunk be to Ascend; yet is it forced oftentimes to Descend. For the Trunk-Roots growing out of some Plants near the ground, and shrinking thereinto, like so many Ropes, do pluck the Trunk annually lower and lower into the ground together with them; as may be seen in Scrophularia, Jacobea, and many other Plants.

4. §. If these Trunk-Roots break out only about the bottom of the Trunk, as in the aforesaid Plants, then the Trunk gradually Descends into the Earth, and is turned into a Root. But if it be very slender, and the Trunk-Roots break forth all along it, then it Creeps horizontally; the said Roots tethering it, as it trails along, to the ground; as in Strawberry, Cinquefoil, Mint, Scorodum, &c.

5. §. As to their Spiral Motion, it is to be noted; That the Wood of all Convoluta, or Winders, stands more close and round together in or near the Center, thereby making a round, and slender Trunk. To the end, it may be more tractable, to the power of the external Motor, what ever that be; and also more secure from breaking by its winding Motion.
6. §. Wherefore, *convolutia* do not wind by any peculiar Nature or Genus, which other Trunks have not; but because their Parts are disposed so, as to render them more fequeaceous to the external Motor. Even as the Eipigers of a Vine, having the like Structure, have also a Motion of Convolution: whereas the Branches themselves upon a contrary account, move in a straight Line.

7. §. The Convolution of Plants, hath been observed only in those that Climb. But it seems probable, that many others do also wind, in which, the main stalk, is as the Axis to the Branches round about. Of which number, I conceive, are all those whose Roots are twisted; but because their Parts are disposed as to render them more sequeaceous to the external Motor.

Even as the Trumpets of a Vine having the like structure, have also a Motion of Convolution: whereas the Branches moving upon a contrary account, move in a straight Line.

8. §. The Convolution of Trunks, is made not one, but divers ways; some moving by South from East to West; and others from West to East. Wherefore it seemeth, that as the Efficient Cause of Convolution, is not within the Plant, but external: so also, that it is not one, but that there are Two Great Efficient of this Motion; so the Sun and the Moon. Some winding together with the Sun, in its Diurnal Motion, (or, if the Earth moves, then, Inclining to the Sun) by South from East to West. And others winding with the Moon, in its Monthly Motion, from West to East.

9. §. This possibly, may also be one sensible way of distinguishing betwixt Solar and Lunar Plants. Thus far, in general, of the Motions of Trunks.

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CHAP. VII.

Of the Nature of Timber or Trunks, as they serve for Mechanick Ufe.

HE last thing I purposed to speak of, is, Those several Qualities of Timber or of Trunks, by which they are fitted for Mechanical Ufe. As Hardness, Softness, Fasness, Cleavage, Toughtness, Brittleness, Durableness, or any of the same Qualities compounded. The Visible Causes whereof are observable, Partly, in the Structure of the several Parts; so the Infections, Sap-Vessels and Air-Vessels; as to the Number, Size, or Position of any of them. And partly, in the Nature of the Parts; I mean such as is manifest to Sense. According to our clear and distinct observing of all which Causes, we may understand, Wherefore any Wood is made ufe of for any certain purpose. And also, wherein fitly to apply it to further Ufe. In order to which, a compleat
compleat History of the Mechanical Uses of Vegetables would very much conduce. I shall for the present give some Instances.

2. §. As First, some Woods are soft, as Deal, and Sallow. Yet from different Causes. Deal, from the great Porosity of the Wood it self, or the large Pores amongst the Sap-Vessels. But Sallow, from the great number of Aer-Vessels spread all over it. And therefore, though they are both soft, yet will not serve for the same purposes; Sallow being well wrought upon, which way ever you cut it: but Deal, especially the white Deal, if it be cut crofs, it tears, and will never polish or work smooth.

3. §. Again, in Sallow, by the equal spreading of the Aer-Vessels, the Softness is equal or alike in all Parts. For which cause it maketh an excellent Coal for Painters Scribels. Because it doth not only make a light Stroke, but ever where certain; and so doth not disturb the even Motion of the Hand. For the same cause, Shoemakers also make use of it for their Carving-boards. Because being every where equally soft, it turns not the edge of their Knives. Which Deal would presently do; because though very soft in some places, yet in others 'tis hard; that is to say, on the inner Verge of every annual Ring of Wood, where the old Sap-Vessels grow much more compact and close together.

4. §. AGAIN, some Woods are soft, but not soft; others are both, as Linn: Its Softness, depending on the numerousness and equal spreading of the Aer-Vessels; Its Fasfnss, on the closeness of the true Wood, and the shortness, and smallness of the Infections. For which cause, it is of excellent use for many purposes; and particularly, for small Sculptures: such as may sometimes be seen for the Frames of Looking-Glasses, or of smaller Pictures in Water-Colours.

5. §. SOME Woods, again, are soft, and hard, as Elm. Its hardnes is depending upon the closeness of the Wood. Its Softness, partly, upon the same cause; and partly, on the smallness of the Infections; as also on the fineness of the Aer-Vessels in proportion with the Wood; and on the thwart and crofs Position of many of them. Hence it is, that Elm, of all others, is the most crofs-grain'd Timber; that is, cleaveth so unevenly, to and fro, according to the crofs Position of the said Vessels.

6. §. Hence also it cleaveth the most Difficulty. Even then, when it is without any Knots. For which reason it is always used, as beft for the Hub of a great Wheel. As also for Water-Pipes, and Pumps. Not because it is the most durable Wood: but because it will not split or crack, either in the working, or afterwards. For the very same reason, it is used for Coffins: that is, because, it will not split in working: not because it will endure longest under ground: for Poles are always made of Oak. So also the Ladies and Sails of a Mill-wheel are always made of Elm: as also the Keel of a Boat. 

7. §. It may here also be noted, That the Planks commonly called Grooing-Boards, lately expofed, as a kind of Prodigy, to the view and hearing of many People, were of Elm. The Aer-Vessels of this Wood, being, though not more numerous, yet more ample, than in any other Timber. So that upon the application of the Red-hot-Iron, as was usual, and thereby the Rerification of the Aer and Watery Parts in the Timber; every Vessel became, as it were a little Wind-Pipe for their
their Expiration. And as a great many Drops falling together in a shower of Rain; so a great many of these Piper playing together, might make a kind of big or groaning noise.

8. **As Elm.** of all Woods, is one of the fastest; So, on the contrary, of all hard Woods, Oak is the most Cleavesome, or splitted the most easily. The cause whereof is, partly, the Vargeness of the Injunctions; and partly, the Diametrical or Radiated Position of most of the Aer-Polles: upon both which accounts, wherever a crack is once begun, 'tis easily continued throughout the Diameter of the Trunk.

9. **Again.** some Woods are hard, fast, and tough. So is Afb, and especially Beech. Hard and fast, from some of the fame Causes, as Elm. Tough not from the Structure, but from the Nature of the Parts; whose Principles are united in a more exact proportion. Wherefore London-Cars have the Rings of their Wheels of Beech; because it tears more difficulty than even Afb is self. Whence also for large Screws, there is no Wood like it. But for Small Screws, of about an Inch Diameter, Birch is the best; as being, though not so hard, yet more tough.

10. **The more Brittle a Wood is,** 'tis likewise usually the more durable. So Oak, which, with respect to its hardnes, is not so tough, but very brittle Wood, is almost as durable as any. Whereas Beech, Birch, and the like, although very tough; yet for Duration, are of no service; for there are no Woods will rot sooner: and therefore, though strong enough, yet unfit to make any Standing Parts of Building, or of Furniture, especially in wet and moist places. Because, these Woods, having a less proportion of Oyl, than there is in Oak; they are apter to imbibe the moisture even of a damp Aer; by which moisture, they either Rot, or breed Worms, which destroy them.

11. **Hence it is,** that what we call the **Heart of Timber,** as it is more brittle, so also more durable; &c. Because more Oyle. So that which is called the **Sap of Oak,** is much more tough than the Heart, although the Heart be more durable. That is to say, the older the Wood is, the Water Parts are the more evaporated, whilst the Oyle still remaines, as a kind of Varnish or Extract in the Wood. Even as we fee, that the older Seeds of any one Kind, are more Oyle than those that are green and young. So that the Oyle or Resinous Parts of the Sap, are a kind of Embalmimg to the Heart, or older Part of a Tree, securing it from the destructive impressions of the Aer. For, which Caufe it is, that Oak, Teem, Cours, Guajacum, &c. which are Oyle Woods, have always much Heart, whereas birch, Alder, Beech, Maple, which are very Unoyle, have never any Heart.

12. **From hence likewise we may understand the Caufe of the Toughnes of Flax:** what we call Flax, being only the Sap-Cells, or Lignous Fibres of the Barque. And generally, the Barque of any Tree, as of Willow ('whereof are usually made a fort of Ropes) is very tough. The Vessels being here younger, and less Oyle than in the Wood. So likewise Hemp, is nothing else but the Sap-Cells of the Barque of the Plant so called. And Scotch-Cloath, is only the House-wifery of the fame Parts of the Barque of Nettle.

13. **Whereby it is very probable,** that there are many other Plants, as well as the above named, whereof might be made good Teem. And of some, especially in some respects, better than of Flax itself. Because that even Hemp, although it will not make so fine A a 2
fine a Staple, as Flax (for all our fine Hollands are made of Flax) yet Flax, which is but of the same fineness as Hemp, will never, by all the Art yet known, be made so white as Hemp is made. The qualities therefore of the best Tw, that can be in Nature, are that the Staple be long, small, tough, and white. So that if in the Barque of any Plant, we can find these qualities, or any of them, to excell; we may be sure, it will be of better use, in some respects, for the making of Cloaths, or other purposes, than Flax itself.

14. §. I W I L L conclude with one Instance more, and that is as to Grafting. The good and happy success whereof, doth certainly depend upon the suitablenes or repondence betwixt the several Parts of the Stock, and Cyon; as the Barque, Wood, and Pith; and that both as to the Number, Size, and Position of the said Parts, and of their several Pores or Vessels: according to the degrees whereof, the Conjunction (ceteris paribus) will be more or less prosperous. So that of all such Conjunctions as are found to be apt and taking, and which some have learned not without long Practice and Experience; another, only by comparing the Branches of Trees together, may with little trouble, and in much less time, inform himself. By the same means, some Conjunctions which seem to be strange, as Quince and Pear, White Thorn and Medlar, &c, do yet, by the repondence of their Parts, as well as by Experience, appear to be good. And there is no doubt, but that many Conjunctions not yet tryed, or not known to have been so, may upon the same ground, be tryed with good success.

15. §. The chief Use of Grafting and Inoculation, is, That they Accelerate the growth of Good Fruit. The Cause whereof, is the Knot, which is always made in the Conjunction. By means of which, all the Sap is strained, and so ascendeth up into the Grasaff or Bud, both Power and in less Quantity; and is therefore better and sooner concocted. Hence, the smaller the Fruit of any Tree, though it be not the best, yet the Sap being there, in less Quantity, is the sooner ripe. On the contrary, where the Sap ascendeth too freely, it doth not only retard the growth of the Fruit, but produceth Barrenness; as is seen in those luxuriant Branches, where it runs all up to Leaves. Hence also Vines, by Bleeding, become more Fruitful: that is, by the Effusion of Part of the Sap, there is a more easier melioration of that which remains. Even as phlebotomy doth oftentimes produce a more healthful and better Habit of our own Bodies. To conclude, the lesser the Quantity, and thereby the melioration of the ascending Sap, by Knots, is Nature's own contrivance; as is seen in Sugar-Cane, Corn, and other Plants.
THE

ANATOMY

OF

LEAVES, FLOWERS, FRUITS and SEEDS.

In Four Parts.

The FOURTH BOOK.

By NEHEMIAH GREW M.D. Fellow of the ROYAL SOCIETY, and of the COLLEGE of PHYSICIANS.

LONDON,

Printed by W. Rawlin, 1682.
THE CONTENTS OF THE First Part.

CHAP. I.
Of the Protections and Folds of Leaves.

CHAP. II.
Of those Things which appear upon the Surface of the Leaf.

CHAP. III.
Of the Figures of Leaves, and the Apparent Position of the Fibres.

CHAP. IV.
Of the Parts and Texture of the Leaf.

CHAP. V.
Of the Duration of Leaves, and the Time of their Generation.

CHAP. VI.
Of the Manner of the Generation of the Leaf. Where also, that of the Two General Parts of a Plant, fr. the Lignous and Parenchymous, is further explain'd.
To the Honourable

Robert Boyle Esq;

S I R,

I had finished the foregoing Books, in which, I conceive, as far as Glasses will yet lead us, I have clearly Descri'd and Delineated the Structure of a Plant; and have endeavour'd, in some part, to Unfold the Reason and Scope of Nature therein: I was willing to fit down, and leave what remained, to the Improvements of the Present and Succeeding Ages.

But in Discourse upon this Subject, You have been pleased frequently to insist, That I should by no means omit, to give likewise, some Examples of the Mechanisme of Nature in all the other Parts. The Performance whereof therefore, next to the Obedience I owe to the Royal Society, is to be looked upon, as a Due to the Authority which Your Judgment hath over me.

This I have said, that, if what is herein done, shall prove acceptable unto Learned Men; they may know, To whom they are oncemore to give their Thanks: After they have so often done it, upon (a better score) the Publishing of Your own Excellent Works, In which, there seems to be a Question, Whether Your Continual Endeavours, to enlarge the Bounds of Natural Knowledge, or Your Successes therein, have been the Greater. So that, whereas Nobility in some, doth only
The Epistle Dedicatory.

only serve to lift them, like Jupiter's Satellites, out of sight: You, by giving a greater Light, have drawn all Mens Eyes upon You. And whilst there are many, in all Ages, fond of Preheminency in the Conduct of Popular Affairs; who yet rarely hit the Mark they aim at; or aim at That they pretend: You have thought fit, rather to separate Your Self, to that more Innocent, and more Noble Sort of Wisdom, which lieth, not in the Arts of Conceiling, but in Discovering, the Truth of Things.

That we may have many to imitate You herein, cannot but be heartily wis'd by all, who regard the Honour of their own Country, as it is, with much Zeal, by

Sir,

Your most obedient

Servant

NEHEMIAH GREW.
THE
ANATOMY
OF
LEAVES,
PROSECUTED
With the bare EYE,
And with the
MICROSCOPE.
Read before the Royal Society, Octob. 26. 1676.

PART I.

CHAP. I.

Of the Protections and Folds of Leaves.

In the General Anatomy of Plants, I have assigned one whole Chapter (a) to the Germen and (a) Leaf. Since then, I have occasionally made divers Remarks of the same; both with the Naked Eye, as there, and also with the Microscope. The Principal whereof, I shall here let down; without repeating any from thence; or obliging my self strictly to the Order there used.

2. §. That which in a Germen, first occurs to the Eye, is the Protection of the Leaves, or the various Methods which Nature takes to preserve them from the Injuries both of the Ground, and of the Weather. To the Instances formerly given, I shall add these that follow.
3. &. AND First, it is observable of the young buds of Annu, that left they should be bruised, or starved, upon their first Enupri- from under the Ground; they are couched, as Fenn is row'd, in ward; each Bud, against the Buds of the Stalk of the foregoing Leaves, and most exactly laid up within the Membranes thence produced: Just as the Child in the Womb, lies with his Head against his Knees; or as it is afterwards embraced with the Arms of the Nurse. And it is a general Rule of Nature, where the Stalks of the Leaves are fo long, that they cannot lap one over another, and where no other special Protection is provided; for the bottoms of the Stalks to be produced into broad Membranes, as Blankets to the succeeding buds; as in Crowfoot, Dovesfoot, Cleaver, Cranebill, Strawberry, Tarow, and others. And sometimes instead of two skins lapped one over another, there is one entire Skin, produced from the Stalk, in which as within a Secundine, the bud is safely4rowed; and which, in its Growth, it gradually breaks open.

4. &. THE same is also observable in Dock, Sorrel, Bistort, and all other Plants of this kindred; with this difference, That every Veil or Secundine is not here produced from the Stalk of the Leaf; but hath its Original Distinction from it. And whereas in the former, every Bud hath only one to itself; in these Plants, every lesser Leaf, together with its own proper Veil, is always included, with the next greater Leaf, in another Veil common to them both; and both thefe with the next, in another; and so on to the greatest. These Veils are extreme thin, and have very few Vellina; being so many meer transparent Skins. For which reason, there is always found a Mucilage or clear Gelly, between every Leaf, and its Veil; and between Veil and Veil. The one, thus preferring the other, (as do the Humors and Membranes of the Eye) from drying and shrinking up, and thereby from becoming useless for the Protection of the Plant.

5. &. THE Orchis, and other Plants of this kindred, because they spring and flower early, when the mornings are cold, have a double Sheath, or Blanket over all. The Buds of some Herbs (as of Plantain) having no Hairs growing on them, are covered with Hairy Thorns. And the Nettle hath Bastard-Leaves, or Interfolia between Leaf and Leaf, for the preservation of its Stings.

6. &. ANOTHER Sort of Protection is seen in Wild Clary, White Archangel, and other Plants of a like Shape. In which, the greater Leaves do still cover and incline the lesser, not by being lapped over them, as where the Leaves are more numerous, is usual; but by a Double Fore-Curl at the bottom of every two greater Leaves; by which the little Unders-bud is embraced, and so kept safe and warm.

7. &. THE Leaves of Onions are all Pipes one within another. These Pipes are everywhere entire, having about the middle, where they have a small Aperture, common to all of them, even the most minute in the Centre; not being a forced Crack, but a Door originally formed, for the inflowing of every lesser Pipe, out of a greater.

8. &. THE LAST I shall give, is that which is remarkable in Common Sumach. The Buds whereof, being exceeding tender, Nature appears solicitous in a peculiar manner, for their preservation. For whereas in other Plants, they are well enough secured only by branding behind the Stalks of the elder Leaves; here they are lodged within the very
very Body of the Stalk; as entirely, as a Kernel is within an Apple, or a Fruit in the Womb. From whence it comes to pass, that the Buds of every Stalk is extremly swelled, as going Great with a Bud.

9. &. UPON THE removal of those Parts, which are contrived for the Protection; the Foults and Composition of the Leaves do next appear: all which are most aptly suited both to the Number, and Shape of the Leaves, and also their Position upon the Branch. In the First Book (a) I have given Examples of these Eight Sorts, 6. the (a) Ch. 4. Plain Lap, the Placature, the Duplitecture, the Multiplicature, the Single Roll, the Double Back-Roll, the Double Fore-Role, and the Treble Tab. 42. Roll. To which I shall add Four or Five more.

10. §. And First, in some Plants, as Ground-Ivy, St. Johns Wort, and divers others, where the Leaves are small, pretty numerous, and grow by pairs, they have no Foults, but stand Flat and Tangent, like a pair of Battledores clapt together.

11. §. They have the like Posture in Baum; saving, that here the Edges of the Leaves are a little curled backward. Not Rolled, a Curl being but the beginning of a Roll. So the several Labels of a Ground-Leaf are all laid in a Back-Curl.

12. §. The Leaves of some Plants, as Herebound, White Lamium, Nettle, and others, are likewise only Tangent, but are set with a Fore-Curl. And the several Labels or Scallops of the Leaf of Common Crowfoot, are all Curled Inward. But those of Hepatica aures, are composèd into Double Fore-Rolls.

13. §. THE Leaves of Sage, Scabious, Red Lamium, Lychinis Sphæstris, and others, are neither couched one over another, as in the Bow-Lap; nor plated, as in the Flat Lap; but being loosely foldèd, of every pair of Leaves, the half of one is reciprocally received between the two halves of another, and may therefore be called the Cleepl. A Position very well suited to the Smallness of their Number, and the Equality of their Size, not so well agreeing with the Bow-Lap; and the somewhac inward Posture of the Fibres, not allowing the Flat Lap. Sometimes, as in Syrings, where the Leaves are broader, the Cleepl is joynd with a Fore-Curie.

14. §. THE last I shall mention, is the Plaits-Roll, as in the Lapathum Alpinum, which some call English Rhubarb. The Leaves whereof are so very large, and the Fibres so prominent, that besides and under the two Back-Rolls, they are also laid in several Plaits, and under those Plaits, again with leffer ones, all most exquively Tuckèd up between the said Fibres: So, as neither to bruise the fame, nor yet to leave any Vacuity: whereby every Leaf, and the whole Bud, lie close and round within their Veils.
CHAP. II.

Of those things which appear upon the Surface of the Leaf.

These are Globular Excrescences, Spots, Hairs, Thorns and Prickles: of all which, except Spots, I have spoken in the Appendix to the Chapter of Leaves in the First Book.

2. Of the Globules, it may here be further noted, That those which are white, and lie sometimes like a fine Powder upon the Leaf, were once transparent, as in Bear-Bear; their clear Liquor being now evaporated to an Extract or White Flowers. This, if licked off, will give you the Taste of the more Essential Content of the Plant; different from that perceived in chewing the Leaf.

3. For the observing of them, it may also be noted, That although they often grow on both sides of the Leaf alike; yet sometimes, as in Ground-Ivy, only or chiefly on the Back-Side. And that in many Plants, where the elder Leaves have none; on the young Buds they are very numerous; as in Corin Tree, Sorrel, and others.

4. As for spots, the smaller ones are observable not only in St. John's-worts, (in which Plant only they are commonly taken notice of,) but also in Rue, Ground-Ivy, Pyreperm and Anagallis, and divers other Plants, when held up against the Light. The original whereof seems to be, at least in some, from the Globules above mentioned; that is, when they break and dry away. So the Spots of Rue-Leaves, which in the Reflection of Light look black, but upon the Trajectory thereof are transparent, are so many little Holes, pounced half way through the thickness of the Leaf, and seem as made, by the breaking and drying away of so many Globules. Whence also, as the Globules are best seen in the younger Leaves, so these Spots in the elder.

5. Besides these, and some others (as those in Ladies-Thistle) which are Natural to the Leaf; there are also some Spots, or rather Streaks, which are Adventitious; as those in the Leaves of Souchus. The Caule whereof, is a small flat Insect, of a grey Colour, and about 1/2 th of an Inch long. Which neither ranging in breadth, nor striking deep into the Leaf; eats so much only as lies just before it, and so runs scudding along betwixt the Skin and the Pulp of the Leaf; leaving a whitish Streak behind it, where the Skin is now loose, as the measure of its Voyage.

6. The Original and several kinds of Thorns, I have described in the above said Appendix. I only add, that the very Leaves of some Plants, if they stand till the second year, are changed into so many Thorns, as in the Furr.
7. §. They are of Use, not only for the Protection of the Bud; but likewise, for the support of the Plant; as is observable in those Climbers, which are neither strong enough to stand of themselves; nor yet, from their fragility, are capable of winding about another, without being torn all to pieces. For which end also, these Thorns grow not like Buds, erected; but point all downwards, like so many Tenters or Hanging-books: as in the Bramble, chiefly on the Stalks; and in Clovers, also on the Leaves themselves; whereby they catch at any Thing that stands next them; and so, although such thin and feeble Plants, yet easily climb to a very great height.

8. §. OF THE several Figures of Hairs, and their Use. I have B. 1. Ch. 4. also spoken. As to one Use, i.e. the Protection they give to the Leaf, Tab. 43. I shall here further note, That the design of Nature, is the more evident if we consider, That all Leaves are not alike Hairy, nor at all times, nor in every part: but differently, according to their Age, Substance, Texture, and Folding up. Their Age: for there are many young Buds covered with a thick warm Hair, which afterwards dries up and disappears, as useless as those of the Vine, Golden Liverwort, &c. Their Substance: so those Buds which are tenderest, and would sooner feel the cold, if naked, have the fullest Hairs as of Thistles, Mullen, Burdock, and others. Their Substance: therefore those Leaves, whose Fibres stand more prominent or above their Surface, left the cold should nip them, are covered with greater Store of Hair; as in Moth-Mullen, Garden-Clay, and the like. And their Feathers, it being observable, That those Leaves which are folded up inward, have little or no Hair on their inner, but only on their Back-Sides, which are open to the Air; as is visible in Coris, Warden, Golden Liverwort, and others.

9. §. Add hereto, That where there is Store of Hair, Nature is the least solicitous for other Covers; and where there is not, she is more. So the Leaves of Beans and Peas, of Nettle, Plantain, &c. not being Hairy, have each a Surfol, or else certain Hairy Thorns, to protect them. And thse Plants which have neither, are such as have a Hitter Joyce, and so less subject to the impressions of Cold, as Spearwort, Scraggras, Watercrews, Fenil, and most of the Umbelliferous Kind.

10. §. Hair is of use to preserve young Buds, not only, from the cold Air, but also from too much Wet: which, if it were contiguous, especially in Winter, would often rot and destroy them. But being made to stand off in drops at the ends of the Hair, doth not hurt, but refresh them. Thus doth Nature make the meanest Things sometimes subservive to the best Ends.
CHAP. III.

Of the Figure of the Leaf; and the Apparent Position of the Fibres.

The Figure of the Leaf offers itself next to be observed, as its Figure. This is infinitely varied with the several Kinds of Plants; and there are some, which have Leaves (besides the two first Dissimilar ones) of Two Kinds or Two distinct Figures; as the Bitter-Sweet, the common Little Bell, Valerian, Lady-Smocks, and others. For the Under Leaves of Bitter-Sweet, are Entire; the Upper, with two Lobes: the Under Leaves of the Little Bell, like those of Pea; the Upper, like those of Carnation, or of Sweet-William. And in some Plants, Nature affords a Kind of Irregularity; the Leaves whereof are of no certain Figure; as in Dragon, Pea, Bishop-Weed, &c.

2. §. BUT the Leaves of most Plants, have a Regular Figure; and this Regularity, both in Length and Circuit, always definable. In Length; by the Proportion between the several Leaves upon one stalk, or between the several Lobes upon one Leaf. So the Leaves of Clematis sylva major, which stand by Ternaries, shorten by equal Proportions, that is to say, if, the chief Fiber of each, be divided into equal Parts; their several Lengths are not as Ten, Eight, and Four; but as Ten, Eight, and Six. So the Lobes and Fibers of Clematis Virginiana Hedera folio, of Artemisia, &c. shorten in like manner by equal Proportions. The same is observible in measuring, upon a Gooseberry-Leaf, from the Point of the first Lobe, to the first Angle; from thence, to the second Point; from thence, to the second Angle; and from thence to the third Point.

3. §. But in many, the Proportion is different. So in the Leaves of the Lesser Maple; the shortening of the smaller Lobes, with respect to the middlemost, is not Equal, but Double to that of the middlemost, with respect to the Greater. For if their chief Fibers be divided into Equal Parts, they are as Eleven, Nine, and Five. On the contrary, in the Leaves of Althea fruticosa Pentaphylloidea, the middlemost Lobes shorten by a greater Proportion than the Left; all three being as Ten, Fourteen, and Twenty.

4. §. WITH respect to the Circumference, the Figure of most Leaves is very Complex. Yet Two things are evident. First, that all Regular Leaves are defined or measured out by Circles; that is, by the Arch or Segments of several Circles, having either the same, or divers Centers and Diameters. Secondly, That the Length of the Leaf, or of the chief Fiber thereof, is the Standard Measure for the Diameters of these Circles: these being either its full Length, or certain equal parts subtracted, or multiplied; as half its Length, or its Length and half, &c.

5. §.
5. §. TO make this appear, I shall give several Instances: of some, where both the Edges are of one Measure; and of others, where they are different. And of both kinds, where they are measured by fewer, and where by more Circles.

6. §. The Leaf of _Lagopus major_ var. _pernix_, is measured by One Circle, the same on both Edges, whose Diameter is Thrice the Length of the Leaf.

7. §. That of _Syderitis Salvia_ fol. by Two Circles: the Diameter of the Lower, being Twice the Length of the Leaf; of the upper, _Tab. 44_; the Length and half. In both these the Circles are drawn Outward; that is, with their Centers some where upon the middlemost or chief Fiber of the Leaf.

8. §. That of _Orange-Tree_, is also measured by Two Circles: but one of them repeated with Opposite Centers. That next the Cone of the Leaf, is drawn Inward; that is, with the Center no where upon the Leaf, but without it. The Diameter hereof is just the Length of the _Tab. 44_. Leaf. The middle part of the Edge is measured by the same Circle, only drawn Outward. The lower Circle next the Stalk, is drawn Inward, as the upper; and its Diameter Three times the Length of the Leaf.

9. §. The Leaf of the _Venetian Fitch_, is measured by Three Circles. That next the Cone, drawn Inward; the Diameter whereof, is Twice the Length of the Leaf; the next is drawn Outward; whereof the Diameter, is just the Length. The third or lowermost, is drawn also Outward; and its Diameter, half the Length. So that they all are taken by an Equal Proportion.

10. §. The Leaf of _Great Laserwort_, is also measured by Three Circles; all drawn Outward, and one of them Repeated. The Diameter of that next the Cone, is Half the Length of the Leaf; _Tab. 45_; of the Third, just the Length; of the Second, Twice the Length; of the Third, just the Length: all of them drawn Outward. That next the Stalk, is the same with the Firth; only drawn Inward.

11. §. That of _Broad-Leaved Laserwort_, is also measured with Three Circles; and one of them repeated with Opposite Centers. The Diameter of the Firth, is Half the Length of the Leaf; of the Second, Twice the Length; of the Third, just the Length: all of them drawn Outward. That next the Stalk, is the same with the Firth; only drawn Inward.

12. §. The Figure of the Leaf of the _Cornelian Cherry_, is exactly that of the foregoing, Inverted: the same measured there beginning at the Base, and ending at the Cone; which here begins at the Cone, and ends at the Base: as by comparing their Draughts together may be observed.

13. §. IN ALL, the foregoing Examples, both the Edges of the Leaves have the same Measure. But they have oftentimes, different ones; as in those that follow.

14. §. The Leaf of _Althea frutigosa_, is measured by Three Circles. The left Edge (as the Leaf lies with the backside upward) by One Circle, but Twice repeated. For the Diameter of the Firth, is the Length of _Tab. 45_; the Leaf; the Second is the same, but drawn upon another Center; the Third also the same, but drawn Inward. The right Edge, is measured by Two Circles: the Diameter of the Firth, being the Length of the Leaf; of the Second, Half the Length:
15. §. That of black Poplar, by Three; and each Edge by Three repeated. On the left, the Diameter of the First, is the Length of the Leaf; of the Second, Half the length; of the Third, the Length and Half. The Measure of the right Edge, is that of the left, Inverted: the same Measure there beginning at the Base, and ending at the Cone; which here begins at the Cone, and ends at the Base.

16. §. That of Dornicium, is measured by Three Circles, whereof, one is repeated Once; and another Thrice. The right Edge by Two, and One repeated. For the Diameter of the First or that next the Cone; is the Length of the Leaf; the next is the same, but drawn outward; the Diameter of the Third, is Half the Length. The left Edge, by Three Circles; whereof One is repeated on the same Edge, and Two, the same, as on the other. For the Diameter of the first, is the Length of the Leaf; of the Second, Four times the Length; the Third, the same as the First; and of the Fourth, Half the Length.

17. §. Lastly, that of Mountain Calamint is measured by Four Circles. The left Edge, by Three Circles, of which, the lowermost is once repeated: the right Edge also by Two; whereof the neither is likewise once repeated.

18. §. It may seem, even from these Instances, no very unobvious Conclusion; That all Crooked Lines, Spiral, Helitick, Elliptick, Hyperbolic, Regular, or Irregular; are made up of the Arches of Circles, having either the same, or divers Centers and Diameters. And, as otherwise, so from the Contemplation of Plants, men might first be invited to Mathematical Enquiries.

19. §. TOGETHER with the Figure of the Leaf, the Position of the Fibers, as it is apparent before Dilution, is observables; especially on the back of the Leaf. Whereof I shall add, to what I have said in the First Book, the following Remarks.

20. §. First, that there are some Leaves, in which the first Collateral Fibers make Right Angles with the Great one in the middle: as the Great-Maple, the Great Celandine, Chandrika, and the rest, or many, of the Intybus Kind; with some few others. But that generally all the chief Fibers of a Leaf, make Acute Angles together: both where they stand collateral with the middle Fiber, as in Strawberry; and where they all part at the Stalk, as in Mallow.

21. §. Again, that of these, there are some few, any two of whose Defining Fibers making two Rays of equal Length, take in One Eighth Part of a Circle, as in Mallow; and in some one Tenth: but in most, they take in either one Twelfth part, as in Holly-Oak; or one Sixth, as in Sirynga. So that where the Fibres stand Collateral with one in the middle, if you suppose them to be drawn out at Opposite Angles; or where the chief Fibers part at the Stalk; you only take in the Stalk; you will thereby divide a Circle into Eight, Twelve, or Six equal Parts; as in Sirynga, the Vine and others. And so likewise, where there are several Sprigs upon one Stem, as in Fennel, Hemlock, and the like; as will best be understood by the Figures.
CHAP. IV.

Of the Parts and Texture of the Leaf.

COME next to observe the several Parts, whereof the Leaf is composed: and first the skin. This being stript off the Leaf, although to the bare Eye it looks no otherwise than a skin of Isinglass; yet being viewed through a good Glass, with a clear and true Light, and in an advantageous Position; it appears to consist not only of Organical Parts, as do the skins of Animals: but these also Regularly mixed together; that is, of Parenchymous and Lignous Fibres, all very curiously interwoven as it were, into a piece of admirably fine white Sarcenet; as in Fig. Tab. 48. Tulip, and the like.

2. From hence, it is easy to conceive how the Skins of all Plants, as well as those of Animals, are periphrable; i.e. between the several Fibers of which they consist. But as the Skins of Animals, especially in some Parts, are made with certain open Pores or Orifices, either for the Reception, or the Elimination of something for the benefit of the Body: so likewise the Skins, of at least many Plants, are formed with several Orifices or Pans-ports, either for the better Aversion of Superfluous Sap, or the Admission of Air.

3. THESE Orifices are not in all Leaves alike; but varied in Bigness, Number, Shape, and Position: Serving to the different Nature of the Plant, or Leaf; and giving the Leaf, as it were, a different Grain. Princes Feather, i.e. a Sort of Sable, they stand only on the Edges of the Leaf; but are very ample. In the White Lily, they are Oval, very white, and each surrounded with a slender white Border. They stand about a 6th or 8th part of an Inch distant, as they appear through Tab. 48, a good Glass, all over the Leaf, but not in any regular Order. These Orifices are the cause of the Greyish Gloss on the upper side the Leaf: for the Back-side, in which there are none of them, is of a dark Sea-Green.

4. In the Leaf of Pine, they are also Oval, and about the same Bigness and Number, as in that of a Lily; yet without a Border. But their Position is very Elegant, standing all, most exactly, in Rank and File from one end of the Leaf to the other.

5. NEXT TO the skin, lies the Pulp or Pulp part of the Leaf; which by the same latitude, as Lily hath taught us in many other Words, I call the Parenchyma. This Parenchyma or Pulp of the Leaf, like the Pith, and all other Parenchymous Parts of a Plant is made up of incomparably small Cylindrick Fibres; and these Fibres, in most Leaves, woven and wound up into little Bladders.

6. The Bladders are here of several Sizes, as in the Pith: but generally more visible in the stalk, than in the body of the Leaf; Va-Tab. 49. ried, as in the Pith, fo here, nor according to the Size, but the Nature of the Leaf: So in Common Dock, and Must Marlein, both Great

Leaves,
Tab. 50.

Leaves, they are Small; in Wild Clary, a Lesser Leaf; they are very Large. In the Body of the Leaf, sometimes the Sides of the greater Bladders, are made up of lesser ones; as in Borage.

7. §. In some Leaves, these Parenchymous Fibres are all drawn close up together, In the Former, they are as the Threads in the Open-work of Bone-Lace; in Thefe, as the same Threads, in the Cloth-work.

8. §. The Pithy Part, in the Stalk, and almoft up to the Top of the chief Fiber, in many Leaves, is Tubular; even whilst they are yet Young and Sappy: as in Sweet Chervil, Hemlock, Endive, Chicory, Lampasana, Dandelion, Burdock, Daife, Scorzoner, and others. And sometimes the said Pithy Part is opened into several little Pipes, like fo many Aer-Vessels, above; a Foot long; as in the Common Dock and the Little Sperge, by some called War-Wort.

9. §. The Strings of the Leaf, or those Fibres which are visible to the bare Eye, are composed of Vessels of the Two General Kinds, i.e. for Sap, and for Aer. They are joyntly distributed throughout the Leaf: Yet not fo, as to run merly parallel; as in Animals, every Artery hath its Vein; but the Aer-Vessels are every where Indivisual, or as it were weekdays in the Sap-Vessels.

10. §. Their Position is various and regular, not only in the Body of the Leaf, as is above shewed; but likewise in the Stalk: of which also I have given several Instances in the First 250th. I shall here note, and more particularly describe, One or Two more. In the Stalk of a Mallow-Leaf, they stand in Six Oblong Parcels of equal Size, and in a Ring near the Circuit. Whereby the Stalk is stronger, the Growth hereof, before and behind, more equal, and fo the posture of the Leaf more erect.

11. §. In Dandelion, they stand in Five Parcels: of which the Greater stands a little behind the Centre of the Stalk, figured into a very small Half-Moon or Semi-Tube, whose Diameter, through a Glass, is not above 1/12 of an Inch. The other Four, are extrm Ply small Cylinders. Altogether make an Angle, twice as big as that of a V Conformat. Whereby, although the Stalk be strong enough to support the younger Leaves; yet those which are grown longer, and so not only by their Bulk, but their farther Extention from the Center of Gravity, are become more weighty; commonly lie flat on the Ground.

12. §. In Wild Clary, they stand also in Five Parcels, the Greater stands not behind, but before the Center; making an Arch, whose Chord in a Glass, is above 1/4 Inch long; and belongeth to a Circle, whose Diameter is an Inch and half. The other Four, are small Cylinders, also different from those in Dandelion; the two bigger, there standing hindmost; but here, the two Left, and the two Bigger, within the two round Ridges of the Stalk.

13. §. From hence it is, that the Leaves of this Plant have not only a Prone or Horizontal Posture, but also make that Forceable Pressure on the Ground, which can by no means be imputed to their Weight. For the Great Arched-Fibre standing before the Centre of the Stalk, and the two Longer Round ones being uppermost, in the Ridges of the Stalk; they put on the upper parts thereof to a more full and forward Growth, and so to bow the Leaf back-ward. And the Fibrous Arch being, though broad, yet almost flat, doth hereby the more easily yield to that Motion.
In Book IV. of Leech, we find the following description of the various parts of the leaf:

1. The Petiole, or stalk of the leaf, is the principal support of the leaf, and is generally more or less visible, depending on the species. It is attached to the stem, and serves to distribute the blood to the leaf.

2. The Blade, or leaf proper, is the part that carries out the functions of photosynthesis. It is typically divided into smaller sections called lobes or segments.

3. The Margin, or edge of the leaf, is often serrated or undulate, and serves to reduce water loss and protect the leaf from damage.

4. The Veins, or vein system, run through the leaf and provide a pathway for the transport of nutrients and water. They are typically arranged in a network pattern.

5. The Lobe, or segment of the leaf, is a smaller division of the Blade. Each lobe may have its own vein system.

6. The Tip, or apex of the leaf, is the leading end and can vary in shape from acute to obtuse.

7. The Base, or the part of the leaf attached to the stem, is often broader and may have a different texture or color.

8. The Margin, as mentioned earlier, is the edge of the leaf and can be entire, serrated, or pinnatifid.

9. The基t, or petiole, is the stalk that connects the leaf to the stem and is often covered by a sheath.

10. The Blade, or leaf proper, is the largest part of the leaf and is where photosynthesis occurs.

11. The Margin, or edge of the leaf, is often serrated or toothed, providing extra protection and reducing water loss.

12. The Veins, or vein network, provide the necessary pathways for nutrient and water transport.

13. The Lobe, or segment, is a smaller division of the Blade and can be further divided into smaller lobes.

14. The Tip, or apex, is the leading end of the leaf and can vary in shape.

15. The Base, or the part of the leaf attached to the stem, is often broader and may have a different texture or color.

16. The Margin, as previously discussed, is the edge of the leaf and can be entire, serrated, or pinnatifid.

17. The Petiole, or stalk, is the main support of the leaf and is typically more visible in younger leaves.

18. The Blade, or leaf proper, is where photosynthesis occurs and is typically the most visible part of the leaf.

19. The Margin, or edge, is often serrated or lobed to reduce water loss and protect the leaf.

20. The Veins, or vein network, are essential for the transport of nutrients and water within the leaf.

21. The Lobe, or segment, is a smaller division of the Blade and can be further divided into smaller lobes.

22. The Tip, or apex, is the leading end of the leaf and can vary in shape.

23. The Base, or the part of the leaf attached to the stem, is often broader and may have a different texture or color.

24. The Margin, as previously discussed, is the edge of the leaf and can be entire, serrated, or pinnatifid.
20. §. The Wofage of the Strings and Parenchymous Fibers together, is here made in the same manner, as hath been described in the Anatomy of the Root, and Trunk: the former being in some Sort as the Warp, the latter as the Woof of the Leaf.

21. §. And one Example we have (it may be more than one) wherein Nature shews, though not a greater, yet a different Art; and that is the Palm-Net. For whereas in other Plants, the Webb is made between the Lignous-Strings and the Fibers of the Parenchyma, only visible through a Microscope: here the said Strings themselves are Interwoven, and the Wofage apparent to the bare Eye. Of these Palm-Nets or Sacks, there are frequent Sorts. One of them is composed in this manner. It hath a Fivefold Series of Lignous Strings or Fibers. The greatest whereof swell out above the reft; and like to many Ribs, are obliquely produced on both hands, fo as to encamp the Sack. Along each of these Ribs, on the inside the Sack, runs a small Whiffih Line; being a Thread of Aer-Vessels growing thereto. Between these Ribs or larger Strings, there are others much left, Two or Three betwixt Rib and Rib, Parallelly interjected. On the inside, there is a Third Series, which is also obliquely produced; but tranfverly to the former. The Fourth and Fifth, confift of the fmalleft Strings; not only tranfverfly produced, but also Alternately, from the outside to the inside of the Sack. By these two laft, all the reft are most elaborately woven into one entire and strong piece of Work.

CHAP. V.

Of the Duration of Leaves, and the Time of their Generation.

An Evergreen, is one degree above a Plant which is simply Perennial: of this, only the Trunk and Buds live all the Winters of That, alfo the Expanded Leaves. And an Evergrow, is a degree above an Evergreen: here, the Buds and young Sprigs, do only live; there, they grow and are put forth.

2. §. An Evergreen, is made fuch, either by the Toughnefs of the Skin, and Clofeness or Density of the Parenchyma, whereby the Leaf is better able to endure Cold; as in Holly; or by the extream Smalnefs or Fewnefs of the Aer-Vessels, whereby the Sap is left dryed up; and fo fufficient, even in Winter, for the Nourishment of the Leaf; as in box, and Yew, as alfo Fir, and all Resiniferous Plants.

3. §. The perpetual Growth of a Plant, femeth to depend chiefly on the Nature of the Sap. For all Juices will not ferment alike, nor with the fame degree of Heat. So that whereas many Plants require a greater Heat, as that of Summer, for the fermenting and distribution of their Juices, and fo their growth; the Warmth of Spring is fufficient for many others; and for fome few, that of Winter it felf.

4. §. As to the Time wherein the Leaves are formed; Firft, it is very probable, That in fome Plants which have Leaves (besides the Diftimilar) of Two differart Figures, as hath the Little Common Bell,
Book IV.

Of Leaves.

Bell, and some others; the Under-Leaves, which differ in Shape from the rest, are all at first formed in the Plume, before it begins to sprout; and the rest afterwards; That is to say, that the former Leaves are all formed (out of Sap from the Trunk) with the Seed it self, and so compose one Principal Part thereof, sc. the Plume: the latter, not till after the Seed is sow'n, and so the Plume supply'd with Sap immediately from the Root. Which Sap, it seems, is so far different from the former, as sometimes to produce a different Sort of Leaves.

3. SECONrLY, of the Buds of all Trees, and of Perennial-Stalks, it appears, That they consist of a great number of Leaves, all perfectly formed to the Centre; where, notwithstanding, they are sometimes, not half so big as a Chees-Mite. So that all the Leaves which stand upon a Branch or Cion of one whole Years Growth, were actually existent in the Bud. It is also very observable, That although these Buds begin to be expanded not till Spring, yet are they entirely Formed, as to all their Integral Parts, in the Autumn foregoing. So that the whole Stock of Leaves which grow upon a Tree, or any Perennial Stalk, this year; were made, or actually in being, the last year. A greater Heat, more Subtilized Air, and better concocted Juice, being requisite for their Generation, than for their bare Expansion and Growth.

6. LASTLY, of all Annual Plants, in which there are several Successive Generations of Buds, one under another in one year; although I have not made the Remarque, yet am apt to believe, That as the Leaves in every Bud are all formed together, as in other Plants: so likewise, that the Successive Generations of the Under-Buds, begin at certain stated Terms: as in some Plants, at every New Moon; in others, at the Full Moon; and in some perhaps; with both; or every Four'night.

CHAP. VI.

Of the Manner of the Generation of the Leaf. Where also, that of the Two General Parts of a Plant, sc. the Lignous and Parenchymous, is further explain'd.

The Visible Causes of the Figures of Leaves, have been formerly mentioned. It may here be further noted, That the greater Fibers of the Leaf, being never Braced in the Stalk; it is a good preparative for their better spreading in the Leaf. As also, that the same is much favour'd, by the extreme thinness of the Air-Fibres herein: whereby they are more easily divaricated, in the latter Fibers, and fo the Leaf dilated.

2. BUT these and the like are to be reckoned a secondary Order of Causes; which serve rather to carry on and improve, that which Nature hath once begun. And therefore, we must not only consider Idea, § 53; the visible Mechanism of the Parts; but also the Principles of which they are composed; wherewith Nature seems to draw her first Strokes.
3. §. Now of these, I have formerly, and as I conceive upon good
ground, supposed, the chief Governing Principle, to be the Saline,
whether Alkaline, Acid, or of any other Kind: being, in some sort as
the Mold, of a Button, to which the other Principles, as its Attire, do
all conform. Or the Salts are, as it were, the Bones, the other Prin-
ciples, as the Flesh which covers them.

4. §. A further Argument hereof may be deduced from the Cuti-
cular and other Concretions, commonly called Mother, in Distill'd
Waters, Vinegar, and other Liquors. For in these Concretions, there is
always a Tendency to Vegetation; and many of them are true Vegetables
in their Kind; as shall hereafter be seen. Now the Liquors, in which
these are generated, do always, wholly or in part, lose their Taste and
Smell, and so become Vapid. The more sensible Principles therein
having made their Transit from the Fluid, into the Concrete Parts. So,
I have known, sometimes, Vinegar it self, to become by these Concre-
tions, almost as Tafjles as Common Water. Whereby it seems evident,
That of Vegetable Principles, there are some, more Matterly than others:
and that of thefe, the Saline is the chief. The fame is likewise argued,
from the frequent Experiment of many good Husband-men; that most
Bodies which abound with Salts, are the greatest Nourishers of Plants.

5. §. This Saline Principle, as is above hinted, is to be under-
stood, a General Name, under which divers Species are comprehen-
ded; and of some whereof, it is always compounded, as in other Bodies,
so in Plants. As shall be made to appear, by divers Experiments, when
we come, hereafter, to speak of Vegetable Salts. Whereby we are con-
ducted, yet further to enquire, What are the Principles of this Prin-
ciple?

6. §. Now these seem to be Four; a Nitrous, an Acid, an Alka-
line, and a Marine. The Admixture of the First, is argued from the
Place, which Nature hath assigned for the Generation and Growth of
most Plants, &c. neither in Caverns under Ground, as for Minerals; nor
above it, as for Animals; but the Surface of the Earth, where this
Sort of Salt is copiously bred. And doth therefore prove, not only a
Mixture, but a good Proportion hereoff with the other Principles of a
Plant. Hence it is, that Dow or Water on Window or Plain and Smooth
Tables, by virtue of a Nitro-Aerial Salt, is often frozen into the resem-
blance of little Shrubs. And the like Figure I have often seen in a well
filtered Solution of the Salt of any of our Purging Waters, as of Espum,
&c., being let to flood. Produced, as I conceive, by the Nitre, which
with the Rain or other Waters, is washed down from the Surface of the
Earth, and so mixed with the Mineral Salts.

7. §. The other Three Salts are exhibited, by the several ways of
Resolving the Principles of a Plant. Many Plants, even in their Natural
State, do yield an Acid Juice. And the Juices of many more, by Fer-
mentation, will become Acid. And molten, by Distillation in a Sand-
Furnace, yield an Acid Liquor.

8. §. By Calculation, all Sorts of Plants, yield more or less, both of
a Fixed and a Volatile Alkali: the former, in the Ashes; the latter, in the
Soot. And, at least the generality, by Fermentation also, yield a Volati-
one; or such a kind of Salt, which, whether we call an Urinous, or
otherwise, hath the like Odour and Taste with that of Urine, Hart-
Horn, Soot, and the like.

9. §.
9. §. The Marine, is obtained no other way, than I know of, but from a Solution of the Alkaline, upon its being expos'd to the Aer. The process wherof, I shall particularly set down in a following Discourse. Of these Salts, mixed in a certain proportion, together, and also Impregnated with some of the other Active Principles of a Plant, and not without an Admixture of some Parts from the Aer; I suppose, that which I call the Essential, is produced: of which, I shall also give an account in the same Discourse.

10. §. ALL THE Four Salts above mentioned, seem in their Order, to have a share in the Formation of a Leaf, or other Part of a Plant: And first of all, the Marine. For all Generations are made in some Fluid: But in every Fluid there is a perpetual Intensive Motion of Parts. So that the first Intention of Nature is, That some of those Parts be disposed to Refl. Now of all the Principles of a Plant, there are none hereunto more disposed, than their Salts; whose Particles, being figur'd with plain Sides, as often as they touch Side to Side, like two Marbles exquisitely polished, they will adhere together. And the Particles of Marine Salt, being Cubick, and so, with respect to their Figure, of greater Bulk than those of any other Salts they will hereby, be most and first of all dispos'd to Refl; and so become, as it were, the Foundation of the following Superstructure.

11. THE Second Intention of Nature is, That the Particles be brought to Refl, in a certain Position, agreeable to the Figure of the Parts which are to be formed. And therefore in the next place, all those Parts of a Plant which are truly Lignous, by the Marine Salts, with the assistance of the Alkaline, but especially of the Nitrux, are made to shoot out in Length, or into an innumerable company of small Cylindrich Fibres: these Salts being altogether, sturdy enough to resist those Impulses which might incline them to conform to any other Figure.

12. §. THE next Intention is, That these Fibres, at the same time in which they are formed, may likewise receive such a Posture as will best answer the indented shape of the Leaf. Which Posture, although in the Growth of the Leaf it is much Govern'd by the Aer-Effects; yet in the Generation hereof, seems to be first determined by the forementioned Salts, according to their several Angles, whereby they are differently applicable one to another.

13. §. Now all the Sides of the Marine Salt, and the Sides and the Ends of the Nitrux, properly so called, stand at Right Angles. And it is very probable, from the Figure of the Crystals in Spirit of Blood, and some other Bodies, that the Particles of the Alkaline are Square at Tab. 53, one End, and Poynted at the other. And those of the Acid, at both; And that, withal, they are Shorter and more Slender.

14. §. It should therefore seem, That where the Alkaline Salt is any way predominant, and that the Particles thereof are placed End to End; there the Lignous Fibres (as the larger ones in many Leaves) Tab. 53, declining their parallel Growth, begin to shoot out obliquely, or at Angles one with another, and those Autumn.
160

The Anatomy

Book IV.

15. §. If the same Salt be predominant, and some of its Particles placed, with the Pointed End of one, to the Side of another, or the Square End of one, to the Pointed End of another; there the said Fibres begin to shoot at Angles less Acute.

Tab. 53.

16. §. But if either the Marine or Nitrous Salt is predominant; or some Particles of the Alkaline, are placed with the Square End of one, to the Side of another; there the Fibres begin to make, not Acute, but Right Angles; as do the greater Fibres, in some Leaves; and the smaller, in all.

Tab. 53.

17. §. IN the same manner, the Fibre in the Circumference of the Leaf is also governed; the Particles of the said Salt, being reducible, not only to any Angle, but also to any Circle, or other Crooked Line, as they are variously applied. For if the major part be applied End to End, and only every Third or Fourth applied End to Side, they produce a great Circle. But if the Pointed End of each, be set to the Side of another, they make a left. And if the Application be the same, but to the contrary Side, they thence begin a new Circle with the same Diameter, but with another Center, answerable to the intended Shape of the Leaf.

Tab. 53.

18. §. AFTER the same manner, the Aer-Vessels may be formed by the Particles of the Acid Salt. Which, without being supposed to be crooked (as those of the Aer, at least the compounded ones, probably be) only by applying the lesser Side of one, to the greater Side of another, will also be reduced to any either Circular or Spiral Line. And so, likewise, for the production of the winding Fibres, which compose the Bladders of the Pith and other Parenchymous Parts of a Plant.

Tab. 53.

19. §. Thus doth Nature everywhere prostrate. For what She appears in Her Works, She must needs be also in their Causes.

THE
THE
ANATOMY
OF
FLOWERS,
PROSECUTED
With the bare EYE,
And with the
MICROSCOPE:
Read before the Royal Society, Novemb. 9. 1676.
The SECOND PART.
By NEHEMIAH GREW M.D. Fellow
of the ROYAL SOCIETY, and of the
COLLEGE of PHYSICIANS.
LONDON,
Printed by W. Rawlins, 1682.
THE CONTENTS OF THE Second Part.

CHAP. I.
Of the EMPALEMENT.

CHAP. II.
Of the FOLIATURE.

CHAP. III.
Of the ATTIRE SEMINIFORM.

CHAP. IV.
Of the FLORID ATTIRE.

CHAP. V.
Of the USE of the ATTIRE.

CHAP. VI.
Of the TIME of the Generation of the Flower.

The Appendix.

Being a METHOD proposed, for the ready finding, by the Leaf and Flower, to what Sort any Plant belongeth.
THE
ANATOMY
OF
FLOWERS.

PART II.

CHAP. I.

Of the EMPALEMENT.

NEXT proceed to the Flower. Where I intend not to repeat those things, which have been by Me already noted in the First Book. And the foregoing Discourse of Leaves, will excuse me from divers particulars, common to These and the Flower. I shall here therefore remark some things not before mentioned, or but in transitu, and such as are more particular to the Flower.

2. §. And First, it may be noted; That where the Leaves of the Flower are few; those of the Empalement or Green Border, are either of the same Number, or just half as many, whether even, or odd. So in Leucanthemum and Chickweed, there are Five Leaves; in the former Five Empalers; in the latter, Ten. In Great Celandine, there are Four Leaves, and but Two Empalers; and so in Poppy. The Arithmetick of Nature being everywhere suitable to Her Geometry.

3. §. Of this Part of the Flower it is likewise observable, That it is rarely, if ever, entire or one piece, but parted into divers little Leafy Pales, especially in all Flowers with the Florid Attire, as of Marigold, Daisy and the like; being so numerous, as to make a Double, and often a Treble, Quadruple or Quintuple Border. Whereby they are aptly designed, not only to protect the Leaves of the Flower in the Bud; and after their Expansion, to keep them tite; but also, by receding, Breechways; one from another, and so making a greater Circle, gradually to give way for the full Growth and safe Spreading of the Attire. Which, in regard it consists of Parts so exquisitely tender, were
it pinched up too close, would be killed or spoyle before it came to the Birth. As Temming Women, gradually slacken their Laces; or as Taylor's use to slit their Stomachers into several Lappets, to spread as their Belly riles.

4. §. Nor is the Posture of the Parts in the Empalement itself suitable: not being filed one just over another, but alternately. Whereby the Pales or Panneles of every Under-Order, serve to stop up the gaps made by the Recefs of the Upper. And so, notwithstanding they all make more room, yet all confpire to keep the Air out.

5. §. It is also worth the notice, That, for the fame purpofe, the Edges at leaft, of the feveral Pales, are neither Fibrous nor Puffy; but fo many extreme fine transparent skins, as in Chamomile. Whereby they clofe fo exactly one over another, that it is impoffible for any Air to creep in, or any steam useful to the Attire or Seed, over hastily to perfpire. As weufe, when we have put a Cork into a Bottle, to tie a Bladder over it.

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CHAP. II.

Of the FOLIATURE.

HE Leaves of the Flower are fold up in fuch Sort, as is moft agreeable to their own Shape and that of their inclofed Attire: whereof I have given Inftances in the Fifth Book. I fhall here add fo much further Remarks.

2. §. The Leaves of the Flower of Blattoria, although of different Size and Shape; are fo lapped one over another, as to make an Equilateral Pentangle.

3. §. The Spiral Fold, which is proper to the Flower, and never seen in the Green Leaves; as it is ife immediately visible on the Surface, fo by cuttting off the top o the Flower before it is expanded, it can also make a Helix; as in Perwinkle, the larger Convolvulus, &c.

4. §. In one Flowers, where the Attire is loftly or spreading, as in Holloak, together with the Spiral Fold, the Leaves are all at the top tacked down a little; thereby making a blunter Cow, and fo a more ample Pyramid for the inclofed Attire.

5. §. In Poppies, although the Leaves are extraordinary broad, yet being but few, and inclosing a small Attire; they could not be well reduced to any regular Fold, without leaving fuch a Vacuity, as by being filled with Air, might be prejudicial to the Seed. For which reafon, they are cram'd up within the Empalement by hundreds of little Wrinkles or Pucker, as if Three or Four fine Cambrick Handkerchiefs were thruf into ones Pocket.
6. 6. In Ladies'-flower, the Leaves are neither laped one over another, as is most usual, nor set Edge to Edge, as sometimes, but Side to Side, answerable to their Shape, and the Distribution of their Fibres. Their broad Tops being also rowled up so as to make a Cone. In Lady-Looking Glass, they stand also Side to Side, but in a different manner: in the Former with the Sides standing inward, but here, bearing outward.

7. 5. In the Marvel of Peru, the Fold is likewise very peculiar. For, besides the several Plates, about Six, whereby the Flower is gathered in the Middle; the Top of it is also gathered up by as many distinct Plates, underneath the former; and these rowled or breathed up together so exactly, that the like could hardly be imitated by a very dextrous Hand.

8. 6. OF the Hairs upon Flowers and their Use to the Attire, 1 Ch. 5. have also spoken in the First Book. I shall here add, That they are likewise of Use to the Leaves themselves, that is, for their closer and safer Conjunction. For of some Flowers it is observable, That they are all over smooth, having on their Edges, which are bordered with Fringes of Hair; as of Spanish Broome, Dulcamara, and others: In Tab. 55, which, the Hairs on the Edge of one Leaf, are so complicated, or at least indented, with those of another, that all the Leaves seem to be but one piece. Nature seeing it fit, by this means to tie them together, left they should be expanded before it be due time.

9. 6. Many Flowers instead of Hairs, are set round about, with a great Number of small Parts, not ending in a Point, but having a Head. Sometimes oval, as in Snap-Dragon, like the Horns of a Butterfly, or a Plumevers Soldering-Iron. But usually Globular, as in Deadly Nightshade, like so many little Mossbrooms sprouting out of the Flower.

10. 5. Out of these Heads, doth sometimes issue a Gummy or Balsamick Joyce. From whence proceeds that Cramminess of some Flowers, whereby, being handled, they stick to our Fingers, as do those of Battaria, and of Marigold; and those of Colca Jovis, where the said Heads are so soft and succulent, that they resemble so many little Drops of Balsam. The Cramminess which is felt upon fresh Carduus, may perhaps proceed from the like Cause.

11. 5. THe Number of the Leaves of the Flower hath been noted by the Learned Sir Thomas Brown, to be usually Five. And this Treat of Nature so far affeeth, that many times where the Leaves of the same the Quire, Flower are of a different Size, yet they keep to this Number, as in Tab. 54. Battaria.

12. 8. I also add, That even those Flowers, which are not properly parted into Leaves, have yet their Tops usually divided into Five great Scallops; as those of Toad-Flax, Snap-Dragon, Coded-Arjuntart, Clary, Broome, and others. And when the Flower hath more than Five, even many times Five Leaves; yet the Top of each Leaf is indented into Five Parts; as in Scorzoner, Cichory, and all the Infidious Kind, with Tab. 54, many others.

13. 8. From whence and other like Influences, it may seem, That there is some certain Species of Salt in Nature, and that in most Plants, of whose Agency there are still some Footsteps or other in the Flower.
14. §. The Number of the Leaves, as hath been said, is commonly Five. Yet some Flowers have fewer, and some more, and that with Constancy, in divers Numbers, from One to One and Twenty; perhaps in all, so far. The Flower of Arum Liliaceum, is in a manner one single Leaf; that of Monks-Robark, Three-Leaf'd; of Popy, Crot-weat, Radish, and many others, Four-Leaf'd; the greater Number of Flowers, Five-Leaf'd; of White Hellebore, Tulip, Onion, and most Plants with bulbous Roots, Six-Leaf'd; of Wild-Cromfoot, Seven-Leaf'd; of French Marigold, commonly Eight-Leaf'd; of Flower-de-luce, Nine-Leaf'd; of chickweed, Ladies Mantle, Ten-Leaf'd; of St. James's Wort, Thirteen-Leaf'd; and I think of Fehrisiga, Catula, Age-ratum, Corn-Marigold, with others; and of Chamomile, Ruphthal-umin, and some few more, the Leaves are commonly One and Twenty. In that of St. James's Wort, the Number is so constant that there is scarce One Flower in Forty, wherein the Leaves are more or fewer than Thirteen. Divers of which Numbers, seem also to have some relation to the Number 5. For 9, is Twice; 13, Thrice; and 25, Five times 5 running into it itself.

15. §. THE Consequent Parts of the Flower are the same as those of the Leaf, &c. the Parenchyma or Pulp, and the Vessels. But in the Barks or bottom of the Flower, the Parenchyma is commonly much more flon-gy and dry, than in the Leaves; containing, after the Flower is opened, little or no Sap, but only a dry and warm Aer. Which standing continually under the Seed, hastens the Maturation or due Execution there-of: as we use to dry Manied Barly over a warm Kiln.

16. §. The Vessels of the Flower, are both for Sap and for Aer, as well as in other Parts. And both of them sometimes, even in the Skin of the Flower; as may be argued from its being stained with divers Colours: produced as hath formerly been shewed, by the mixed Tinctures of the said Vessels. These Colours, in many Flowers, as Tu- lips, as they are in the Skin it self, so therein only; the Pulp of the Leaf being white.

17. §. The Lignous or Sap-Vessels are fewer, and the Aer-Vessels smaller in the Flower, than in the Leaf. And therefore it is very difficult to observe the latter by Glasses; especially the Proportion which they hold to the other Parts. But if you break the Leaves of some Flowers, with very great gentleness; they may hereby be Unravelled or drawn out, as in the Green Leaves, to some visible length; and their different Number in divers Flowers may be discerned.

18. §. THE Use of the Flower or of the Foliation whereof we are speaking, is various; as hath formerly been shewed. I now only add, That one Use hereof feemeth to be, for the Separation of the more Volatile and stronger Sulphur of the Plant. That so the Seed, which lyeth within or next it, may be so much the milder, and the Principles thereof more fixed and concentrated. And this, both for its better Duration till the time of Sowing; and also, that its Fermentation, when it is sow'n, may not be too hot and precipitates; but faitle to so flow and equal a motion, as is the Vegetation of a Seed.

19. §. And that this Sulphur is separated and discharged by the Flower, seems evident, not only from the Strength of its Odour, above that of the other Parts; but likewise, in that many times where there is no Flower, or that very small, the Seed, that is its Cover, as in the Con-labiforous
Book IV.

of Flowers.

elliferous Kind, is the more odorous. And therefore also, the Vine hath no Flower, partly, that the most Volatile Spirit and Sulphur might all run into the Fruit.

20. §. THE Figure of the Flower, although it is often much more complex, than that of the Leaf; yet there is no doubt, but that the Measure hereof may be defined in some way, answerable to that exemplified in the foregoing Part. The difference is only this, That whereas the Green Leaves, and the Plain Leaves also of the Flower, are all measured by the parts of several Circles: those Flowers which are Belyed, and those Leaves of the Flower which are not Plain, but Convex, are all measured by the parts of several Spheres. And as the Diameters of those Circles, bear a certain proportion to the midle Steuma of the Leaf; so the Axes of these Spheres, to an imaginary one in the Centre of the Flower.

21. §. NOW the reason why the Figure of the Flower is more multiplex, than that of the Leaf; may be, partly, because it is under the Command and Government of those Salts, which are here more refined and separate, than in the Leaf; and so more free to lay the Foundation of any kind of Figure, for which, of their own Nature, they are adapted. Partly, for that as the Nitrous and Alkaline Salts are chiefly reigrant in the Leaf; so in the Flower, in which the Parenchymous Part hath a greater proportion than in the Leaf, it is most reaonable, to ascribe the Predominion to the Acid (a); the Particles whereof both as they are less, and also pointed at both ends, (c) seem to be more easily applicable one to another for the making of any Sort of Line or Figure.

CHAP. III.

Of the Attire, and first of that sort which may be called Seminiform.

I THINK the Foliature stands the Attire; which is of Two general Kinds, every where Various and Elegant; according to the Description I have given of them in the First Book. I shall here add some further Remarks.

2. §. And first, of that Sort of Attire, which may be called Seminiform; being usually, as it were, a little Sheaf of Seed-like Particles; standing on so many Pedicills, as the Ear doth upon the End of the Straw.

2. §. Of their Colour, it is observable, That for the most part, they are White or Yellow; sometimes Blew; but never Red, let the Flower or Foliature be of what Colour it will. Neither doth their Colour allways follow that of the Foliature, although that be not Red. Whereby it appears, how very Curious and Critical Nature is, in the Separation of the Fayces in Plants: that such small Parts as these of the Attire, and so near the Leaves of the Flower, should yet receive a different Timbre.

4. §.
4. 6. Thefe Parts differ alfo in their Position; standing sometimes double upon each Pedicel, as in Toad-flax, Snap-dragon, and some others; but ufually single, as in Blattaria, Clematis Austriaca, &c. Sometimes faftned to their Pedicels at their middle, flopping down after the manner of Poppy and other hanging Flowers; as in Spanifh-Broom, Hiflop, Scabious, Beben, &c. Sometimes they fand erect, as in Clematis Austriaca, Ladies-Looking-Glafs, Rape-Crowfoot, &c. Thofe of Codex Arfinart have no Pedicels, but f tand upon a large Bafe.

5. 6. Of the Pedicels themfelves, it is to be noted, That they are rarely faftned to the Top of the Repository or Cafe of the Seed, but round about the Bottom. Partly, That hereby they may the better intercept and separate the Incongruous Parts of the Sap from the Seed. Yet in the Codex Arfinart they f tand at the Top. Which is not the only thing peculiar in that Plant; it being the property thereof, to ejeculate its Seed, upon the leaf touch. Which property feemeth to de- pend, partly, upon the Position of the faid Pedicels, as fhall be fhewed in speaking of the Seed.

6. 6. Thofe Seed-like Parts are alfo of different Number. In Great Celandine, Rose, Rape-Crowfoot, numerous; in Great Plantaine, and some other Herbs, much more conflagious than the Foliature it felf. In Germander-Chickweed, they are always Two, and no more. Sometimes they follow the number of the Leaves, efpecialiy in the number 5; as in Blattaria, Black Henbean, &c. In Stichwort and Lycnitis Sylveftris, they are 10, fjual double to the number of the Leaves.

7. 6. They differ alfo in their Bignefs, being in fome smaller Flowers, large; as in Borage, Ladies-Looking-Glafs, and others; and in fome larger Flowers, fmall; as in the Rose.

8. 6. But efpecially in their Shape, which is always very Elegant, and with much Variety. In Borage, like the point of a Spear. In Blattaria, like a Horse-shoe. In Clematis Austriaca, like the Spatula, wherein Apothecaries make their Mixtures. In Mallow, like a Head-Roll. In Hiflop, they have one Cleft before 5 in Blattaria, one round about 5 in Water Botton, one at the Top 5 in Scabious, they have a double Cleft, one on each fide; and f0 in St. Johns Wort, Hifocyamus, and others 5 before they open, in the Shape of a double Purfe.

9. 6. Thofe Parts are all hollow; each being the Theca or Cafe of a great many extrem Small Particles, either Globular, or outherife Convex; but always regularly fitur'd. They are all crowded together, and faftned in clofe Rankes, without any Pedicels, to the Infides of the Theca, like other lefser Seeds within a greater; or after the fame manner as in Hifocyamus and fome other Plants, the true Seeds themselves grow all round about clofe to the Bed of the Cafe 5 as in Clay, and the Figures now referred to, may be feen. And when they are ripe, the Cafe alfo opens and admits them to the Aer, as the Seed-Cafe doth the Seed. The whole Attire, together with the Foliature and Seed-Cafe, See in one Example, amongst the Figures.

10. 6. The Colour of these Small Particles conained in the Theca, is alfo different. But as That is ufarly White or Yellow, fo are Thofe: sometimes Bluift^ but never Red. And sometimes not of the fame Colour with that of the Theca. Which further fhews how fpuripulous Nature is, in differencing the Timbres of the feveral Parts.
11. §. They are also of different Bigness and Figure. Those in 
Snap-dragon, are of the smallest size I have seen; being no bigger Tab. 58. 
through a good Microscope, than the least Cheese-Mite to the naked 
Eye. In Plantain, also through a Glass, like a Scurvy-grass-seed. In 
Bears-foot, like a Mustard-seed. In Carnation, like a Turnip-seed. In 
Bindweed, like a Peper-Corn. In all these of a Globular Figure.

12. In Devils-bit, they are also Round, but depressed, like the Seed 
of Gorse-grass, or a Holland Cheefe. In the Bean and all sorts of Pulb, 
and Trefyls, as also in Blow-bottle, &c. they are Cylindrical. In Orange Tab. 58. 
Lilly, Oval, one 5th of an Inch long, like an Anti-Egg. In Deadly-Night-
shade, also oval, but smaller at both Ends. And those of Pancy, Cup-
kick. In all these and the former, they are Smooth.

13. §. But in Mallow, Holydock, and all of that kind, they are be-
set round about with little Thorns; whereby each looks like the Seed-
Ball of Roman Nettle, or like the Fruit of Thorn-Apple, or the Figs cal-
led frutibus orbis nuncup, or the Murices, used antiently in Wars. They are 
also very great, thickew, through a Glass, of the bigness of a large 
White Pea; being 200 or 300 times bigger than those in Snapdragon, 
of which there are about a Thousand in each Theca, that is, in the space 
of about 1000th Cubical Part of an Inch.

14. §. In some Plants, as in Deadly Night-shade, where these Par-
ticles are White, they seem, by a very good Glass, and advantageous Posi-
tion, to be compos'd of Parenchymous and Lignous Fibres, stitched 
together, as in the other Parts.

15. §. In Colocyntus, and with some Analogy in Wild Cucumber, 
and I suppose all of that kind) the Attire is very peculiar, not consti-
ting of several little These, upon so many Pedicels, as is described; but 
is all one entire Part, like a thick Column in the midst of the Flower; 
having several little Ridges, and Furrows winding from the Top to the 
Bottom round about. In the middle of each Ridge runs a Line, where 
the Skips, after sometime, openeth into two Lips, presenting the Globular 
Particles contained in the hollow of every Ridge.

16. §. Where the Attire consists of several Seed-like Parts, as is 
described there, another Part distinct, like a little Column or Pina-
cle, stands on the Top of the Theca or true Seed-Cafe. Which is 
also regularly and variously Figure'd. In Bindweed, it hath a round 
Head, like that of a great Pin. In the Common Bell, St. John's Wort, it is Tab. 56, 57. 
divided into Three Parts. In Geranium, into Five; in Ajurum, into 
Six. Sometimes, the Head is Smooth, and sometimes beset with lit-
tle Thorns, as in Hyoscyamus. Of the Use of these Parts, anon.
CHAP. IV.

Of the FLORID ATTIRE.

In this Attire there is also much Elegant Variety, according to the Description we have given of it in the First Book. It always consists of several Suits; Ten, Twenty, Forty, a Hundred, or more, according to the Bigness of the Flower. And every Suit most commonly, of three distinct Parts, all of a Regular, but Different Figure. The umltoft Part, is always like a little Flower with Five Leaves and a Tubular Bafe, like that of Cowslip. So that every Flower with the Florid Attire, Embosomes, or is, a Poy of perfect Flowers.

2. §. In some Flowers, every one of these Florets, is encompassed with an Hedg of Hairs; and every Hair branched on both sides almost like a Sprig of Fir, as in After Attires, Golden-Rod, and others.

3. §. The Bafe of the Florid is usually Cylindrical, but sometimes Square, as in French Marigold. And the Leaves hereof which, for the most part, are Smooth on the Incline, in the same Flower are all over Hairy. And the Edges of these little Flowers, are frequently Ridges, or as it was, He would, like the Edge of a Band.

4. §. The midlemoft of the Three Parts, which I call the Sheath, is usually fastened towards the Top, or else at the Bottom of the Florid. This is rather indented, than parted into Leaves. The Surface seldom Plain or Even, but wrought with Five Ridges, and as many Gulters running almost Parallel from the Top to the Bottom.

5. §. The Inner Part, which I call the Blade, runs through the hollow of the Two Former, and so is fastned, with the Florid, to the convex of the Seed-Cafe. The Head and Sides of this Part, is always beftet round about with Globules, commonly through a Glass, as big as a Turner-feed, or a great Pins-Head. In some Plants growing close to the Blade, as in the common Marigold, in the French, and others, upon Pedicels or little flender Stalks. Thafe, as the Blade springeth up from within the Sheath, are till rubed off, and fo fand like a Powder on them both. And sometimes, as in Cichory, they feem to grow on the Incline the Sheath, if it be slit with a small Pin: as also in Knapweed, in which they are numerous. Yet in the Seed-like Attire, always more numerous, than in the Florid.

6. §. The Head of the Blade is always divided into Two, and sometimes into Three Parts, as in Cichory; which, by degrees, curl outward, after the manner of Scorpion-Glaids.

7. §. The Description now given, agrees principally to the Corynophleporous Kind, as Tanys, Chamomile, and the like. But in Scoramoneum, as also Cichory, Hawk-Weed, Monkcar and all the Intybon Kind, with many more
more, the Attire is not separate from the Foliature, so as to stand without that in one entire Pkfì 5 but every Leaf of the Flower hath its own Attire apart. For the sake of which, the Basis of every Leaf is formed into a little Tube or Pipe, whereby it embosoms its own Attire within it self. Confisting commonly of Two Parts, a Sheath and a Blade: the Leaf itself answering to the Floret in other Flowers.

8. §. In some Plants, besides the Attire or Pofi in the middle of the Flower; the Leaves also have each their own to themselves, as in Marigold: yet this, as I take it, confisting only of one single Part, which answers to the Blade; the Leaf itself being as the Sheath.

9. §. In many Plants, this Florid Attire is very large; so that not only the Suit, but also the several Parts whereof every Suit consists, being thoroughly ripe and well blown open, are all visible to the bare Eye, as in Knapsweed, and all the Thistle Kind. This Attire is all the Flower, that this fort of Plants have; being, though Empal’d, yet without any Foliature.

10. §. And sometimes, there is little or no Flower besides this Attire, although extrem small, as in Golden Rod, Wormwood and others. Where it may be noted, That the Medicine called Wormseed or Semen Santonici, is no Sort of Seed, but the Buds of small Flowers, or of the Florid Attire of that Plant.

CHAP. V.

Of the Use of the Attire.

If the Secondary Use hereof, I have spoken in the First Book; and particularly, of the Globulets or small Particles within the Theca of the Seed-like Attire, and upon the Blades of the Florid. I have conjectur’d, That they are that Body which Bees gather and carry upon their Thighs, and is commonly called their Bread. For the Wax they carry in little Flakes in their Chaps: but the Bread is a Kind of Powder; yet somewhat mois, as are the said little Particles of the Attire.

2. §. But the Primary and chief Use of the Attire is such, as hath respect to the Plant it self; and so appears to be very great and necessary. Because, even those Plants which have no Flower or Foliature, are yet some way or other Attir’d; either with the Seminiform, or the Florid Attire. So that it seems to perform its service to the Seed, as the Foliature, to the Fruit.

3. §. In discourse hereof with our Learned Savilian Professor Sir Thomas Millington, he told me, he conceived, That the Attire doth serve, as the Male, for the Generation of the Seed.

4. §. I immediately reply’d, That I was of the same Opinion; and gave him some reasons for it, and answered some Objections, which might oppose them. But withall, in regard every Plant is apparetialus or Male and Female, that I was also of Opinion, That it serveth for
the separation of some parts, as well as the affusion of others. The sum therefore of my thoughts concerning this matter, is as follows.

5. §. And first, it seems, that the attire serves to discharge some redundant part of the sap, as a work preparatory to the generation of the seed. In particular, that as the foliage serves to carry off the volatile saline sulphur: so the attire, to minorate and adjust the aereal; to the end, the seed may become the more oily, and its principles, the better fixed. And therefore the foliage generally hath a much stronger odour, than the attire: because the saline sulphur is stronger, than an aereal, which is too subtile to affect the sense. Hence also it is, that the colour of the parts of the attire, is usually white, or yellow, never red: the former, depending upon a greater participation of aer; the latter, of sulphur. I add further, that the most volatile and aereal sulphur; being by means of these parts much discharged; it may hereby come to pass, not only that the seed is more oily, and its principles more fixed: but also, that the body or parenchyma thereof, is so compact and clothe: for although it contains of bladders, yet such, as are twenty times smaller than in any other part of a plant of the like bigness. Whereas, were the aer copiously mixed with the sap here, as in the pith, fruit, and other parenchymous parts; it would give so quick a ferment to the sap, as to dilate and amplify the bladders of the seed, beyond its present compact and durable texture; and so expel it, either to a precipitant growth, or sudden rot. Wherefore, as the seed-cafe is the womb; so the attire (which always stands upon or round about it) and those parts of the sap herinto discharged; are, as it were, the menes, or flowers, by which the sap in the womb, is duly qualified, for the approaching generation of the seed.

6. §. And as the young and early attire before it opens, answers to the menes in the female: so is it probable, that afterward when it opens or cracks, it performs the office of the male. This is hinted from the shape of the parts. For in the florid attire, the blade doth not unlately resemble a small penis, with the sheath upon it, as its prepuvium. And in the seed-like attire, the several theca, are like so many little testicles. And the globules and other small particles upon the blade or penis, and in the theca, are as the vegetable sperma. Which, so soon as the penis is exerted, or the testicles come to break, falls down upon the seed-cafe or womb, and so touches it with a prolific virtue.

7. §. Contentious hereto it is also observable, that those herbs generally have the seed-like attire, which either produce a greater quantity of seed, or a perennial root: and that there is no tree, with the florid attire. As if the other, because it contains a far greater proportion of the above-said particles, that is, of sperma; 'tis able to beget a more numerous, vivacious, or gigantic birth.

8. §. That the same plant is both male and female, may the rather be believed, in that swails, and some other animals, are such. And the parts which imitate the menes, and the sperma, are not precisely the same: the former, being the external parts of the attire, and the sap, which feeds them; the latter, the small particles or moyst powder which the external inclofe.
Of the Time of the Generation of the Flower.

HE Time in which the Flower is Generated or Formed is a Providence in Nature, whereof, I do a little wonder, that no one, amongst so many observers of Plants, hath ever yet taken any notice. It is therefore to be remarked, That all Flowers are formed or perfectly finished, in all their Parts, long before they appear in sight; usually Three or Four Months, and sometimes half a year, or more. And that in all Perennial Plants, those Flowers which appear and are called the Flowers of any one year, are not formed in that year; but were actually in Being, and entirely formed in all Parts, the year before; as in many Herbs, and in all Shrubs and Trees.

2. §. This will be best be seen by some Instances. So the Flower of Mecoreon, which opens in January, is entirely formed about the middle of August in the year foregoing. At which time, the Green Leaves of the Bud being cautiously removed, the Leaves of the Flower, and the These Semiiformes or Seed-like Attire, encompassing the Seed-Cafe, through an indifferent Glass, are all distinctly visible.

3. §. The like may be seen in Syringa, and other Shrubs, and in Trees. In as many of which, as are Fragifomes, the Fruit also, which answers to the Seed-Cafe, in other Plants, is about the same time entirely formed.

4. §. And so in Herbs; as the Flower of Acharum, which appeareth in April or May, is entirely formed in August or July of the foregoing year. For there are here, as well as in Trees, Two Sorts of Buds; some Tab. 64. which are compos'd only of Green Leaves; and some which also contain a Flower and the Seed-Cafe. So in Bears-foot, by some called the January Rose, the Flower-Buds, which open in January are all formed in or before the Month of August in the year preceding.
5. 6. The same may also be seen about the end of August or the beginning of September in a Tulip-Root. In which, the two innermost Shells dryer than the rest, stand hollow, with the little young Flower (which appears in March or April following) inclosed now in their Centre. Being thus kept warm and dry, left it should either perish, or be precipitated upon the Winter, by sprouting too soon.

6. From hence it is plain, That although the Flower appears before the Seed; yet if the comparison be made betwixt the Flower and Seed of the same year, the Seed is first formed, and afterward the Flower. That is, the Seed, for which Nature chooses the First-born Sap, is formed in the fore part of the year: which work being finished, out of the left second part of the Sap, the Flowers intended for the Sire and Matrix of the next years Seed; is afterwards produced.

7. The true Time of the Generation of the Flower being known, it may also be an Inducement to make Tryal, for the bringing of many Flowers to grow fairly in Winter, which are used to grow, that is, to appear, only in the Spring and Summer: Je, by keeping the Plants warm, and thereby enticing the young lurking Flowers to come abroad.

The Appendix.

Being a Method proposed, for the ready finding, by the Leaf and Flower, to what Sort any Plant belongeth.

Although many have bestowed extraordinary Care and Industry upon the searching out, and Description of Plants; and for the reducing of them to their several Tribes: yet I will take leave, here to propose a short Method whereby Learners, seeing a Plant they know not, may be informed to what Sort it belongs, and so be directed where to find it described and discourse of. For, except they have a Master to conduct them, which few have; they must needs, by seeking at random, lose a great deal of time, which by a regular Enquiry might be saved. Besides, that what is learned by their own Observation, will abide much longer on their mind, than what they are only Pointed to, by another.

2. 6. Now the most Philosophick way of distinguishing or sorting of Plants, were by the Characteristick Properties in all Parts, both Compound, Constituents, and Contents. But of the Compound, the Seeds, and some other Parts, are oftentimes very minute: and the Roots always hid. As also the Constituent Parts, every where, without cutting and the use of Glasses. Nor can the Contents be accurately observed otherwise. So that for the Ufe here intended, those Properties are the first to be inquired upon, which are the most Conspicuous, and in those Parts, where the Learner may the most readily and without any difficulty take notice of them; as in the Flower and Leaf. The Flower hath Varieties enough of it self. But in regard it is often wanting, when the Green Leaf is not; it is therefore convenient, that be be assisted by
by both, and that the Varieties of both be distinctly reduced unto Tables. Which may be done, after the following, or some other like manner.

3. §. And First for the Leaves. The most obvious Varieties of which, are in their Position, Size or Shape.

4. §. Leaves are 'fastned with, or without a Stalk. Without, only close to the Branch, as in Sowthistle; or surrounding it, as in Thinner-Wax.

5. §. Both these ways, they stand either singly, that is, but one at the same height; or more together.

6. §. More together, in Even or Odd Numbers. In Even Numbers, commonly Two and Two, as in Sage, Polium; Sometimes Four, as in Gross-wort, Madder, Herb True-Love, Pannum: Maje; or more, as, I think, in Woodrose, &c. In Odd Numbers, Three, as in all Trefoys, Strawberries; Five, in Pentaphil, Castanea Equina; Seven, in Tormentil.

7. §. The Sizes of Leaves are innumerable. It is therefore necessary to reduce them to a Standard. And so, they may be reckoned, Three; Small, Mean and Great: with respect to the Length of the Leaf, the Breadth, or both. From one Inch and under, all Leaves may be accounted Small; from one Inch and over, to five Inches, Mean; from five and over, Great.

8. §. The Shapes of Leaves are also numberless. But the most obvious divisions which they admit of, are such as these:—

9. §. Leaves are Membranous, as the greater part; Squamocous, as Ajos, or Filamentous. Which are Solid, as in Fennel, Menn, Buphthal- mun, Chamomile, Groundpine; or hollow, as in Onion.

10. §. Membranous, have all their main Fibres produced either from the Stalk, as in Holyoak; or from the middle Stem of the Leaf, as in Molt. From the middle Stem, reciprocally, as in Scabious, or oppositely, that is, one over against another, as in Rose: and both ways, at Acute Angles, as in Molt; or Right, as in Dandelion.

11. §. Again, they are different with respect to the Top, the Bottom, and the Sides. The Top is Thorny, as in Fenn; or Unarmed. Unarmed, either Produced, that is, Poincted, or at least, Roundish; or in Laminum, Ironwort; or else Reduced, as in Woodforl. And so the Bottom, is either Reduced towards the Top, as in Ground-Joy; or Produced upon the Stalk, as in Poplar, Bay, &c.

12. §. The Sides or Edges of the Leaf, are either of one and the fame Meeur, as commonly; or of divers, as in Dorroneum. Both ways they are Even, as in Syringa, Mous-car; or Uneven. The Uneven, are Prickly, as Holly, Eryngium, Tofile; or Unarmed. Unarmed, are Infected, or Refected. Infected deeply, that is, Lobed, as Golden Lierwort, Clematis Peregrina; or with shallow Infecteds, as in Molt. And so, Indented, or Scalloped: the former, when the Angle is made with Straight Lines, as in Dandelion; the latter, with Crooked, as in Thalidium. Refected, that is, both Lobed, and Infected, or when upon the greater Infecteds, there are other lefer ones, as in Wild-Clary, Leuzey, Majermorton.

13. §. THE most Conspicuous Varieties of Flowers, are in their Position, Size, Shape, and Colour.

14. §. Most are fastned with Stalks; but many without. Sometimes, they are placed round about the Branch, that is, Coronated, as in
in *Pulegium*; and sometimes, all on one side; either in *Ranunculus* only, as in *Bunus*; or in *Ranunculus* and *Ficaria*, as in *foxglove*. In *Saxifraga lutea*, they grow on the leaf.

15. §. Again, they either stand singly, as in *Corn Marigold*; or Clust'rd. And so, either all upon one branch; or on several little Ramified Sprigs. On one branch, prolonged like a Tail, as in *Blattaria*; or Contracted. And so, either without Stalks, that is, Capitalled, as in *Scabious*; or with Stalks, that is, Umbellated, as *Fennel*, &c. On several Sprigs, as in *Tanaacetum*; Tarragon.

16. §. The Sides of Flowers, as of the Leaves, may be reduced to Three. From ⅓ an Inch and under, in Diameter or Length, may be accounted small. From ⅓ an Inch and over to an Inch and ⅓, may go for Mean. And from an Inch and ⅓ and over, Great.

17. In respect of the Shape, Flowers are Open or Belled. Open have both Leaves and Attire, as moft; or else are all Attire, as of *Burdock*, Beta *Cretica*.

18. §. The Open, consist of a Certain Number of Leaves, One, Two, Three, Four, Five, Six, Seven, Eight, Nine, Ten, Thirteen, or One and Twenty. Uncertain, commonly called Double. Those of a Certain Number, either Uniform, that is, all of a certain size and Shape, as usually; or Biform, or Triform, as in *Iris, Blattaria*. And these again, Even Edged or Notched; with Three Points, as in *Marigold*; or Five, in *Cichory*.

19. §. The Bell'd, are either so in whole; or in Part, that is, with the Top divided into Leaves, and the Bottom, Hollow: The former, are also Even Edged, as in *Convolvulus*; or Notched, as in *Tecophilium*. The latter have their Leaves distinguished as before. Their Bottom or Base either fastened to the Seed-Cafe, as in *Snap-dragon*; or standing below it. And so, either Straight, as I think in *Toad-flax*; or Crooked, as in *Violet*, Lark-heel.

20. §. In all thefe, the Attire is either Seminiform, or Florid. And both, Clust'rd, or Divided; as in *Mallow*, St. *Johns wort*; *Starwort*, Hawkweed.

21. §. The Colours of the Flower, are White, as in *Water-Crowfoot*; Red, as *Lychnis*; *Blem*, as *Borage*; Purple, as *Stock-July-Flower*; Black, as in *some Anemones*; *Yellow*, in *Wall-Flower*; *Tawny*, in *Columb's F apis*; *Green*, in *Laureola*. Which are either Single, or Mixed: Two together, as in *Buty-Flower*, White and Red; in *White Hellebore*, White and Green; in *Monk's Robin*, Red and Green; &c. Or Three together, as in *Pansy*, *Tellow*, *Blem*, and *Black*, i.e. atro-preparates.

22. §. How far these, and some other like Definitions, being reduced to Tables, would serve for the finding out of any Sort of Plant, may be conceived, if we consider, how great a Variety, a few Bells, in the ringing of Changes, will produce. And the search will be easy, and successful, if in every foregoing Table, Reference be made to those that follow; and in the Tables containing the last Divisions, the Names of the Plants therein pointed out, be expressed.
THE

ANATOMY

OF

FRUITS,

PROSECUTED

With the bare EYE,

And with the

MICROSCOPE:

Read before the Royal Society, in the Year 1677.

The THIRD PART.

By NEHEMIAH GREW M.D. Fellow
of the ROYAL SOCIETY, and of the COLLEGE of PHYSICIANS.

LONDON,

Printed by W. Rawlins, 1682.
THE

CONTENTS

OF THE

Third Part.

CHAP. I.
Of the APPLE; and of the LIMON, and CUCUMER, the Fruits of Plants vulgarly called POMIFEROUS.

CHAP. II.
Of the PEAR and QUINCE.

CHAP. III.
Of the PLUM, and some other Fruits of the same Kindred.

CHAP. IV.
Of the GRAPE, and HAZEL-NUT; with some other Fruits analogous to each of them.

CHAP. V.
Of the SEED-CASE or MEMBRANEOUS UTERUS.

CHAP. VI.
Of the USE of the Parts to the Fruit.

CHAP. VII.
Of the USE of the Parts to the Seed. And the TIME, in which, the Uterus or Fruit and Seed-Case are formed.
THE ANATOMY OF FRUITS.

PART III.

CHAP. I.

Of the APPLE; and of the LEMON, and CUCUMBER, the Fruits of Plants vulgarly called POMIFEROUS.

The Description and Use of Leaves and Flowers, together with the Figures thereto belonging, were presented to this Honourable Society, the last year. I shall conclude this Subject with Fruits and Seeds; beginning with Fruits, which will take up the present Discourse.

2. And First, I shall describe the Compounding Parts of some, more generally known. Which having done, I shall next observe the Uses of the same; either for the Fruit it self, or for the Seed. Some of the Descriptions, the Reader may be pleased to compare with those in the First Book, Ch. 6. I begin with the Apple; to which I shall subjoin the Lemon, and Cucumber, commonly reduced to the Pome Kind.

3. An Apple, besides the Skin, consisteth of a Parenchyma, Vesicles, and Coar. The Parenchyma or Pulp, is the same with that of the Barks 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 the Structure common to them both; being both composed of Bladders. In which, notwithstanding, there is this difference, That
That whereas in the Barque, they are spherical, and very small, most of them, through a good Glass, not exceeding 1/10 of an Inch in Diameter, and some of them, less; here, they are oblong and very large, most of them about 1/4 of an Inch in Length, or more, according to the largeness and tenderness of the Fruit; being all uniformly tender'd or stretched out, by the arching of the Vessels, from the Core towards the Circumference of the Apple.

4. $\text{\textit{The Vessels, as in the other Parts of a Plant, are Suckiferous, and for Air. Both the Branches of the former, and the single Vessels of the latter, are extrem small. They run every where together, not collateral, as Veins and Arteries do in Animals; but the latter, sheathed in the former.}}$

5. $\text{\textit{They are distributed into Twenty principal Branches. The Ten utmost, a little within the Apple, are diverted from a straight Line, into so many great Arches; from which a few small Fibres are without any order dispersed through the Apple. The Five middlemost, and the Five inmost, run in a straight Line as far as the Core, and are there diverted into as many lesser Arches; the former, at the outer, and the latter at the inner Angles of the Core. Upon these five inmost hang all the Seeds.}}$

6. $\text{\textit{These Ten, and the other Ten above said, do all meet together at the top of the Apple, where originally, they all ran into the Flower. But betwixt them, there are scarce any intercurrent Fibres; so that they appear every where disjunct from the bottom to the top of the Apple.}}$

7. $\text{\textit{A Limon hath a Threefold Parenchyma; which seem to be derived one from another: the Texture, by every derivation, being somewhat altered, and so made more close and elaborate. The utmost, called the Rind, hath the most open, and the coursest Texture; being composed of the largest Threds, and those Threds woven up into larger Bladders. Those little Cells, which contain the Essential Oyl of the Fruit, and stand near the Surface of the Rind, are some of the said Bladders much more dilated.}}$

8. $\text{\textit{From this utmost Parenchyma, Nine or Ten Injections or Lamells are produced, betwixt as many Portions of the Pulp, Part, towards the Centre, where they all unite into one Body, answerable to the Pith in the Trunk or Root of a Tree; and is a conspicuous demonstration, of the communion betwixt the Barque and the Pith; which there, is much more obscure and difficult to observe. At the bottom, but especially the top of the Fruit, the Pith is so far expanded, as without the mediation of any Lamels, to be joyned to the Rind.}}$

9. $\text{\textit{Throughout this Parenchyma, the Vessels are dispersed. But the chief Branches stand on the inner Edge of the Rind, and the outer Edge of the Pith, just at the two extremities of every Lamel. From those Branches on the Edge of the Pith, other little and very short ones shoot into the Pulp of the Fruit, upon which the Seeds are appendant. In the Centre of the Pith, are Eight or Nine, in a Ring, which run through the Fruit up to the Flower.}}$

10. $\text{\textit{Between the Rind and the Pith and those several Lamells, which joyn them together, stands the second Sort of Parenchyma, different from the former, in being somewhat clofer, and finer wrought, Divided, by the Lamells, into several distinct Bodies; every one of them a great and entire Bag.}}$
Book IV. of Fruits. 181

11. §. Within every great bag, is contained a Third Parenchyma, which is also a Cluster of other little Bags, about the bigness of an Oat, all disjoined one from another, and having their distinct Stalks, Tab. 66, of several Lengths, by which they are all fastened to the utmost Side of the great bag, wherein they are contained. Within each of these lesser Bags are contained many hundreds of Bladders, confisting of most extream fine Threads woven up together into that Figure. Within these Bladders lies the Acid Juice of the Limon.

12. §. A CUCUMER, hath also a Threefold Parenchyma. The Utmost, is derived, from the Bark. In this, being expos'd for some time to dry, and then cut transversely with a Razor; not only the Bladders, but also the Threads whereof the Bladders consist, through a good Microscope, are apparent.

13. §. Throughout this Parenchyma the Sap-Vessels are dispers'd ; near the Circumference, in Ten or Twelve very large Branches. Each Tab. 66, of these larger Branches, embosoms another of Aer-Vessels in its Centre. Adjacent to the Midle Parenchyma, they stand in Clusters of much smaller Branches, but more numerous.

14. §. Out of all these Sap-Vessels, issues a transparent and viscous Mucilage; which being dry'd, becomes as hard and tough as Gum Tragacanth. Analogous to which, I suppose, is the truly purgative part of Elaterium.

15. §. The Midle Parenchyma is derived from the Pit'; and divided into Three Columns, standing trian-gularly, and having each of them a Triangular Figure. Within these Columns stand a distinct Sort of Sap-Vessels: from whence, several small and short Fibres shoot into the Utmost Parenchyma, whereupon the Seeds do hang. So that these Columns are as it were the Beds on which the Seeds grow. With each of the Seed-Branches or Fibres, goes some part of the said Parenchyma or Column, out of which, the Cover of the Seed are formed.

16. §. The Utmost Parenchyma wherein the Seeds lie, and which answers to the Pulp of a Limon, seems likewise to be derived from the Tab. 66, Columns, that is, to be originally thence produced upon the Seed-Fibres, and afterwards spread and augmented into a Pulp. By Three Infections from the Columns, and as many from the Utmost Parenchyma, and these re-infert'd; it is divided into Six Triangular Bodies; and every Triangle, into Three Ovals.

17. §. A near resemblance betwixt the Garden and Wild Cucumber, with respect to the Inward Structure, as well as the Outward Figure, Tab. 66, may be observed: Both of them having a Threefold Parenchyma. Yet with this difference, That the Three White Triangular Bodies or Columns in the one, isanswered by a White Ring or Tube in the other.

CHAP.
CHAP. II.

Of the PEAR and QUINCE.

PEAR, besides the Skin, consisteth of a Twofold Parenchyma, or Vessels, Tartarous Knots or Grains, and a Cour. The Skin is lined with a great number of the said Tartarous Grains, through a Glass, about the bigness of small Shot: whereby it looks within, like the Skin of the Scar (and some other Fruits. Besides those which grow to the skin, there are also many more standing near adjacent to it all round about the Fruit: altogether about ½ of an Inch in thicknefs, through a Microscope, as in a Slice of a Pear cut transversely is apparent. Somewhat more or lefs, as I take it, according to the Delicacy or Harfines of the Fruit; as more in a Burgandy, or other soft and sweet Pear, than in those which are called Strangulatonia. As all Vinosi Liquors, and those especially which are the most Tartarous, become more soft and sweet, according as they cast off their Tartar, in a greater quantity, upon the Sides of the Veffel.

2. The Outer Parenchyma, is of the fame Original, and general Structure, as in an Apple. But the Bladders, answerable to the Shape of this Fruit, not altogether fo long, with respect to their Breth. Throughout this Parenchyma, are also dispersed many small Tartarous Grains; most of them somewhat round, as those next the skin, and of a like Size; but nothing near fo numerous.

3. The Bladders here, have also a different Position from that they have in an Apple: there, they are all fo stretched out, as to have respect to one common Centre, which is that of the Apple it self. But here, they every where bear a respect to the said Tartarous Grains; every Grain being the Centre of a certain Number of Bladders, like a Star, in the middle of its Vortex. Whereby, fo many of the Tartarous parts of the Sap, as cannot well be thrown off upon the skin, are more commodiously discharged, upon every little Knot or Grain, nearer hand.

4. Throughout this Parenchyma, the Vessels likewise are dispersed: Of the Two general Kinds, for Sap, and for Air. The Aer-Vessels, are here extremly small, as well as in an Apple; yet one degree, larger. They are both together distributed into Fifteen principal Branches. The Five Utmost make as many Arches, but commonly not near so deep as in an Apple. From these, some small Fibres, yet a little more numerously than in an Apple, are dispersed throughout the Parenchyma. The Ten Utmost run along to the Seed, and from thence, with the other Five, to the Flower.

5. Next the Core, stands the Inner Parenchyma, in divers respects different from the Outer. The Bladders of the latter, as hath been said, large and long; of the former, small and round, answerable to those of the Pink, of which it seemsto be derived. Throughout that,
of Fruits.

Book IV.

183

The Vessels and Tartarous Grains are dispersed; in this, there are neither. The Eddle whereof is, that is sweet, this fower; for which reason, I have taken leave to name it, the Aetery.

6. 6. Between this and the outer Parenchyma, the said Tartarous Grains begin, first to stand nearer together, to grow bigger, and of a more unequal Surface 5 and by degrees, to unite into a Body, in some Pear, and especially towards the Cork, almost as hard as a Plum-Stone; which I have thereupon, named the Calculary. So that a Pear, is Nature Preface or Introduction to a Plum.

7. §. This Tartarous Body, and those small Grains above said, I have formerly supposed, to be precipitated out of the Sap, by virtue of the Vessels. Which is not only argued from their growing, where the Vessels, only in the outer Parenchyma; but in that the very Bounds or Figure of the Calculary, is determined by the Situation of the chief of those Vessels; as in cutting a Pear smoothly through the Centre and by the Length, is apparent.

8. §. The Coar as well as the Aetery, seems to be derived from the Pith. And is therefore lesse here, than in an Apple, where the whole Pith of the stalk, goes to the making of the Coar only.

9. §. In most Pears, at the bottom of the Coar, and a little below the Centre of the Fruit, there is a kind of small Unbended Knot, from whence is extended a straight Channel or Ductus, which opens at the middle of the Cork, or Stool of the Flower, scarce wide enough to admit the smallest Pin. Made for the use hereafter mentioned.

10. §. A Quince, is nearly allied to a Pear. The differences between them are these; In the Quince, the outer Parenchyma is more close, that is, the Bladders are smaller. The Vessels more numerous, and more deeply enarched; the Calculary greater, and more spread; and according to the Shape of the Fruit: but the Aetery, is 65: The Coar stands higher or nearer to the Cork: divided, not into five, but four Cells. And the Ductus from the bottom of the Coar to the top of the Fruit, much more open and observable.

CHAP. III.

Of the Plum, and some other Fruits of the same Kindred.

PLUM consists of a Parenchyma, the Two general Kinds of Vessels, and a Stone. All which I have already described in the First Book. 1 Ch. 6. shall here add, and further clear some things. And First, it is to be noted, That, in Proportion to the Bulk of the Fruit, there are more Vessels in a Plum, than in an Apple, Pear, or Quince. As also, That in Plums, all the Vessels are braced together into one Uniform Piece of Net-Work, every where terminating at an equal Distance from the Circumference, &c. 3d. of an Inch or thereabout. And as for the Bore of the Aet-Vessels, although the Glass I used, when I examined this Fruit, would not reach it, yet
is it to be presumed, that they bear a just Proportion to those in the
Trunk of the same Tree; and that therefore they are here larger, than
in an Apple or Pear. The Skin likewise of a Plum, is more fibrous,
and tough, than in those Fruits. The Ends of these Diversities,
we shall presently speak of.

2. 5. Of the Stone, amongst other particulars wherein the con-

trivance of Nature is very admirable, I have formerly shewed, That
it is composed of Two or rather Three distinct Bodies. One of them,
the Lining; which answers to the Coat in a Pear. And is originated
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: as when a small Glass-Pipe, is
blown and expanded into a Bubble. Or as if a Bladder, being stretched,
and put through the Neck of a Bottle; were then blown up, so
as to be every where contiguous to the Sides, and become, as it were,
the Lining of the bottle.

3. 5. The Foundation or Ground of the Outer and more Bulky
Part of the Stone, is the Inner Part of the Parenchyma; and answers
to the Acetery in a Pear. As the Fruit grows, the Tartareous Parts
of the Sap, being continually precipitated upon this Parenchyma, it is
hereby petrify'd. As will best be seen, by comparing the several A-
ges of the same Fruit together. And in some Stones; on the Surface
whereof, some of the said Tartareous Parts appear in distinct Grains.
So that whereas in a Pear, the Calcareous and the Acetary are distinct;
here in a Plum, they are thrown one into the other. Or, as some
Mineral Waters only make a Crust about a Stick or other Bodies im-
mered in them; but others, by sinking into these Bodies, do here-
by petrify them: So in a Pear, the Tartareous Parts of the Sap, only
make a Crust about the Acetary; but in a Plum, they sink into the
Body thereof, or that Part of the Parenchyma, which stands in the
place of it, whereby it is converted into a Stone. The Figures of Stones
shall hereafter be spoken of, when I come in the next Part, to the Co-
vers of the Seed.

4. 5. AN APRECOCK is of the Plum-Kind. But some
things are herein better observed. As first, the Position of the Blad-
ders 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 all thrown off into the Stone: the Bladders therefore are so dis-
posed, as not to have respect to several Centres, as in a Pear: but only the
Stone, to which they all do most exactly radiate; thereto conveying
the succulent Sap, in so many little Streams. This is best seen, when the
Fruit is full ripe.

5. 5. In this Fruit, while it is young, the gradual transmutation
of the Inner Part of the Parenchyma into a Stone, is also more apparent,
And so are the Three Coats, which serve for the Generation of the
Seed; being now all very distinct; and remarkable, not only for
their Bulk; but also, the Anatomy which they bear to the Three Mem-
branes in many Viviparous Animals. Whereof I shall give a more par-
icular Description, when I come, in the following Part, to the Co-
vers of the Seed.

6. 5. A PEACH hath a much bigger Stone, than either a Plum,
or an Aprecock: and hath therefore, when full ripe, and especially in
Book IV.  

of Fruits.  

185

hot Countries, a more defecated or better refined Juice. For the reason why the stone is so great, is because the Vessels run so very numerously through the Body of it; and so cause a more copious precipitation of the Lees of the Sap thereinto.

7. §. A CHEERRY is likewise near related to a Plum. But the Bracteate or Reticulation of the Vessels, is here carried out further, so as to be all round about contiguous to the skin. And as the Aervessels in the Branch of a Cherry-Tree, are larger than those of an Apple-Branch, but less than those of a Plum-Branch; so may they be presumed, to bear the same Proportion here in the Fruit.

8. §. A WALNUT, is a Nuciforne, or betwixt a Plum and a Nut, as a Bat is betwixt a Beast and a Bird. For the Rind answers to the Pulp, and the Shell, as the stone, is also lined. But the Seed-Vessels, which in a Plum run through a Chanel made on purpose in the Stone; do here enter, as in a Nut, at the Centre of the Shell. By which means, they are invested with a more fair Parenchyma; which Nature hath provided, as her cloth, for the making of the Coat wide enough for so vast a Kernel.

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C H A P. IV.

Of the GRAPE, and HAZEL-NUT; with some other Fruits, analogous to each of them.

GRAPE, is a Plum with two Stones; for their thickness, as hard as any other. The Distribution of the Vessels is also somewhat different. For the principal Fibres running up directly betwixt the Stones, and the smaller, making only one single Nut, near the Circumference; they all meet together at the Top of the Grape. It is also to be noted, That many Lignous Fibres are visibly mixed with the Skin it self: whereby it becomes very thick and tough. And as the Seed-Vessels in the Trunk of a Vine, are greater than in that of an Apple, Pear, or Plum: So is it to be presumed, that in a Grape, they are greater than in the Fruits of those Trees.

2. §. The Parenchyma or Pulp of a Grape, seems to be derived, not from the barks, as in an Apple; nor partly from the Bark, and partly from the Pith, as in a Gooseberry; but wholly from the Pith; at least, as far as the Reticulation of the Fibres; and the Skin only from the Bark; whereby the Pulp becomes so tender and delicate a Meat.

3. §. A GOOSEBERRY, hath a Threefold Parenchyma. The Utmolft is derived from the Bark; of a Greener Colour, and very Sappy. The middlemost, from the Pith; somewhat white, and more dry, as the Diastomal Infections in some Roots. In both of them, the Bladders are very conspicuous, above what they are in any Fruit, I at present think of; so as to be visible to a good Eye without a Glass.
4. §. Betwixt these Two Parenchymas, do run most of the principal Fibres, or vascular Threads. From which several smaller ones are branched into the Immot Parenchyma; upon which, the Seeds do hang.

5. §. Each of these smaller branches is invested with some part of the middle or white Parenchyma. Serving partly to make the Cores of the Seed; and partly, the Pulp, that is, the Immot and finest Parenchyma of the Berry, in which the Seed lies.

A White COR IN, without taking off the Skin, sheweth not unpleasingly how the Seeds are formed. As for the Trunk of the Tree continues not to any considerable Length, entire, as in a Plum, but is presently divided into several Branches; nor are the Edges of the Leaf entire, as also in a Plum, but slit into several Lobes; and the Fruit, into a great many Corins in a Bunch: So again, the Seeds do hang upon the Fibres, like Two other Branches, in every Corin. As by Refraction, Objects of all Sizes are represented on the Walls of the Eye. The Operations of Nature being every where Uniform: and sometimes the same in small, transcribed from a greater Copy.

7. §. A NUT, is a Plum inverted, or turned inside out. For the Shell, standing naked, includes the Parenchyma: the bearded Cap, not precisely answering to that, but to the Empolament of the Flower; which likewise in many other Plants, out-lives the Foliation and Embosomes the Uterus of the Seed. And whereas the Stone of a Plum is not Faced, but Lined with a Parenchyma derived at second hand from the Fils; The Shell of a Nut is not Lined, but Faced with the inner Skin of the Cap.

8. §. A N A K E R N, is the Nut of an Oak. Yet with this difference; That besides the Cap, it stands in, it hath only a Leather or Parchment Cover instead of a Shell. From whence it come to pass, that whereas the Kernel of a Nut is sweet; that of an Akern, is of a very rough Tast: the external Parts of the Sap, which in a Nut are drained off into the Shell, being here imbied by the Kernel it self.

CHAP. V.

Of the SEED-CASE, or MEMBRANEOUS UTERUS.

Of the forementioned Fruits, I shall subjoyn, in some Examples, the Description of the Seed-Case, which is analogous to the Fruit. For the Fruit, strictly so called, is, A Fleshy Uterus, which grows more moist and pulpy, as the Seed ripens. But the Seed-Case, whether it be called a Cod, Pod, or by any other name, is, A Membraneous Uterus, which as the Seed ripens, still grows more dry and hard: as in most Plants.

2. §. THE SEED-CASE, is either originally open; Or only when the seed is ripe; Or never opens at all, till the Seed be sown. Of the first Sort, is that of Latifolia; as also of Clary, Sage, Hyssop, and the
the like: wherein one and the same part, is both the Emplacement of the Flower, and when that is gone, survives as the Cafe of the Seed.

3. §. Of the Lat, is that of Myxgium Monsporium, Lithospermum, all the Stones of Fruits, with divers others. And some Cakes, which are soft, as, I think, that of Garden Radifi. The former, by cleaving in some part or other, the by roting under Ground.

4. §. That of Garden Radifi, is a Light and Spongy or Pithy Body originally, every where entire. But, as it ripens, breaks within into several White and Dry Membranes round about the Seed. By the Length and about 6th of an Inch distant from the sides of the Cake, do run a pair of little Vascular Ropes. Some smaller Fibres are from these transmitted to the sides of the Cake; by which they are kept tite and steady. Upon divers others produced towards the Centre, hang the Seeds, like Two Ropes of Onions.

5. §. Of those which open so soon as the Seed is ripe; some are made to open at the Top, as Poppy Heads; some on the side, as most Cocks; and some at the bottom, as that of Cased Amaryllis.

6. §. The Poppy-Head, is a little Dose Cake divided by Eight or Ten Partitions, into so many Stalls. On both sides the Partitions, hangs a most numerous Brood of Seeds. The Partitions and sides of the Head, are made of the Bark, and Lined with the Pith. While young, they are very thick and spongy; and together with the Seeds, do then fill all up. The Head is then also every where entire; but as it dries, it gradually opens at the Top, into several Windows, one for every Stall: which are all covered with a very fair Canopy. A Fabric designed for several purposes, as shall hereafter be said.

7. §. Of those which open on the side; some are made to open, only on One Side; some, on both Sides; some, with Three Sides; some, with more; and some horizontally or round about.

8. §. The Cad of Garden Bean (and fo the rest of the Leguminous kind) opens on one side. It hath a Twofold Parenchyma. The Utmost derived from the Bark; in which stand all the Cells, in the Tab. 70. several Parcels; one whereof, at the back of the Cad, is much larger than the rest, shaped like a Copula used in Schemes; from whence shoot those softer Fibres upon which the Beans do grow.

9. §. The Inner Parenchyma is derived from the Pith. Upon its Nativity, and for some time afterwards, entire and wholly composed of Bladders, as the Outer. From the Base of the Cad they are gradually enlarged, so as to compose this Parenchyma into a very soft and delicate Sponge. In which (the Cad being well grown) the very Threads where of the Bladders were woven, are many of them so loose and ample, as easily to be drawn out (as in the unravelling of Knit-work) to a considerable Length, fairly visible through an ordinary Glass.

10. §. This may further confirm all that I have formerly said of the B. 2. P. 1. Fibrous Texture of the Pith, and of all the other Parenchymous Parts of Ch. 5. & B. Plants.

11. §. The Seed-Cake of Medica, is a Cad wound up: in the Echnatia, spirally; in the Tornata, by an Helix. Not finished all together; but, upon the fall of the Flower, beginning to wind, continues its Circles, till it be come to its full Growth.
12. §. THE Seed-Cafe of Yellow Henbean opens on both Sides. On the Top, is erected a Column, about an Inch long; which, as the Cafe swells, grows, and at last falls off. On the Sides of the Uterus or Cafe, Two Vascular Fibres run oppolitely from the bottom to the top, and fo into the Column. Along the Tract of these Fibres, the Cafe, as it ages, gradually cleaves on both Sides afunder.

13. §. The Cafe is lined with a dry and thin Parchment, as smooth as Glass. In the Centre of the Cafe, stands a great Parenchymous Bof, which is, as it were, the Bed or Placentula of the Seeds; which lie all over it, as in a Strawberry. And fo in many other Plants. Throughout this Bed, the Vessels for the Generation and Nourishment of the Seeds, are distributed; one very small Fibre, flooting, from the direct ones, obliquely into each Seed.

14. §. THE Seed-Cafe of Tulip, opens with Three Sides; being, when young, a Prism or long Triangle. From the middle of each Side, a Partition or Board is produced; all three meeting in the Centre of the Cafe; and so parting it into Six Stalls for the Seed. The insides hereof, are, lined with a thin smooth and glossy Parchment, like that in Hen-bean; derived from the Pith, as the outside, from the Bark; and fo in many other Seed-Cafes.

15. §. The Vessels, after they rise above the Stalls, are disposed with great artifice. For first, they are divided into Three principal Branches, which run along the Three Angles of the Cafe; where the Three Sides, as it ages, gradually cleave afunder. From these chief Branches, at the Three Angles, divers leffer ones run horizontally, and meet at the middle of each Side. From whence again, many yet smaller ones are produced through the breadth of each Partition to their Edges in the Centre of the Cafe. Where, once more, they are distributed into very fine and short Threads, whereupon hang the Seeds.

16. §. THE Seed-Cafe of Strawmonium or Thorn Apple, is divided into Four Clofets; Not open one into another, as in Poppy, Tulip &c. but so many distinct Inclofures. In the midst of each Clofet stands a Column, joyned to the Side of the Clofet by a Wall or Lamina. Through the Length of the Columns run several greater and leffer Branches of Vessels, from whence others are obliquely produced, upon which the Seeds grow.

17. §. THE Seed-Cafe of Anagallis or Pimpernel, is a little Globe; which opens not by its Meridian or Vertically, as do the former; but by its Horizon. For divers very small Fibres, being produced from the Stalk to the middle of the Cafe; do there fetch a Circle, and so divide it exactly into Two Hemispheres; the Uppermost of which, when the Seeds are ripe, falleth off; and fo the wind loves them.

18. §. THE Seed-Cafe of Coded Arsmart, neither opens at the Top, nor on the Sides, as do all the former; but at the Bottom. It is compofed of Four Sides: the Outer Part of which, is softer and more succulent; the Inner a little and firm Membrane. In the Centre of the Cafe, is erected a Pole or Column upon which the Seeds do all hang very loofely.

19. §. From this Mechanism, the manner of that violent and surprising Ejecration of the Seeds, is intelligible. Which is not a motion originally in the Seeds themselves; but contrived by the Structure of the Cafe. For the Seeds hanging very loofe, and not on the Sides of the
the Cafe, as sometimes, but on the Pole, in the Centre, with their thicker end downward, they stand ready for a discharge: and the Sides of the Cafe being lined with a strong and Tenfed Membrane, they hereby perform the office of so many little Bombs: which, remaining fast at the Top, and (contrary to what we see in other Plants) opening or being let off at the Bottom, forcibly curl upward, and so drive all the Seeds before them.

CHAP. VI.

Of the USE of the Parts to the Fruit.

In the foregoing Descriptions, I have already mention'd the USE of the Parts in some particulars. I shall now a little further explain the manner of their service, both to the Fruit, and to the Seed.

2. §. And first, the Vessels serve for the Figure of the Fruit. So in an Apple, the Ten great and utmost Branches serve not only to nourish and feed it; but also, by the Arched Lines they draw, to direct and govern the Growth thereof into an orbicular Figure. The Dilatation of these Vessels, not being hindered by any Braces or Conjunction with the Interior ones. By the Slenderness of the Aer-Vessels, as in the Root, so here in the Fruit, much promoted. And by their Saline Principle, first began.

3. §. The Five middlemost and the Five Inmost serve together, to figure the Coar5, the former bounding the Outer, the Latter, the Inner Angles. For were they only Five, or were all Ten in the same Circle, they would only make a round Compass like that of a hollow Fitch. Hence it is that Apples, in which some small Threads of the Vessels strike out into the Circumference, are very Uneven with divers Knobs and Ridges. But Plums, Cherries, &c. where the Vessels all terminate at an Equal distance from the Skin, are even all round about.

4. §. The Bulk of the Fruit dependeth also on the Branches of the Vessels. For in Plums and Cherries, they are more numerous, but in Apples and Pears they are very loose one from another, and so have Liberty left them to spread abroad.

5. §. As also on their Size, that is, on the Size of the Aer-Vessels. Which, as the less they are themselves, they serve to make a bigger Fruit. As the less they are in any Root, they serve to make it more ample. For the less they are, the more pliable to the Attraction of the Air: and in their Growth must make so many more spiral Rings: by both which means, they make the greater Arches. And therefore a Pear is commonly a smaller Fruit than an Apple; a Plum than a Pear; and a Grape, than a Plum; in all which the Aer-Vessels are still greater and greater.

6. §.
6. §. From the same Cause, it is also most agreeable, That the Fruit should not come before the Leave or Flower, but last of all. For the Aer-Vessels, as hath been often noted, are not exactly Cylindrick, but tapered; that is, not only the Fibres consisting of divers of these Vessels, but the Vessels themselves, as they ascend into the Trunk, Branches, Leaves, Flower, and Fruit, grow still more and more slender. So that the smallest coming last, and being the most pliable; they are also best accommodated for the Expansion of the Parenchyma into that we call the Fruit.

7. §. It is likewise a proper Question to be asked, How it comes to pass, That some Plants bear a Fruit, and not all? I answer, That as the Size of the Aer-Vessels conducdeth to the Bulk of the Fruit, and the Order of its Growth: So the Number of them, to their being, or not being, any Fruit at all. For the Fruit, as we have already defined it, is an Uterus, which grows moyster and softer, as the Seed ripens. The reason, therefore, why the Uterus in some Plants, continues moist and soft after the Seed is ripe; and in some, dries up; is, because in the former, there is a smaller, in the latter, a greater Quantity of the Aer-Vessels in proportion to the other Parts of the Uterus, and so a greater quantity of Aer. Which as in the Pith of most Plants, so here, by degrees excludes the Sap, or rendering it more evaporable, comes in the room of it; and so the Uterus is dried up: that is, there is no Fruit produced, but only a Seed-Cafe.

8. §. From the Size, Number, and Position of all the Vessels in Fruits a reason also may be given, for the diversity of their Tastes. Some Instances have been before given; to which I shall add one or two more. So the Rind of an Orange, is bitter; the Pulp, sweeter. Because the former is furnished with many Lignous Vessels, the Sulphurous or Oly Tincture whereof, being copiously mixed with the Acid of the Parenchyma, produce that Tast. Whereas the Pulp, which is very fower, is void of all manner of Vessels. But if the Sap-Vessels are either less numerous or less Sulphurous; they give fo mild a Tincture to the Parenchyma, as not to produce a bitter, but a sweeter or soft Tast; as in Apples, Grapes, Gooseberries, &c. And of a Gooseberry, it is particularly to be noted, that whereas, in a Limon, the Pulp only is fower, as being void of Vessels: here, on the contrary, the Pulp only is fweet, whereinto all the Vessels strike, and the Rind fower.

9. §. The diversities of the Skin it self, have their Use. And therefore, the more tender and delicate the Fruit is; the Skin, on the contrary, is thicker and more tough. So Apples have a thicker Skin, than Pears; Plums, than Apples; and Grapes than Plums; those having as it were, only a Coat of Kid, but this of good thick Buff. And therefore some Fruits, although tender, yet either not having so rich a Juice, or coming early, and so not being expos'd to excessive heats, have a very thin Skin, as Mulberries, Strawberries, &c,
Of the Use of the Parts of the Seed. And the Time, in which the Uterus or Fruit and Seed-Cafe are formed.

And first, for example, in an Apple, the Five Inmost Branches, do best serve for the Generation of the Seed; these running into the Attire of the Flower, and so carrying off the most Aerial Spirit from the Seed; by which means, it becomes a more compact and denter Body, than the Fruit, and so more accommodate to the process of Vegetation; as P. 2. Ch. 5.

§. 5.

2. §. The Elongation likewise of the Seed-Vessels, in the Fruit and Cafe, sometimes directly, as in Plums and Nuts, and sometimes by several Ambages before they shoot into the Seeds, as in Tulip; this serves a design for the highest refining and maturation of the Seminal Sap.

§. 6. For the better drying of the Seed, and the disburring or fowing of it in due time, the opening of the Cafe is, in the same manner, also contrived: either at the Top, as in Poppy; or on the Sides, as in Tulip, Pimpernels; or at the Bottom, as in Codded Arumart. All which openings are effected by the running of the AER-Vessels along those places: for by drying the Parenchyma next adjacent, they cause it to chop and cleave afunder.

§. 7. Of the Seed-Cafe of Poppy, it is particularly to be noted, that as the several Windows serve to let in AER, for the drying of the Seeds, after their full Growth: So the Canopy over them, serves to keep out Rain. For here, the Cafe not cleaving down the Side, as it usually doth; should the Rain get in, it would stand in it, as in a Pot, and so rot the Seeds. And as the Canopy serves to preserve the Seeds to the several Partitions or Walls, for their better Stowage. For by an eafe survey of this little piece of Ground, it is plain, that as they stand on both Sides every Wall, there is as much more Ground for them to stand upon, as if there were no parting Walls, but the Seeds stuck all round about upon the Ambit or Sides of the Cafe, or upon a great Bed or Placentae within it, as in Hyoscyamus, Anagallis, &c. where there is a less numerous Brood.
6. §. The Corpuslikewise, by standing between the moist Parenchyma and the Seed, and being hollow and so filled with Air, doth much conduce to the ripening and drying of the Seed, and its greater firmness both for keeping, and sowing. So the Parchment Lining of the Seed-Cafe, as in Hyoscyamus, &c. is answerable to a Coar.

7. §. The Parenchyma serveth, amongst other purposes, for the Generation of the Covers of the Seed; as in some instances hath been shewed. For which intent, sometimes the Exterior Parenchyma, as in a Lime, sometimes the middlemost, as in a Gooseberry or Cucumber, is subservient; both of them, in those Fruits, being more white and dry than the rest, and so fitter to make the Covers of the Seed.

8. §. The Parenchyma is also of use for the warmth of the Seed; as in the Seed-Cafe of Garden Radishes. Wherein, as it ripens the Parenchyma gradually dries, breaks, and shrinks up into several soft Membranes, in which the Seeds, in the Centre of the Cafe, lie swaddled, as in so many fine Calico Clouts.

9. I SHALL conclude with observing the Time of the Generation of the Fruit and Seed-Cafe. This hath hitherto been thought to be instituted upon the opening, I say not, the forming, but the opening of the Flower, or not long before. Notwithstanding which, what I have formerly said of the Flower; I now do the like, of the Uterus it self; that in very many Plants, 'tis formed, with the Flower, the year before it appears and comes to its full Growth. As for instance, in Azarum, not only all the Parts of the Flower, but the Uterus it self, and there in also the outer Cover of the Seed of any one year, are perfectly formed in August or September of the year foregoing. The like may be seen in Tulip, Mezereum, Corin, and many other Perennial Plants.
THE ANATOMY OF SEEDS,

PROSECUTED

With the bare EYE,

And with the

MICROSCOPE.

The Figures presented to the Royal Society, in
the Year 1677.

The FOURTH PART.

By NEHEMIAH GREW M.D. Fellow
of the ROYAL SOCIETY, and of the
COLLEGE of PHYSICIANS.

LONDON,

Printed by W. Rawlins, 1682.

Mo.Bot.Garden, Hh.
THE CONTENTS OF THE Fourth Part.

CHAP. I.
Of the FIGURES of Seeds.

CHAP. II.
Of the NUMBER and MOTIONS of Seeds.

CHAP. III.
Of the several COVERS of Seeds, and of the VITELLOM.

CHAP. IV.
Of the FOETUS or true SEED: and first of the RADICLE and LOBES.

CHAP. V.
Of the BUDS of Seeds. And of the PARTS of which these, the Radicle and Lobes are compounded.

CHAP. VI.
Of the GENERATION of the Seed.
THE ANATOMY OF SEEDS.

PART IV.

CHAP. I.

Of the FIGURES of Seeds.

The figures of Seeds, or rather of their outward covers, are made suitable, partly to their Collocation in the Uterus, as the End. So those of Mallow, standing like a Coronet round the Stalk, are of a wedged Figure, whereby their sharp Edges do all meet together in one Centre. Partly, to the various distribution of the Vessels or Fibers, as one Cause; by which the Measures and Surface of Seeds, as well as of the Leaves of Plants, are diversified. And partly, to the Nature of the Saline and other Principles regent in a Plant, as another principal Cause. And therefore the more stony, brittle, or full of Salt the Covers of any Seeds are, they are generally more angular, and their Figure, whether angular or not, more constantly observed. So the Tartareous Stone of a Plum, is not only more angular, but also more regular than the Husk of the Kernel of a Pear or Apple.

2. §. For all Stones are measured by several Circles, whose Diameters hold a certain proportion to the Length of the Stone; in the same manner as hath been shewed in the description of the Leaf. So P. I. Ch. 3. the Stone of the Pears-Cod-Plum, is measured by two Circles. That of the Turkey-Plum with Four. That of the Apricock-Plum, with Two Tab. 72, repeated oppositely; being perfectly Rhomboid. To which, those also of the Wheat-Plum, Damascoen, and some others, allude. And some are measured by four Circles, and one repeated.
3. §. The Figures, not only of the larger sorts of Seeds, but even of the smallest, have much and elegant variety. We shall take the pleasure of comparing these which follow.

Tab. 73. And first of all, some are perfectly Spherick, and with an even Surface; as that of little Century. That of spergula is also Spherick; but hath a knobbled Surface, and is encompassed with a Membranous Rimm, like the Horizon of a Globe. That of little Celadine is Circular, but comphressed like a Cheese.

5. §. Others are Nephriched, or as it were Hemispherick. Of which Figures, and hereunto approaching, there are a greater number than of any other; as that which agrees with the more frequent Shape and Fold of the Lober and Radicle of the Seed, as shall be seen. Yet with some difference, as to their Shape and Surface. So, that of Lychnis sylvestris is figur'd just like the kidney of a Cat; and hath a knobbled surface. That of Poppy comes near it in Shape; but hath a surface exactly like that part of the Paunch of a Sheep, called the Hony-Coone. That of great Celadine is a little more oblong; and so, like the Kidney, not of a Cat, but of a Sheep: chequered with parallel Rings and other short Lines placed alternately between them.

6. §. Where, by the way, we may see, as well by the Seed, as by the other Parts, of how different kinds, the Great and Little Celadine, notwithstanding their Names, are to be esteemed.

7. §. The Seed also of Ben or Spitting Poppy is somewhat like a Kidney: but hath its Circumference raised up into a double Rind; to which several small Ridges do in some sort also radiate from one Centre of the Seed.

8. §. The Seed of Chickweed, is partly like a Kidney, and partly like a little Retort. As also that of Pentaphyl fragiferum. But the former is rough cast with small pieces having as it were feet on each side, like little Insects. With which, the Seed of Lachanthemum (which may be called, the Giant-Chickweed) doth much agree. The latter, hath several Fibrous Ridges, resembling the Fibres in the Articles of the Heart; or running from the nose to the Circumference, somewhat like the Asymuth Lines on a Quadrant.

9. §. Some are Oval; as that of the little Bell, and rough cast with Fibres almost parallel and produced by the Length of the Seed. In which latter respect, the Seeds also of Trachelium and some other like Plants, are agreeable. That of Brooklime, is also Oval, but encompassed with a thick Rimm, narrowing all the way to the Base of the Seed.

10. §. The Seed of Doreesfoot hath an oval Coke, and a flat Base. Its Surface favours, like that of Poppy, Tood-fleece, and some other Seeds. That of Sedum minus effimum laterum, is in a manner the Figure of the former inverted, being flat, not at the Base, but on the Top. And whereas that rises with a blunt Angle, this hath only a Rind, raised above the Surface of the Seed.

11. §. The Seeds of divers sorts of Grass, are more Conick, as particularly of that, which for the likeness its Seed hath to a Barly Corn, may be called Barley-Grass. And I little doubt, but that among the several sorts of Grass, there are some which answer to all the kinds of Eherent Grains, as Oat-Grass, Rice-Grass, Wheat-Grass, Rye-Grass. And accordingly, that they may be more profitably sown in one Ground, than in another; and used with distinction, for the higher, or more wholesome.
Book IV.

of Seeds.

197

wholesome feeding of Cattle. A Rye, though it seems an imperfect
plant, yet besides its flower, hath also a plentiful brood of Seeds of a
Conick Figure.

12. §. Some Seeds are Cylindrick, as that of St. Johnswort, as
also of Tansy, and some other like Plants, with some little diversity in
the Shape or Surface of the Seed. That of Verwam, is in a manner,
half a cylinder; the true Seed lying in the Covers, like a Child, in a
Cradle without an head.

13. §. Others are rather Conico-Cylindrick, as that of Jacobea;
having a Coronet on the top, and several furrows by the Length round
about. Answerable to which, is that of Erigeron; in Shape not
unlike to a Rowling-pin.

14. §. Some are Planio-Conick, as that of Nettle, which is shaped
somewhat like the end of a Spear. That of Eye-bright is more Elipstick;
with several Ridges running by the Length; and joyned together with
short pieces transversely, as in the looping of Lace. That of Worm-
Tab. 74;
wood not very unlike a little flat Essence-Glafs: in which, the Fibres
are produced by the Length, as the Ridges are in Eye-bright. And so in
Tarrow, which is also encompassed with a Membraneous Rinn. That
of Dandelion, is Planio-Conick towards the Base. And so those of Let-
tice, Souches, and some others. To which, those also of Horecanum, Tra-
gopogon, Scorzonera, &c. with respect to their Surface, do all al-
lude.

15. §. And some are Conico-Triangular. Of which, that of Sorrel
is Conick at both ends; the sides equal; and upon every Angle,
hath a narrow and sharp Rinn. As also that of Anagallis; but the
Sides are Spheric-comick, and so the ends are blunt. They are also
puounced with many little round Cavities. But have no Rinn upon
the Angles.

16. §. The Seed of Nigella is Triangular, and Conick only at the
Top. On every Angle, hath a narrow Rinn; the three Sides equal,
and Spheric-comick; surrounded with seven or eight Ridges by the bight,
joyned together in some places with others transversely. That of Ar-
Tab. 74;
tum, is also Triangular and Conick at the Top. But one of the Sides
is almost equal to the other two; which stand low. That of Knot-
Grass hath three Sides, one les than another; being as 5, 3, and 2,
or thereabout.

17. §. The next (which I take to be the Seed of a sort of Eu-
glofs) is very oddly figured. The Base, and; the Top, conick; the
Back, swelling and round as an Egg; the Belly also swelling, but rising
up into an obtuse Angle highest in the middle, somewhat like a Brest-
piece of Armour: and is encompassed with a Rinn flapped upward.

18. §. That of Moldavian Broom, is Triangular, and Conick only
at the Base. The place where it is fattened, shaped like the Breast of
a Dart. Two of the Sides are Planio-conick, the Third Spheric-comick, Tab. 74.
and near as big as both the other two. The Head flat, with a Rinn
erected upon each Side, to asto make a Spherical Triangle. Approaching
to this, are those of Sage, Horehound, Clary, &c.

19. §. That also of Bells Tanaceti folio, hath two Sides Planio-
comick, and a third Spheric-comick. The two first have several Ridges run-
ting to the Base. Which is not perfectly conick, but a little dilated
into two obtuse Angles. The Head Triangular, with one Side convex,
the other two straight, a little hollowed, and having a small pinnacle in the Center.

20. §. That of Stachas Arabicus, as the former, saving, that the Head is oval, and the Base sloped into a little Triangle. That of Warwicorn or Sun-Spurge, hath a very complex Figure. The belly consists of two Planes, each, as the former;  the Back, Sphericick. The whole Seed, in a manner, Comick-oval. Yet the Base and Head both flat. In the middle of the former, a Peg by which the Seed is fastened; and of the latter, a pointed Knob. The middle of the Belly-Sides, hollowed, so as to make a flat Rimm of equal Breadth; and the hollows filled up with Bladders like those in all the Parenchymus Parts of a Plant.

21. §. Lastly, there are some Seeds which are square. Whereof some are straight, as that of Fox-glove; which hath also an even Surface: And that of Blattaria, in which there are several little hollows in even Rows. And so in Brownworth.

22. §. And some Convex, as that of Chrysanthemum Americum.  The Sides all plain; and a thin Rimm erected upon every Angle. As also on the four Sides of the Head, which is flat, with a little Pinacle in the middle.

23. §. The Seed also of Tansey, is a Comick and bended square not with the Angle forward, as the former, but the Side. And in the place of every Rimm, hath a round Ridge. Somewhat like to this, are those of Febrisflaga, Mayweed, and some others. Thus far of the Figures of Seeds.

CHAP. II.

Of the NUMBER and MOTIONS of Seeds.

Nature hath secured the Propagation of Plants several ways, but chiefly by the Seed: for the Production of which, the Root, Leaves, Flower, and Fruit, do all officiate, as hath been shewed. And according as the Plant, or the Seed it bears, is more liable to be destroyed, Provision is made for Propagation, either by a greater number of Seeds, or other ways. So the Seeds of Strawberry, being gathered, or eaten by Vermin, with the Fruit; the Plant is therefore easily propagated by Trunk-Roots. So Poppy, being an annual Plant, is highly prolific: for instance, the White Poppy, which commonly bears about four mature Heads, in each of which, there are at least ten Partitions, on both sides whereof, the Seeds grow: and upon the part of one side, about 100 Seeds; that is, 800 on one Partition: which being multiplied by 10 (the number of Partitions) makes 8000; and 8000 again by 4 (the number of Heads) makes 32000 Seeds, the yearly product of that Plant.
Book IV.

of Seeds.

199

2. 8. So in Typha major, the Seeds being blow'n off and low'n (as the Eggs of many fishes spawn'd) with great hazard, they are
strangely numerous. For as they stand altogether upon the Spike, they
make a Cylinder at least six Inches long, and near half of an Inch in Di-
ameter, or an Inch and a half about. Now of these Seeds, set side to
side, as they stand on the Spike, make but half of an Inch; so that 7 is
make a line of an Inch in Length. But because upon the Spike, the
Hair belonging to the Seeds come between them; we will abate 10, and
count but 62. To which 4 of 62, that is (without the Fraction ) 46, being added, makes 108 for the Circuit of the Cylinder.
And the Cylinder being six Inches long, there are six times 62, that is,
372, for a Line the length of the Cylinder. Which number being
multiplied by 108, produce 40,176 the number of Seeds which stand
upon one Stalk; and so, upon three Stalks, which one Plant commonly
bears, there are in one year, above a hundred and twenty Thou-
sand Seeds.

3. 8. SO SOON as the Seed is ripe, Nature taketh several Me-
thods for its being duly low'n: not only in the opening of the Uterus,
as in some Insects (a) hath already been seen; but also in the make
of the Seed itself. For first, the Seeds of many Plants, which affect
Ch. 5. Tab. a peculiar Soil or soil, as of Arum, Poppy, &c. are heavy and small 70, & 71.

enough, without further care, to fall directly down into the Ground;
and so to grow in the same place where themselves had their Birth.

4. 4. But if they are so large and light, as to be expos'd to the
wind, they are often furnished with one or more Hooks: To stay them
from flying over far from their proper place, till by the fall of Leaves
or otherwise, they are lately lodged. So the Seeds of Arums have one
single Hook, those of Agrimony and Goose-grass, many; both the for-
timer, loading a Bank for warmth, the latter, a Hedge for its support.

5. 6. On the contrary, many Seeds are furnished with Wings or
Feathers. Partly, with the help of the Wind to carry them, when
they are ripe, from off the Plant, as those of Ash, Maple, Orach, &c.
leav'ing thereon too long, they should either be corrupted, or
misd their feaon. And partly, to enable them to make their flight,
more or less, abroad: that so they may not, by falling together, come
up too thick; and that if one should miss a good Soil or Bed, another
may hit. So the Kernels of Pine have wings not unlike to those of
some Insects; yet very short, in respect of the weight of the Seed; Tab. 72.
whereby they fiy not in the Air, but like domestick Fowls, only
flutter upon the Ground. But those of Typha, Dandelion and moft
of the Papous kind, with many more, have very long and numerous
Feathers, by which they are waited every way, and to any distance
necessary for the aforefaid purposes.

6. 9. Again, there are some Seeds, which are scattered not by
flying abroad, but by being either sprouted, or Slung away. The first
are those of Wood sorrel; which having a running Root, Nature se's it fit
to low the Seeds at some distance. The doing of which is effect'd by
a white thick and sturdily Cover of a Tendinous or Springy Nature, in
Tab. 72: which the Seed lies within the Cape. This Cover, so soon as it begins
to dry, bursts open on one side, in an instant, and is violently turned
inside outward, as you would turn the Gizzard of a Fowl; and so
snaptly throws off the Seed.
7. §. The Seeds of Harts-tongue, and of all that Tribe, are Sling or Shot away. The doing of which is performed by the curious contrivance of the Seed-Cafe; as in Codded Arsimart, and some other like Plants. Only there, the Spring moves and curls up inward; but here it moves outward. I shall describe it, as well as the Weather (which when I observed it was cloudy) would permit. Every Seed-Cafe, as it appears through a good Glass, stands upon a Pedicle from ½ an Inch to an Inch or more in Length; at the bottom about as thick again as a Horse-hair, and a little thicker at the Top, on which stands the Cafe, of a Silver Colour; about the bigness of a Cherry-flone, of a spheric, Figure, and girded about with a sturdy Tendon or Spring, of the Colour of Gold: the whole Machine looking not much unlike a little Padlock. The Surface of the Spring resembles a fine Seren, or some of the Acr-Vessels in the Wood of a Plant. So soon as by the Innate Air of the Plant, or otherwise, this Spring is become stark enough, it suddenly breaks the Cafe into two halves, like two little Cups, and so flings the Seed.

8. §. These Cakes grow in oblique Furrows or Trenches on the back side the Leaf, from ½ of an Inch to an Inch in Length, and about ¼ of an Inch broad. In one of these Trenches an Inch long are more than 300 of the Cakes above described; and allowing but 10 Seeds to every Cafe, above 3000 Seeds. Which being multiplied by the number of Furrows in one Leaf, with allowance for the lesser Furrows; and that sum by the number of Leaves commonly growing upon one Root, comes to above Ten Hundred Thousand Seeds, the annual product of this Plant. The Seed is of a Tawny Colour, through a good Glass about ½ of an Inch long, flat, and somewhat oval. Of these, ten Thousand are not so big as a white Pepper Corn.

CHAP. III.

Of the several COVERS of Seeds, and of the VI-TELLUM.

The next step of Nature’s Management, relates chiefly to the Growth of the Seed when it is sown. For which purpose, the outer Covers are somewhere furnished with Apertures sufficient for the reception of Alimental Mover from the Ground; and Directions for the footing forth of the young Root into it. As in the Seed of a Ground, at the bottom of a Bean, on the Side; and in a Chestnut, at the Top; in which places the Radicle or young Root always lies and puts forth, in the said several Seeds. And the Seed of Palma Chrysa, which falls to the Ground not only in the usual Covers, but also in the Seed-Cafe, for the more plentiful admission of Aliment, hath a double Aperture. Not much unlike to this, is that found sometimes
in larger parcels of Euphorbiun; for which cause I suspect it to be the Gumm of a Plant of the Tithymal kind.

If the Cover of the Seed be stony and very hard, it is also distinguished into several Pieces; whereby they easily cleave another without much resistance to the eruption of the Root. So the Shell of a Hazel-nut easily cleaves on the edge; and the cleft begins below at the point, where the Root stands and shoots forth. The Shell of some Walnuts cleaves into three Parts; and the Stone of the Bellierick Myrobalan into five: that is, being very thick and hard, if one piece should not yield, another may not fail to do it. And the Covers or Husks of some sorts of Grain, as of Millet, are only folded or lapped one over another, the better to give way to their tender Sprouts.

Besides the Kernels of Plums and some other Fruits, there are very many Seeds, even of the smaller sort, which have also stony Covers; as of Carthamon, Mygarmum monasfermon, Beet, Borage, Lithopherme, Amaranthus, Violet, &c. Sometimes, for the reception of the harbinger and left matured Principles from the Seed, in its Generation, as in Borage. Commonly, to keep it warmer before and after its sowing. For which purpose, the outer Covers of some Seeds, are as it were Lined with Fur: in that of Great Maple, Short; or of Gossepinum, Long. And if the Seed requires a longer stay underground, the hardness of the Cover serves to stint the Aliment; lest too much, should either rot it, or cause it to germinate, before its proper season, or full time for a more Masculine Growth.

On the contrary, many Seeds, as those of Clary, Garden-Cress, and others of that Tribe, have their upper Covers faced with a Maculage: which being easily receptive of any Moisture in the Ground, gradually swells, till it lies like a Gelly round about the Seed. Either for a more plentiful supply of Aliment; or at least, to soften the Covers, the better to accelerate the Growth of the Seed.

The proces of Nature in the several steps of the Vegetation of the Seed, hath formerly been explained.

The COVERS of all, or at least the far greater number of Seeds, are Three; some way or other derived from the Pulp, as shall after be seen. And sometimes, Four; even those of round Fruits, have Three, besides the Stone. In that of Gossipinum, there are Two Coats under that lined with the Cotton. The Seeds of Cucumer, Goat’s-beard, Broom, Scabious, Lettuce, &c. although so small, have plainly Three Coats. But in some of these, and many more, there are only Two distinctly visible, except in the State of Generation.

In the Upper Coat, the Seed-Vessels are dilatationed. The Second, is first a mere Pulp; but afterwards shrinks up and sticks close to the upper. The Third or Immost is more dense; and if it be thin, for the most part, transparent; whereby the Seed seems sometimes to be naked while it lies therein; as in Almonds, Cucumers, and the like. For this sticks not to the middle Coat, as that doth to the outer; but commonly, remains entire, after those are stripp’d off, being as it were, the Smock of the Seed.

Millet and some other small Seeds, it comes finely off upon soaking in warm Water or on the Tongue. In Fenugreek, it’s soft, and of an Ammon-Colour; and being moistened, looks almost like fine Gley. But commonly, it’s a pretty tough Membrane, and often with some
some thickness, as in Plums, Borage, Scabious. Yet always extreme thin at the Tip of the Radicle; the more easily to break and yield to it, as the Secondine to the Fetus, when it first shoots into the Ground. And sometimes, as in the Seeds of an Orange, it hath at one end, the resemblance of a Placenta. But of this, and the two upper Coats, I shall give a further Description in the last Chapter.

9. §. As ALL Seeds are ex Ovo; so there are many with thin Covers, as of Orach, Spinage, Beets, and the rest of that Tribe, &c. which beides the Albumen or clear Liquor out of which they are bred; have also, a Vitellum, or a Body therunto Analogous; being neither part of the Seed, nor part of the Covers, but distinct from them both. With respect to the Bulk of the Seed, very large, as white as Starch, and pretty friable, like good Rice or Barley: of a roundish Figure, and grooved on the Girth, so as to have a double Edge; Whereby the Seed, which is long and slender, lies round it, as a Sack of Corn upon a Pack-Saddle or a Rope upon a Full- wheel. Upon my first notice hereof, it seemed to answer to a Placenta. But upon further consideration, the Analogy doth not hold betwixt them. For the Placenta lies without the Membranes in which the Fetus is contained: whereas this body lies within the Covers contiguous to the Seed, and so becomes its first and finest Attire, as the Tilk doth to the Chick. For which purpose, as in the Generation of the Seed, it is a pure Milky Chyle; So in its Vegetation, it is converted into the like again.

10. §. The same Body for Sulliance, is observable in the Seeds of Rhapontick, Dock, Sorrel, and the rest of that kindred, with this difference; That whereas in Orach, &c. the Seed only lies upon it; here, the main Body or Lobes of the Seed are immered therein, the Radicle standing naked or above it. So that the said Lobes, and therein the Seminal-Root are beded herein, as in a Tub of Meal or a little pot of pure refuse'd Mould, necessary for the first Vegetation of the Radicle.

11. §. BY THESE middle Steps, Nature proceeds from the Thinner Covers of Seeds; or those, which after the Generation of the Seed is smitted, shrink up; to the Bulky Kind, or those which keep their Bulk after they are dry. Wherein, not only the Lobes, as in Dock, but the whole Seed is immediately lodged. Different in Substance, Shape and Bulk; but always many times bigger than the true Seed within it: for which it is commonly mistaken; but is no more the Seed, than is the Stone of a Plum, the Kernel.

12. §. In the Barbado Nut, 'tis White, Soft, Convick-oval, and taking all its Dimensions, 8 or 10 times bigger than the Seed within it. In Asken Keys, 'tis of a fait Colour, hard, yet somewhat Oly, Oval and flat, and of the same Bigness as in the Barbado Nut, with respect to the Seed. In the Fruit commonly called Nux Vomica Officinarum, 'tis of the Colour and Hardness of a Core-Horn; and makes almost the whole Body of the Fruit, being about 14 or 15 times the Bulk of the Seed.

In Goosegrass or Clover 'tis of the like Horny Substance, but shaped somewhat like a Bonet with the Rimus thick in. And so in a Coffee-Berry; but rowled or fouled up into a kind of Oval Figure, with a Notch or Rima through the Length, where the two Ends meet. With other Diversities which will best be understood, when I come presently to the Description of the Seed herein contained.
CHAP. IV.

Of the FOETUS or true SEED: and first of the RADIICLE and LOBES.

HAVING discoursed of the Cover, I come next to the Seed or Foetus itself. Of the Shape and Posture whereof, I shall give some Examples, first, among those with the thinner sort of Covers; and then, of those with the Bulky one: where I shall speak only of the Lobes, or Main Body, and the Radicle. Next, I shall describe the several sorts of Nodes or Buds of Seeds. And lastly, the several Parts, of which the Lobes, Radicle, and Buds are compounded.

2. §. Among seeds with the Thinner Covers, are those of all sorts of Corn and Grains: Of a different make, from that of most other Seeds: The Main Body being not divided into Lobes, but one entire Piece, doubled in the form of a Pair of Lips. And whereas commonly, the whole Seed is very soft and Only, here, only those two minute Parts, which become the Root and Stalk, are so: The Main Body being of a different Substance: when the Corn is ripe, hard and friable; but when it is fown, easily colliquable into a kind of Milk or Chyle, so that, in some respects, it hath a near Analogy to a Vitellum. For as that is gradually melted into a Pulp of Chyle, and by the Branches of the Cystanacali, carried into the Bowels of the Chick. So is this, into a like Substance, and by the Branches of the Seminal Root (formerly described) conveyed to those Parts, which become the future Plant. B 1. ch. 1.

3. §. Of Relation to this Kind, the Seeds of Dates, and of some other like Plants, may be esteemed. For that which is commonly called the Stone, seems indeed to be the Main Body of the Seed, doubled or folded up in the same manner as in Corn. To which that Part which becomes the Plant, is annexed. But whereas in Corn, 'tis placed at Tab. 75.
the Bottom of the Main Body; here it lies in a small round cavity in the middle of the Back. The Stone, or Main Body, where this Part grows to it, is not so hard, as more remote from it: and is therefore probably in some part dissolved, by lying in the Ground, as in Corn.

4. §. But for the most part, the Main Body is divided, as hath been said, into two Lobes; and those in Substance Homogeneous to the other Part or Parts, plainly distinguished in most Kernels and other large seeds; and not difficultly in many lesser ones, as in that of Viola Lanaria, Scabious, Doves-Foot, &c. if slipped out of their Covers before they are full ripe.

5. §. In Hounds-Tongue, they are of a circular figure, and very large in Proportion to the Radicle. In Cucumber, oblong, with some visible Branches of the Seminal Root; and the Radicle somewhat bigger. But in Scorzona, very long, like the Legs of a Pair of Compasses; and the two first, or dissimilar Leaves of the Plant into which they are converted, are of the same Shape. Of these and many more, the Radicle is short and pointed; and lies in one straight Line with the Lobes.

6. §. In Viola Lanaria, they are very large; and the Branches of the Seminal Root, fairly apparent, so as to resemble a Pair of Leaves. The Radicle pretty long, equally thick from end to end, and couched down upon the two Lobes, each of them having a little Shoulder for it to lie upon. In Wood, where it hath the like Posture and Shape, as also in Chamelions, Erina, and many others, it is very Bulky, being bigger than both the Lobes put together.

7. §. Of this Part, I think it may be observed, That commonly those Seeds, wherein it is very small with respect to the Lobes, produce a Perennial Plant: And so, vice versa, where it is very large, an Annual one. In the latter, the Seminal Virtue being more vigorous, and tending more hastily to the Bulines of Generation, followed with the Death of the Plant.

8. §. In the former Seeds, the Lobes lie flat one against another. But in Garden-Radish, they are folded up, so as to receive the Radicle into their Bosom: as when a Chicken tucks his Head under his Wing.

9. §. In Hollyhock, the Lobes are placed upwards, and re-placed downwards again. Being most agreeably compos'd to the Shape of the Covers, as those are to their Posture on the Plant. In Maple, they are placed one over another, and so rouled up.

10. §. In the Cotton-Seed, which consists of wholly of two very broad and thin Lobes or Leaves, the Folds are yet more numerous; all curiously reduced to an exact and solid Oval.

11. §. It happens now and then, that instead of two, there are three Lobes, as in the Kernels of Plants, Apples, and other Fruits, and the smaller sorts of Seeds, will spring up sometimes with more than two dissimilar Leaves, originally the Lobes of the Seed. These are observed by some, more frequently to produce a double Flower, which may be, because the Seminal Virtue in such Seeds, is increased by a third Part.
Book IV.  

Of Seeds.  

12. § In many Seeds, the Radicle is of one and the same Colour from end to end. But in others, as in the Lupine, it is observable, that the upper and greater half, is White; the Lower to the Point, hath a kind of Horary Globs, and seems to be of a somewhat different make. Tab. 75. Whereby it comes to pass, that after the Radicle is short, and a little way, only this lower half extends and becomes the Root. The upper half is produced or raised above ground, as a Pillar upon which the Lobes, or dissimilar Leaves are erected.

13. § This Seed, on the out side of each Lobe, and near the Radicle, hath a very small and round Node, like a Notch; whereof, in the first Book: the whole Seed looking not much unlike a Pidgeons Head; Ch. 7. the Radicle resembling the Bill, and the Notch the Eye.

14. § In the Seed of Garden-Orach, both the Radicle and Lobes Tab. 75. are very long and slender, and lie almost in a compleat Circle round about the Vitellum before described. The Lobes of Rhapontick are shaped like the Bitt of a Spade; and the Radicle stands erected above them like the Handle.

15. § Of SEEDS also with the Bulky Cover, there are many not divided into Lobes; being in a manner, all one Piece; as all of the Bllow-Kind. In some of which, though the immot Cover be thin; yet compared either with the other Covers, or with the Seed itself, it may very well be accounted of the Bulky-Kind.

16. § In Flags, it is above twenty times bigger than the Seed within it. Consisting of Bladders all Radiated towards the Seat of the Seed, the Seed itself is shaped somewhat like a Penknife. The lower Part Tab. 76. which becomes the Buck, as the Haft, is thick, and cometh near to a Cylindrical Figure, and the end, round. The upper Part which becomes the first Years Leaf, as the Blade, is rather flat, double edged, and pointed, and the Point a little bent. The Fibers and Bladders of which it consists, are all disposed into Parallel Lines running by the length. In Lily, where this Cover is thinner and more Transparent, without being cut, but only held up against the Light, the Seed may be seen within it.

17. § But the greater number of Seeds also with the Bulky Cover, are divided into two Lobes; which, for the most part, resemble a pair of little Leaves. In the Purging Nut of Angola, the Shell being taken off, the upper Covers (dry'd and shrunk up) seem to be but one. Tab. 76. In thefe, the Spermatick Vessels are Branched. Under thefe, lies the Thick and Immot Cover; which being cut down the middle, exhibits the true Seed; Consisting of a couple of fair Leaves, Veined, and as white as Milk; joined together with the Radicle at their Base; and let into a Hollow, made in the Cover, of an unwearable Shape. The like is observable in the Barbado-Nut, Ricinus Americana, and some other Indian Fruits; with some little difference in the Shape of the Root and Leaves.

18. § In the foregoing Fruits, the Bulky Cover is very soft. But in the Nuc Odontium officinarum, this near as hard, as a Date-Stone. Tab. 76. In this, besides the hollow made for the reception of the Seed, or the two Leaves and Root; the Sides are separated or distinct almost to the Edge of the Cover round about, especially towards the Root; so that it may not unaptly be compared to a little Pouch with the Sides clapt together.

18. § In
19. §. In this and the Nuts above mentioned, the Seeds are all very large. But in some other Plants, they are extrem small, so as to be hardly visible without a Glass, as in Staphisagria, Peony, &c. In staphisagria, the Thicke or Inner Cover, is commonly a Spherical Triangle, conic towards the Base. At the point of which, there is a little Cavity, in which the Seed, about as big as a small pins head, is lodged. The Root whereof is a little pointed, and the two Lobes rounded at the Top.

20. §. In Peony, the same Cover is Soft, White, and of an Oval Figure; the part used in Medicine. Usually thought to be the Seed itself. But is near two hundred times bigger than the true Seed, which is almost invisible. It lies in a little Cavity near the bottom of the Cover, with a thick and blunt Root, and two pointed Lobes or Leaves.

21. §. IN the Coffee-Berry, the Seed lies in the Inner or Cartilaginous Cover (formerly described) where one would not expect to find it, for near the Top or Surface of the Back. The Lobes of the Seed are veined like two very minute Leaves, and joined to a long Root like a Stalk. The end of which comes just to the bottom of the Cover, ready for its exit into the Ground.

22. §. In Goografs, where the Inner Cover is also Cartilaginous or Horney, the Seed is polluted in much a like manner, and looks just like a couple of pointed Leaves with a very long Stalk.

23. §. THE Seed of Stramonium, is also inclosed in a Bulky Cover. Which being soak'd in warm water, and very warily cut about the edges, with a Razor, the Seed may be taken out of it entire. Shaped like that of Orach, but much longer. For the Reception whereof, the Cover is formed with a hollow, which runs round about it near the Edge; where in the Seed lies like a little winding Snake.

CHAP. V.

Of the BUDS of Seeds. And of the PARTS, of which these, the Radicle, and Lobes are compounded.

ROM between the two Lobes, rises up the Stalk of the Plant. The original whereof, either to the naked Eye, or by a good Glass, is always visible in the Seed.

2. §. In many Plants, Nature sees fit only to lay the foundation hereof in a small round Node, whereupon the Leaves, in the Vegetation of the Seed, are superfructed: as in Viola Lunaria, and others.

3. §. But in the greater number of Seeds, is formed a true Bud, confitting of perfect Leaves; different from those, which grow upon the Stalk, only in Bigness; and so far in Shape, as the same Parts of an Animal Fetus, in its several ages in the Womb. In many Seeds, as well
small as great, and as well of Herbs as Trees, it is very apparent. But oftentimes lyeth so deep between the Lobes as to be almost undiscernible, as in Maple.

4. §. The Leaves of the Bud, in different Plants, are of a different Number; in some, Two; in others, Four, Six, and sometimes more. In the Bay-Berry, they are only two; very small, but thick or far, and finely veined. In the Seed of Carduus, veredis, they are also Tab. 78. Two; almost invisible; broad at the Bottom, pointed at the Top, thick or fat, yet plated inward, and poshured a little distant one from the other; for the two next to rise up between them. The like may be seen in Carthamus; and so, I suppose, in all the Cardiaceae Kind.

5. §. In some Herbs, although the Bud consisteth but of two perfect Leaves, yet they are very conspicuous. Not only in larger Seeds, Tab. 78, as in the Phaselus or French Bean; but in those which are small, in the Seed of Hemp. In this, the two Leaves are both plated, and so let Edge to Edge, with mutual Undulations. Of that Length, as to be extended beyond a third part of the Lobes.

6. §. In the Seed of She, the Bud consisteth of Four Leaves; of Tab. 78, which, the greater pair is the outer, and guards the leaf. Shaped not much unlike those in the Seed of Cardiaceae; but are a little more visible.

7. §. In the Bud of an Almond, we may easily count fix, or eight Leaves, and sometimes more; the Inermost being laid bare by a dexterous Tab. 78. Separation of the Outer. These are by much the greatest, doubled inward, and so lapped one over another; whereby they embosse all the rest, as a Hen spreads her Wings over her Chickens. The like is observable in many other large Kernels, as also in the Garden Bean, and some other Plants. With respect to which, I have taken leave (a) to (b) B. 1. call this Part the Plume.

8. §. THE LOBES of the Seed, and so likewise the Radicle and Bud consist of a Skin, Parenchyma, and Branched Vessels; all which I have formerly describ'd. (b) I shall now add the following Remarques.

9. §. And first of the Skin, which in some Seeds, as the French Bean may easily be separated from the Parenchyma; especially if the Bean be soaked in water for some days; for then it will slip off, like the Skin in any part of the Body where it is blistered. 'Tis woven into Bladders, as the Parenchyma; but into smaller ones, and upon the Tab. 79. Lobes of a Garden Bean, all radiated towards the Center. With these Bladders, there are also mixed a sort of Lignous Fibres, incomparably small, which give a Toughness to the Skin, and by which the Bladders are directed into Rays.

10. §. The Bladders of the Parenchyma, as is said, are much larger than those of the Skin, especially in the Lobes. In those of a Garden Bean, somewhat oval, about ¼ of an Inch Diametre by their Breath Tab. 79. and directed towards the Branches of the Seminal Root. In the Radicle, they are twenty times smaller, than in the Lobes: and so in the Plume.

11. §. Throughout the Parenchyma run the Branched Vessels, which Tab. 79, in the Lobes make the Seminal Root; in the Radicle and Plume, the Wood of the Root and stalk. In all of them, distributed as hath been (c) (c) B. 1. formerly shewed.

12. §.
12. §. I shall here further note, That the utmost divisions are no where extended to the Circumference of the Lobes, but are all inofculated together at a considerable distance from it, as in the Leaves of some Plants.

13. §. In the Lobes they all meet in one solid Nerve. But in the Radicle, are dilated into a hollow Trunk, filled up with a Pith; composed of Bladders somewhat bigger than those which make, as it were, the Barque of the Radicle. In the Radicle of a French Bean, the Pith is very conspicuous.

14. §. The Vessels are of two kinds, as in the other Parts of a Plant; for Sap, and for Aer. Not running collateral, as Arteries and Veins; but the latter every where sheathed in the former. From the Aer-Vessels it is, that if a Bean be steeped in water, and then the Radicle cut transversely and pressed, it will yield Bubbles as well as Liquor. These Vessels are admirably small, yet through a very good Glass become visible.

15. §. The Liquor contained in the Seed, when full ripe is chiefly Oyl; generally, found in a greater proportion here, than in any other part of a Plant. Being as the Pickle, in which the Seminal Virtues, i.e. the more volatile and active Principles of the Seed, are immerfed for their Preservation: and to curb them from too great a Luxuriance in the Vegetation of the Seed.
Book IV.

CHAP. VI.

Of the GENERATION of the SEED.

S I made choice of a Garden-Bean, to shew the manner of the Vegetation of the Seed: so I shall take an Apricock, as very apt and convenient, to observe and represent the Method which Nature taketh in its Generation.

2. §. In order to this, the first thing that is to be done, is to make a fit Uterus. Both to keep the Membranes of the Fetus warm, and succulent, till it be formed: and to preserve and secure the Fetus itself afterwards, till it comes to be born into the Ground.

3. §. For this purpose, the Pulp and Stone of the Fruit are both necessary; but primarily the Stone: the Meat or Pulp being no otherwise necessary, but because the Stone cannot be made without it; the pervading of that Parenchyma which is the Ground of the Stone, being effected, by the filling of the Tartar from the Pulp thereinto.

4. §. And that, at the first, the Ground of the Stone, is a distinct, but soft Parenchyma is evident in the cutting of a young Apricock. Of which, also a slice cut off, with a Razor, and viewed through a good Glass, may be compos'd of Bladders, as the Pulp itself. Only, whereas many of those of the Pulp are large, now about as big as a white Pepper-Corn: these are no bigger than a Mustard-Seed. But as the Parenchyma hardens into a Stone, these Bladders are all gradually filled up, and disappear.

5. §. This Parenchyma is derived immediately from the Pith, as the Pulp is from the Barque; and makes the far greater part of the Stone. 'Tis covered all over within, with a very thin Lining; derived not from the Pith but the Parenchyma which covers the Seed-Branch, upon its first entrance within the hollow of the Stone. This Lining is of a close substance; yet compos'd of Bladders, exquisitely small and hardly visible, by which means, it soon becomes a very hard and dry Body; and is hereby fitted, both to promote the induration of the rest of the Stone; and the seasonable drying, and so, the shrinking up, of the Covers of the Seed, to make room for its Growth.

6. §. The Stone being made hard and dry; it could never be so sufficiently softened by lying under ground, but that, it would keep the Seed a perpetual prisoner, unless it were also made pretty easily to cleave in two. For which purpose, the Skin of the Fruit doth observably conduce. For in a Slice of a young Apricock, cut transversely with a very sharp knife, it may be seen, especially with the help of a Glass, to be doubled inward from the two Lips of the Fruit, and so to be continued,
continued, not only through the Pulp, but also through the Stone itself, into the hollow of the same, where it meets, and is united with the Lining thereof. Whereby, as it further helps to the drying and hardening of the Stone; so also renders it cleavable in that part, where it runs through it. And therefore, whereas towards the Stalk, it goes no farther than to the Seed-Branch, and so but half way through the Stone: towards the Top of the Fruit, where the Radicle stands, and where the Stone begins to cleave, it runs quite through it.

7. §. Nature having thus provided a convenient Utensil, She next taketh care about the Membranes of the Fetus. These are Three apparently distinct, and in many respects different one from another.

8. §. The outer Membrane is derived from the Parenchyma which surrounds the Seed-Branch: which, upon its entry into the hollow of the Stone, is expanded, as it were, into two Bladders, one within another; whereof, one becomes the Lining of the Stone; the other, this outer Membrane: as is best seen by cutting a young Apricock, when it is about half an Inch long, down through the middle, or from the Seat of the Flower to the Stalk, between the two Lips.

9. §. This outer Membrane, at this age, hath a good full and firm Body, about 1/4th of an Inch thick, or through an ordinary Glass, half an Inch, where it is thickest, as at the Stiles and the greater end: the Pulp being thinner, for the more easy eruption of the Radicle into the Earth. Composed of Bladders, through an ordinary Glass, about as big, as a Colewort-Seed.

10. §. Throughout this Membrane, the Vessels contained in the Seed-Branch are distributed. Beginning a little below the smaller end of the Coat or Membrane, they thence fetch their circuit both ways round about, just beneath the Surface of the Membrane, and at last, meet in the middle of the greater end, where they are all inoculated, so as to make a kind of umbilical Node. From whence they strike deeper into it, and at last, into the middle Membrane, in which they presently become invisible. By these Vessels, the Sap is brought and spewed into the middle Membrane. So that the outer Membrane seemeth, in some respects, to be answerable to the Placenta in Animals.

11. §. The middle Membrane, is derived from the bottom of the Outer. From whence especially, but also round about, the Bladders hereof (all angular) are more and more amplified towards the Centre; most of them being at least two hundred times bigger, than those of the Outer Membrane: whereby it looks, through a Glass, not unlike a Coome full of Honey: or in regard of their great transparence, like a company of little Crystal Pans full of a pure Lymph.

12. §. This Middle Membrane, is properly so called, from the state and condition it hath, upon the Augmentation of the Seed, at which time, it obtains the nature of an Involucrum. But originally, it is every where entire, without any Hollow, filling up the Cavity of the Outer Membrane, like a soft and delicate Pulp. After a short time, there
there appears in it a small Ducles or Channel; which runs from the bottom to the top, like an Axis, through the middle of it. At first, Tab. 81., no wider than to receive the Hair of a Man’s Head; not visible, except in a slice hereof cut transversely, and viewed in a Glass. Being grown a little wider, it may be seen, if the Membrane be dextrally cut by the length. At which time, it is also dilated into two Oval Cavities, one at each end: which are as two little Cisterns, whereinto a most pure Lymph runs continually owzetth, and is therein reserved for the nourishment of the Seed; and through the Channel which runs between the Cisterns is emptied out of one Cistern into another, according as the Seed or the Innermost Membrane hath need of it: i.e. as the Weather and other Circumstances do more or less accelerate their Growth, and so render the Lymph useful to them.

13. §. A few days after this, the Innermost Membrane begins to appear; growing, like a soft Node or Bud, out of the upper Cistern; to the lower end of which it is joined by a short and tender Stalk, from whence it is produced into a Conic oval Figure, answerable to that of the Cistern.

14. §. This Membrane, though soft and full of Sap, yet being compared with the midlemoft, is a close and compact Body, composed of Bladders above 300 times smaller than they are in that: Whereby, as the Seed is so well guarded, as not to be supplied with any part of the Lymph, but the purest: so neither with any more of this, than will suffice, without the danger of making an Inundation out of so great a Lake.

15. §. This Membrane, if it be pulled with a most steady hand, and very gently, upwards, it will draw a small transparent string after it to the bottom of the Midle Membrane: The said string though for the greater part, Parenchymous, yet being strengthened with the admixture of some Lignous Fibres; no otherwise visible in either of these two Membranes. So that they seem, to be a small portion of those which are inoculated at the bottom of the Outer Membrane, and thence produced through the midlemoft, underneath the Channel, till at last they break forth into the upper Cistern, where they form this Inner Membrane: a piece of close-wrought Work, suitable to the incomparable fineness of all the Stuff out of which it is made.

16. §. The same Membrane is originally entire, as the Midlemoft: but being grown to about the bigness of a Carvi-Seed, becomes a little hollow near the Cone. And the Lignous Fibres above-said, fetching their compails from the Base, shoot forth into the Cone; and so make a very small Node therein, for the first Essay towards the Generation of the Seed. The said Fibers being thus spun out, to the utmost degree of fineness for this purpose.

17. §. This Node, being grown about 4th part as big as a Cheese-Mite; it begins next to be divided by a little indenture at the Top, Tab. 81. Which growing by degrees full deeper, the Node is hereby at length distinguished into two Lobes or thick Leaves.

18. §.
The Anatomy

Book IV

18. §. So soon as these are finished, their Buds begins afterwards to be contracted, and so to be formed into a Radicle or that part of the Seed which becomes the Root. As the Stalks of Fruits do grow longer, while the Fruits themselves are expanded. So that in this estate, the Radicle is, as it were, the Stalk of the Seed.

19. §. At this time, the Seed being extremely small, the Lobes are not so manageable as to be separated one from the other. But it is most reasonable to suppose that so soon as the Radicle is finished, the next step is the pulling forth of another Node, between the Lobes, in order to the making of a Bud, and so the perfection of the Seed.

20. §. This being done or in doing, the Radicle or Stalk of the Seed, contracting still more and more at the bottom, hangs at the Inner Membrane, only by an extremely small and short Ligament or Novel-String. Which at last, also breaks; and so the Seed, as Fruits when they are ripe, falls off and lies loose in the Inner Membrane; this gradually shrinking up and so becoming more hollow, to make room for the further Growth of the Seed.
Several
LECTURES
Read before the
ROYAL SOCIETY

By NEHEMIAH GREW M.D. Fellow
of the ROYAL SOCIETY, and of the
COLLEGE OF PHYSICIANS.

LONDON,
Printed by W. Rawlins, 1682.
THE TITLES
Of the following
LECTURES.


II. Of the LUCTATION arising upon the Mixture of several Menstruum's with all sorts of Bodies. The second Edition.

III. An Essay, Of the various Proportions, wherein LIXIAL SALTS are found in Plants.

IV. Of the ESSENTIAL and MARINE SALTS of Plants.

V. Of the COLOURS of Plants.

VI. Of the Diversities and Causes of TASTS chiefly in Plants. With an Appendix, Of the ODOURS of Plants.

VII. Experiments in Consort, upon the SOLUTION of SALTS in Water.
TO THE
Right Honourable
WILLIAM
Lord Vi-Count BROWNECKER,
PRESIDENT
OF THE
Royal Society.

MY LORD,

NE Reason why I Dedicate the following Discourses to Your Lordship, is, For that by Your great and undeserved Respect, You have obliged me to do no less.

Another, my Lord, is, Because I could not but Publicly return Your Lordship Thanks, for minding the Royal Society of so good a Way, they are lately resolved upon, for the Management of a great part of their Business. Wherein, my Lord, I do more than presume, that I also speak the Sense of the whole Society; I think, not any one excepted.

I may with the same Confidence intimate, my Lord, how happy they account themselves, in having a Person so fit to preside their Affairs, as Your Lordship. The Largeness of your Knowledge, the Exactness of your Judgment, the Evenness of your Conduct; being some of those necessary Qualifications, which His Majesty had in His Eye (as right well understanding what He did) when He fixed His Choice upon Your Lordship.

I know, my Lord, that there are some men, who have
just so much Understanding, as only to teach them how to be Ambitious: The Flattering of whom, is somewhat like the Tickling of Children, till they fall a Dancing. But I also know, that Tour Lordship unconcerneth Tour self as much, in what I even now spake; as Caesar did himself, when his Souldiers began to style him King. For as he said, Non Rex, fed Caesar: So let Tour Lordship be but once nam'd, and all that follows, is but a Tautology to what You are already known to be. Tour being President of the Royal Society; Tour being the First that was Chosen, and Chosen by so Knowing a Prince; becomes so real a Panegyrick to Tour Lordship, as leaveth Verbal ones without any found.

Whence, my Lord, I have a third Reason most naturally emergent, which is, That I dare to submit my self, as to what I have hereafter said, to Tour Lordships Censure. Tour being so able and just an Arbitr oi betwixt the same and all those Persons therein concern'd; that You can neither be deceived, nor corrupted, to make a Judgment in any Point, to the Injury of either.

And truly, my Lord, were it only from a Principle of self-Interest, yet I could not desire it should be otherwise. For the World, if it lives, will certainly grow as much more knowing than it is; as it is now more, than it was heretofore. So that we have as little Reason to despise Antiquity; as we can have willingness, that we our selves should be despised by Posterity.

Yet some difference there is to be made; viz. betwixt those of all Ages, who have been modestly ignorant; and those who have thought, or pretended, that they were Omniscient. Or if knowing and acknowledging that they were Ignorant; have yet not been contented to be so; unless, with as good manners, as sense, they did conjure all Mankind not to offer at the knowing any more than themselves.

Upon the whole, my Lord, I desire not You should be a Patron, any further than You are a Judge. For if this small Effay hath deserved the least acceptance, I am sure, that in being one, You will be both.

My Lord,
Your Lordships most Faithful and Obedient Servant,

NEHEMIAH GREW.
HAVING the honour to perform the Task of this day; I shall endeavour to conform to the Philosophy, which this Society doth profess; which is, Reasoning grounded upon Experiment, and the Common Notions of Sense. The former being, without the latter, too subtle and intangible; the latter without the former, too gross and unmanageable: but both together, bearing a true analogy to our selves; who are neither Angels, nor mere Animals, but Men.

The Subject I have chosen to speak of, is Mixture. Whereof, that our Discourse may be the more consistent, and the better intelligible; all I have to say, shall be ranged into this Method; viz.

1. First, I shall give a brief account of the received Doctrine of Mixture.

2. Next, lay down some Propositions of the Principles whereof all Mixed Bodies consist.

3. Then, open the true Nature of Mixture; or say, What it is.

4. And then enumerate the Causes of Mixture; or say, How it is made.

5. Lastly, I shall shew the Power of Mixture; or, What it can do.
C H A P. I.

Of the received Doctrine of Mixture.

First, As to the received Doctrine of Mixture; not to trouble you with tedious quotations of what Aristo1e, Galen, Fernelius, Scaliger, Senecius, Riveius, and other learned men say hereof; we may suppose the whole summed up in that Definition which Aristotle himself hath given of it, and which the greater number of his Followers, have almost religiously adhered to; viz., that his, τῶν μετὰ ἀλλοιωθόν ἑνώμεν, that is, of the received Volume of Mixture. Which Definition, as it is usually explained, is both Unintelligible, and Unuseful.

Cap. ult. 2. §. Two things are unintelligible: what they mean by Alteration, and what by Union. In this Alteration, they say, That the very forms of the Elements are altered. And therefore lay it down for an Axiom, quod in Mixto, Formae Elementares tantum sunt in potentia; but let us see the consequence. For if in a mixed body, the forms of the Elements are but in potentia; then the Elements themselves are but in potentia; for we all say, Forma dat esse. And if the Compounding Elements, are only in potentia; then the Compounded Body itself can be only in potentia: yet to say it is no more, is most absurd.

3. §. As for the Union of Elements in a mixed body; they make it such, as brings them at last to affect, the Penetration of Bodies, and that the Union of mixed Bodies is nothing else. For they say it is made in such sort, that every particle of the mixed Body, partake of the Nature of the whole. Which Nature, arithem from the contemplated qualities of the four Elements. Whence they conclude, That every particle of the mixed Body, containeth in itself all the four Elements. Which is plainly to affect a penetration of Bodies. For every Element is, at least, one particle; if therefore every particle of the mixed Body, containeth four Elements; then four particles are but one. I conclude then, That the received Doctrine of Mixture is Unintelligible.

4. §. Whence it follows, That it is also barren and Unuseful. For who can make any use of that which he understandeth not? And the experience of so many years, wherein it hath been ventilated by the disputes of men, proveth as much: Scarcely any of them, except the learned Senecius, daring to venture upon Experiment, for fear they should come to understand themselves.

5. §. It is confessed, that many gallant things have been found out by artificial Mixture. But no thanks to this Definition of it. For as an Ignorant Man may make bad Work, and a good Rule be never the worse; so one that is Ingenious may make good Work, and a bad Rule be never the better. The question is not, what have men done? but what have they done upon this foundation, quod Mixtio fit misticlibitum alteratorum unio. Had this ever taught them to do anything, even so much as to make the Inde wherewith they have wrote, all their Disputes? I confess, they would have had something to show for it. But the truth is, their notions of Mixture, have been so far from doing us any good, that they have done us much harm: being, through their seeming subtlety, but real absurdity, as so many phantastick spectrums, serving only to affright men from coming near them, or the Subject whereof they treat.

6. §.
Lect. I. Of Mixture. The Principles, &c. 223

§. 6. I shall therefore endeavour to open the true Nature of Mixture. And I shall build my Doctrine upon the Common Notions of Sense: which none can deny; and every one may conceive of. In order to which, I shall take leave to lay down some Propositions, of the Principles of all mixed Bodies.

CHAP. II.

Of the Principles of Bodies.

And first, by Principles, I mean Atomes, or certain Sorts of Atomes, or of the simplest of Bodies. For otherwise they would not be Principles, for a compounded Principle, in strict speaking, is a Contradiction. Even as Fives, Threes, or Two's are not the Principles of Number, but Units.

2. §. Whence, secondly, it follows, that they are also Indivisible. Not Mathematically; for the Atomes of every Principle have their Dimensions. But Physically; and so, what is but one, cannot be made two. If it be asked, Whether a Stick cut with a Knife, be not of one, made two? I say, that a Stick, is not one Body, but many millions of Bodies; that is, of Atomes; not any one whereof is divided within itself, but only they are separated one from another, where the Knife forceth its way. As in the drawing of a man's Finger through a Heap of Corn; there is no Division made in any one Grain, but only a Separation of them one from another, all remaining still in themselves entire. I say, therefore, that what is Physically one, is also most firm, and Indivisible, that is, Impenetrable: for Penetration is but the Separation, not the Division of Atomes.

3. §. Hence, thirdly, they are also Immutable. For that which cannot be divided, cannot be chang'd. So that of the whole World of Atomes, not any one hath ever suffer'd, or can suffer the least Mutation. Hereupon is grounded the Constancy of Causes and Effects. So that, in all Generations, it is not less certain, that the self same Principle is still propagated from the same; than, that Man is from Man. Wherefore, compounded Bodies are generated; but Principles are not, but only propagated; that is, in every Generation, they pass, in themselves unaltered, from one Body, into another.

4. §. If Principles, or Atomes, are all Immutable; it again follows, That they are of Divers Kinds. For one and the same Principle, or Kind of Atomes, will still make the same Thing, and have the same Effect: so that all Generations would then be the same. Wherefore, since they are Immutable, they must be Divers.

5. §. This Diversity, for the same reason, is not small, but very Numerous. For as the World, taken together, is Nature's Shop; so the Principles of Things are her Tools, and her Materials. Wherefore, as it speaks the goodness of a Shop; so the Perfection of the Universe. That it is furnished with many Tools wherewith, and many Materials whereunto to work. And consequently, that Philosophy beareth beft its own name; which doth not strain all to two or three Principles, like two or three Bells.
The Principles of Bodies.  

Book IV.

Bells in a Steeple, making a pitiful Chime: but tryest to rise up to Nature's own Number, and so to ring all the Changes in the World.

6. 6. Yet doth not this vast Diversity take away the Regimen and Subordination of Principles. There being a certain lesser number of them, which either by their greater quantity, or other ways, have Rule and Dominion, in their several Orders, over all the rest. For where-ever the Subject is Multitude, Order is part of its Perfection. For Order is Proportion. And how can Nature be imagin'd to hold Proportion in all things else, and not here? Wherefore, as certainly, as Order and Government are in all the Parts of the Rational; so certainly, of the Material World. Whence it is, That although the Species of Principles be very numerous; yet the Principles called Galenical, Chemical, or any others, which do any way fall under the notice of Sense, are notwithstanding reducible to a smaller number: viz. according to the number of Predominant Principles in Nature; or, rather in this part of the Universe which is near and round about us. To the Power and Empire whereof, all other Principles do submit. Which Submission, is not the quitting of their own Nature; but only their appearance under the external Face or Habit of the said Predominant Principles.

7. 8. As there can be no Order of Principles, without Diversity; so no Diversity, but what is originally made by these two ways; i.e. by size and Figure. By these they may be exceeding different: and all other Properties besides, whereby they differ, must be dependent upon these Two.

8. 9. Nor therefore, can they be of any other Figures, than what are Regular. For Regularity, is a Similitude continued. Since therefore all kinds of Atomes are divers only by their size and Figure; if the felie name size and Figure were not common to a certain number of Atomes, they could not be laid to be of any one kind: and consequently, if there were no Similitude of Atomes, there could be no Distinction of Principles.

9. 10. Hence also, these two Modes of Atomes, viz. their size and Figure, are the true, and only original Qualities of Atomes. That is, an Atome is such or such, because it is of such a certain size and Figure.

10. 11. Lastly, As these two Modes, taken severally, are the Qualities of an Atome: so consider'd together, they are its Form. A substantal Form of a Body, being an unintelligible thing. I say of a Body; for although the Rational Soul be a substantal Form; yet is it the Form of a Man, and not of a Body. For the Form of a Body, we can conceive of no otherwise, than as of the Modification of a Body, or a Composition of all the Modes of a Body. Which also agrees with that Definition of a Form, which amongst the Peripatick Philosophers is well enough accepted, viz. quod sit, Ratio ejus Effentiae, que unique Rei competit. Which Ratio, if it be referred to a Body, what is it, but the Modification of that Body? Having thus proposed a Summary of my Thoughts about Principles; I shall next proceed to shew what their Mixture is.
ND first of all, from the Premises, we arrive at this Conclusion; 5. That the Formation and Transformation of all Bodies, can be nothing else, but the Mixture of Bodies. For all Principles are immutable; as we have above proved: and therefore not generable, formable, or transformable. And the Forms of Principles, being but their Modes, are also immutable. Ch. 2. § 3.

So that the whole Business of the Material World, is nothing else, but Mixture.

2. §. Again, as Nature worketh everywhere only by Mixture; so is this Mixture everywhere but one thing, and can be but one. For whether it be the Mixture of great Bodies, or of small; of Compounds, or of Atomes: it is everywhere Mixture, and the Mixture of Bodies.

Wherefore, Mixture is either an intelligible Affection of all Bodies, or of none; which later, no man will say. As many ways therefore, as we can see, or conceive the Mixture of any great Bodies, which we hold in our hand; so many ways we may, of the sublimest Mixture which Nature maketh, or of Atomes themselves; and no other ways.

3. §. Now all the ways we can distinguish Mixture by, are, in general, these Two; either in respect of the Bodies mixed, or else of the Modes of the Mixture itself.

4. §. In respect of the Bodies Mixed, Mixture is distinguished also; two ways; viz. by Conjugation, and by Proportion.

5. §. By Conjugation, I mean, a Mixture of some certain Principles, and not of others. Which is threefold. First, As to Number: as when one Body may be compounded of two Principles, another of three, a third of four, a fourth of five, and so on. Secondly, As to Kind: where, though there be a conjunction of the same Number, yet not of the same Kind. Thirdly, When they differ from one another both in Number and Kind. So many ways the Principles of Bodies may be conceived to be Conjugated: and therefore are: for here, that which may be, is. The Consequence is clear.

For if, Nature hath various Materials wherewith to make these Mixtures; as we have shewed. Secondly, By these Mixtures the easy, and without the concurrence of any imaginary Forms, must produce all the varieties in the material World; as likewise hath been said. Wherefore, since all imaginable Mixtures may be made, and that to some purpose; if they should not be so, Nature would be Imperfect: because we our selves can think, how the might put her Materials to further use, then so the would do. To think therefore, that all Kinds of Principles, or all Elements go to make up every Compound Body, as by the Peripatetic Philosophy, we are taught: is a conceit, no more to be credited, than one that should tell us, all Kind of Wheels and other Parts
The Nature of Mixture.

6. Secondly, The Mixture of Principles is diversifid, as by Conjugation, so also by Proportion. That is, by the divers Quantities, of the several Principles or Parts mixed together. As if the Quantity of one, were as five to ten; of a second, as five to fifteen; of a third, as five to twenty; &c. Or if that of one, be as five to six; of a second, as six to seven; of a third, as seven to eight. By which, and by other Proportions, Mixture may be varied innumerable ways.

7. Again, As Mixture is varied with respect to the Bodies Mixed; so likewise in respect of the Mixture itself, which I call the Location of Principles, or the Motes of their Conjunction. Which may be various, as well as their Conjugation and Proportion. Yet are they all reducible unto two general Modes: all Bodies, and therefore all Principles, being mixed either by Meditation, or by Contact.

8. Now all Contact, whether of Compounds, or of Atomes, can be no other way, than such as is answerable to their Figures. Whereof, therefore, we can conceive but three general ways, viz.

First, By Contact in a Point, or some smaller part: as when two Atomes meet, which are globular or otherwise globous. Secondly, By Contact in a Plain: as in the conjunction of the sides of Triangular or Quadrangular Atomes, or otherwise flat. Thirdly, By Contact in a Concave: as when one Atom is admitted into the Concave or hole of another; as a Spigot is into a Fosset. The first may be called, Apposition; the second, Application; the third, Reception or Incorporation.

9. In the two last ways, Atomes may be joined by Meditation; but each of all the left. As when the two extremes of one Atom are received into the Concaves or the holes of two others.

10. And these are all the general ways, whereby we can conceive Bodies to be Mixed together; so, by their various Conjugation, Proportion and Location. So that the Composition of Atomes, in Bodies; is like that of Letters, in Words. What a Thunderclap would such a Word be, wherein all the four and twenty Letters were pack'd up? One therefore is compounded of more, another of fewer: this of some, and that of others: and both the Conjugation, Proportion, and Location of Letters is varied in every Word: whereby, we have many thousands of differing Words, without any alteration at all, in the Letters themselves; and might have ten times as many, more. In like manner, therefore, or in the same analogous way, as the Letters of the Alphabet, are the Principles of Words; so Principles, are the Alphabet of Things.

11. What we have said of Principles; and of Mixture as consequent thereupon; may be a foundation for an intelligible account, of the Nature and Causes of most of the Innate Properties, and Qualities of bodies; as of Gravity, Levity, Fixity, Fluidity, Angularity, Roundness, Heat, Cold, Blackness, Whiteness, Sovereignty, Sweetness, Fragrancy, Fetidness, and very many more. I say an intelligible account; for such as is grounded upon the Notions of Sens, and made out Mechanically. But the exemplification hereof, being too large a field for
for this, or any one Lecture, I shall, before I come to the Conjectures of Mixture, only deduce from the Premises; these following Corollaries.

12. §. First, That there is no alteration of Principles or of Elements in the most perfect Mixture of Bodies. It cannot be; for Principles are Immutable, as we have said. And if it could be, yet it needeth not to be; for they are many, and compoundable infinite ways; as hath been shewed. So that we have no need to perplex our selves with any of those difficulties, that arise from the Doctrine of the Alteration of Elements. The ground of which conceit, is that, of three being but four Elements, and all in every particle of the mixed Body. And so men being puzzled, how from thence to make out the infinite variety of Bodies, they figned them to be alterable, and altered, upon every perfect Mixture. Not considering, that if their four Elements be alterable, as few as they are, no fewer then three of them may be spared: for one Element, if alterable, may be made any.

13. §. Hence, Secondly, may be solved that great Dispute, Whether such as we call Lixivial Salts, are made by the fire? For first, No Principle is made by the fire: all Principles being unalterable; and therefore unmakable. Secondly, We must therefore distinguish between the Principle, and its various Mixture with other Principles; from whence it may receive different Shapes and Names. Wherefore, a Lixivial Salt, qua Lixivial, is certainly made by the fire. But quatuor Salts, it is not: that Principle being extractable out of most Bodies; and by divers other ways, then by the fire. For whether you calculate a body, or else ferment it, (after the manner shewed by the curious Improver of Chemical Knowledge, Dr. Daniel Cox) or put it under ground, or drown it in the Sea; it still yieldeth some kind of Salt. All which Salts are made, not by making the Saline Principle; but only by its being differently Mixed, by those several ways of the Solution of Bodies; with other Principles: from which its different Mixture, it receives the various Denominations, of Marine, Nitreous, Volatile, or Lixivial.

14. §. Hence, Thirdly, the most perfect Mixture of Bodies, can go no higher than Contact; For all Principles are unalterable; and all Matter is imperceptible; as hath been said. In the most visible and laxe Mixture, there is Contact; and in the most subtle and perfect, as in Generation it self, there is nothing more.

15. §. Hence, Fourthly, we easily understand, how divers of the fame Principles, belonging both to Vegetables and many other Bodies, are also actually existent in the Body of Man. Because even in Generation or Transmutation, the Principles which are translated from one Body to another, as from a Vegetable to an Animal, are not in the least altered in themselves; but only their Mixture, that is, their Conjunction, Proportion and Location, is varied.

16. §. Hence also the difference of Mixture, arising from the difference of Contact, is intelligible; so as to those three degrees, Congregation, Union, and Concentration.

Congregation, and Inconstant Mixture, is when the several Atomes touch but in a Point, or smaller part. In which manner, I have divers arguments, inducing me to believe the Atomes of all Fluid Bodies, qua Fluid, do touch, and in no other.
The Nature of Mixture

Ch. 3. § 8. *Union,* is when they touch in a Plain. As in the crystals and shootings of all Salts, and other like Bodies. For if we pursue their divided and subdivided parts, with our eye, as far as we can; they still terminate, on every side, in Plains. Wherefore, 'tis intelligible, That their very Atomes do also terminate, and therefore touch, in Plain.

Concentration, is when two, or more Atomes touch by Reception.

Ch. 3. § 8. and Infrusion of one into another: which is the closest, and finest Mixture of all; as in any fixed unendurable, or unstable Body: the Atomes of such Bodies, being not able to make any Smell or Taste, unless they were first dissolved; that is to say, unpin'd one from another.

17. §. Hence, Sixthly, we understand, how in some cases, there seemeth to be a Penetration of Bodies; and in what sense it may be admitted: viz. if we will mean no more by Penetration, but Infrusion. For the Infrusion of one Atome into the Concave or hole of another, is a kind of Penetration; whereby they take up less room in the mixed Body, then they would do by any other way of Contact.
As a naked knife and its sheath, take up almost double room, to what they do, when the knife is sheathed. Whence we may assign the reason, Why many Liquors being mixed; take up less room or space, then they did apart; as the Ingenious Mr. Hook, hath made it to appear by Experiment, that they do. I say the plain reason hereof, or at least one reason, is the Infrusion of many of their Atomes into one another. Which yet is not a Penetration of Bodies strictly so called.

18. §. Seventhly, If all that Nature maketh, be but Mixture; and all this Mixture be but Contact; 'tis then evident, That Natural and Artificial Mixture, are the same. And all those seeming subtles whereby Philosophers have gone about to distinguish them; have been but so many Scarcrows to affright Men from the Imitation of Nature.

19. §. Eighthly, Hence it follows, That Art it self may go far in doing what Nature doth. And who can say, how far? For we have nothing to Make; but only to mix those Materials, which are already made to our hands. Even Nature her self, as hath been said, maketh nothing new; but only mixeth all things. So far, therefore, as we can govern Mixture, we may do what Nature doth.

20. §. Which that we may still the better understand; let us before, and in the next place, see the Causes of Mixture. For since Natural and Artificial Mixture are the same; the immediate Causes of both, are and must be the same.
C H A P. IV.

Of the C A U S E S of Mixture.

Now all the Causes of Mixture we can conceive of, must, I think, be reduced to these six in general: viz. Congruity, Weight, Compression, Solution, Dissolution, and Agitation.

1. Congruity, or aptitude and responscence between the Sizes and Figures of Parts to be mixed: whereby Bodies may be truly called the Instrumental Causes of their own Mixture. As when a Plain answers to a Plain, a Square to a Square, a Convex to a Concave, or a Left to a Greater or an Equal, &c. according to which Respondencies in the parts of Bodies, they are more or less easily minglable.

2. Weight, by means whereof all Fluid Bodies, upon supposition of the Congruity of their parts, must unavoidably mingle.

3. Compression; which either by the Air, or any other Body, added to Weight, must, in some degree, further Mixture. Because, that Weight itself, is but Pression. For further Proof of all the said Causes, I made this Experiment: Let Oyle of Anisceda, and Oyl of Vitriol be put apart into the Receiver of an Air-Pump. And, having exhausted it of the Air, let the two said Oyls be then applied one upon the other. Whereupon, First, it is visible, that they here mix and conglute together; that is, their parts are wedged and intruded one into another, without the usual compression of the Air; for that is exhausted, and therefore only by the Congruity of their receiving and intruding parts; and by their Weight, by which alone they are so compressed, as to make that Intrusion. Secondly, It is also evident, That although they do Conglute; yet not altogether so much, as when poured together in the same manner, and quantity, in the open Air. Wherefore, Compression, whether made by the Air, or any thing else, as it doth further the Dissolution of some Bodies, so the Mixture of others, and the greater the Compression, the more.

4. Solution; For all Bodies mix best, in Forma fluida. And that for two reasons. First, Because the parts of a Body are not then in a state of Union, but of Separation; and therefore, in a more capable state, for their Mixture and Union with the parts of another Body. Secondly, because then they are also in a state of Motion, more or less; and therefore, in a continual tendency towards Mixture; all Mixture being made by Motion. Wherefore all Generations, and most perfect Mixtures in Nature, are made by Fluids: whether Animal, Vegetable, or Mineral. Which is also agreeable to the Doctrine of the Honourable Mr. Boyle, in his Excellent Treatise of the Nature and Virtues of Gems. And it is well known, That Bodies are ordinarily petrified, or Stones made, out of Water. That is, out of petrifying parts dissolved per minimas in Water, as both their Membrum and their Vehicle. Wherefore, if we will talk of making Gold, it must not be by the Philosophers Stone, but by the Philosophers Liquor.

5. §. Di-
5. §. Digestion. For which there is the same reason, as for Mixture, by Solution. For, First, All heat doth attenuate, that is, still further separate the parts of a Body; and so render them more mingles with the parts of another. And therefore, Secondly, Doth also add more Motion to them, in order to their Mixture.

6. §. Agitation. Which I am induced to believe a great and effectual means of Mixture, upon divers Considerations. As, First, That the making of Blood in the Bodies of Animals, and the mixing of the Chyle therewith, is very much promoted by the same means; so by the Agitation of the parts of the Blood and Chyle, in their continual Circulation. Again, from the making of Butter out of Milk, by the same means; whereby alone is made a separation of the oleous parts from the Whey, and Conjunction of the Oleous together. Moreover, From the great Effects of Digestion, well known to all that are convenerant in Chymical Preparations, Which Digestion it self, is but a kind of insensible agitation of the parts of digested Bodies. 'Tis also a known Experiment, That the readiest way to dissolve Sugar in Wine or other Liquor, is to give the Vessel a half turn, together with a smart knock; against any hard and steady Body: whereby all the parts of the Sugar and Liquor, are put into a vehement Agitation, and so the Sugar immediately dissolved, and mixed with the Liquor. And I remember, that having (with intent, to make Mr. Matthews's Pill) put some Oyl of Turpentine and Salt of Tartar together in a Bottle, and sent it up hither out of the Country; I found, that the continual Agitation upon the Road, for three or four days, had done more towards their Mixture, than a far greater time of Digestion alone had done before. And it is certain, That a vehement Agitation, especially, if continu'd, or joyned with Digestion, will accelerate the Mixture of some Bodies, ten times more, than any bare Digestion alone; as may be proved by many Experiments. I will instance in this one. Let some Oyl of Turpentine and good Spirit of Nitre be stop'd up together in a Bottle, and the Bottle held to the Fire, till the Liquors be a little heated, and begin to bubble. Then having removed it, and the Bubbles by degrees increasing more and more; the two Liquors will of themselves, at last fall into so impetuous an Ebullition, as to make a kind of Explosion; sending forth a smoke, for the space of almost two yards high. Whereupon, the parts of both the Liquors, being violently agitated, they are, in a great portion, incorporated into a thick Balsam; in a moment: and that without any intense heat, as may be felt by the Bottle. And thus much for the Causes of Mixture.
CHAP. V.

Of the POWER and USE of Mixture.

HAVING enumerated the general Causes, we shall, lastly, enquire into the Power and Use of Mixture; or, into what it can Do and Teach. And I shall Instance in six particulars. First, to Render all Bodies Sociable, whatsoever they be. Secondly, To Make Artificial Bodies in Imitation of those of Nature's own production. Thirdly, to make or imitate the sensible Qualities of Bodies; as Smells, and Tastes. Fourthly, To make, or imitate their Faculties. Fifthly, It is a Key, to discover the Nature of Bodies. Sixthly, To discover their Use, and the Manner of their Medicinal Operation.

INSTANCE I.

First, To render all Bodies Sociable or Mingleable: as Water with Oyl, Salt with Spirit, and the like. For Natural and Artificial Mixture, are the same; as we have before proved. If therefore Nature can do it, as we see in the Generation of Bodies she doth, 'tis likewise in the Power of Art to do it.

2. §. And for the doing of it, two general Rules result from the Premises. §. The Application of Causes, and the Choice of Materials. As for the Causes, they are such as I have now instanced in. And for the Application of them, I shall give these two Rules.

3. §. First, That we tread in Nature's steps as near as we can: not only in the Application of such a Cause; as may be most proper for such a Mixture; but also in allowing it sufficient time for its effect. For so we see Nature her self, for her more perfect Mixtures, usually doth. She maketh not a Flower, or an Apple, a Horse, or a Man, in a moment; but all things by degrees, and for her more perfect and elaborate Mixtures, for the most part, the requireth more time. Because all such Mixtures are made and currid on per minima; and therefore require a greater time for the compleating of them.

4. §. A second Rule is, Not only to make a due Application of the Causes; but sometimes to Accumulate them. By which means, we may not only, imitate Nature, but in some cases, go beyond her. For as by adding a Graft or bud to the Stock, we may produce Fruit, sooner, and sometimes better, than Nature by the Stock alone would do: So here, by accumulating the Causes of Mixture, that is, by joyning two, three, or more together; or by applying more in some Cases, where Nature applyeth fewer, we may be able to make, if not a more perfect, yet a far more speedy Mixture, than Nature doth. As by joyning Compression, Heat, and violent Agitation, and so continuing them all together, by some means contrived for the purpose, for the space of a Week,
Week, or Month, or longer, without cessation. Which may probably produce, not only strange, but useful Effects, in the Solution of some, and the Mixture of other Bodies. And may serve to mix such Bodies, as through the small number of their congruous parts, are hardly minglable any other way. Agitation being, as carrying the Key to and fro, till it hit the Lock; or within the Lock, till it hit the Wards.

5. Secondly, For the Choice of materials, if they are not immediately, that is, of themselves, minglable; we are then to turn one

Ch. 3. § 9. Species of Mixture into a Rule; which is, To mix them by mediation of some third, whether more simple or compounded Body, which may be congruous in part to them both: as Sulphurous Salts are to Water and Oyl; and are for that reason minglable with either of them. Or, By any two congruous Bodies, which are also, in part, congruous to two others: and other like ways. Whereby the parts of Bodies, though never to heterogeneous, may yet be all bound and locked up together. Even as twenty Keys may be united, only by uniting the two Rings whereon they hang.

6. The Consideration of these things, have put me upon making several Experiments, for the mingling of heterogeneous Bodies. I shall give two Examples of Tisyal; the one upon Fluid, the other upon consistant Bodies.

7. § For the first, I took Oyl of Anisfeeds, and pouring it upon another Body; I so order'd it, that it was thereby turned into a perfect milk-white Balsam, or Batyr. By which means the said Oyl became minglable with any Winy, or Watery Liquor; easily, and instantaneously dissolving therein, in the form of a milk. And note, That this is done, without the least alteration of the Smell, Taste, Nature, or Operation of the said Oyl. By somewhat the like means, not only Oyl of Anisfeeds, but any other inflammable Oyl, may be transformed into a milk-white Batyr; and in like manner be mingled with Water or any other Liquor. Which is of various use in Medicine; and what I find oftentimes very convenient and advantageous to be done.

8. § Again, not only Fluid but consistant Bodies, which of themselves will mix only with Oyl; by due mixture with other Bodies, may be render'd easily dissoluble in Water as may Resin, and all resines and friable Gums. As also Wax: and this without changing much of their Color, Taste, or Smell. Whereof likewise, whatsoever others may do, the Physician may make a manifold Use.

INSTANCE II.

By Mixture also, we may be taught to Imitate the Productions of Nature. As to which, from what we have before said of Mixture, we may conclude; That there is no Generation of Bodies unorganical, but what is in the Power of Mixture to imitate. As of Animals, to Imitate Blood, Fat, Chyle, Spittle, Flegm, bile, &c. Of Vegetables, to Imitate a Milk, Mucilage, Resin, Gum, or Salt. Of Minerals, to Imitate Vitriol, Alum, and other Salts; as also Metals, and the like.

2. § I do not say, I can do all this; yet if, upon good Promises, we can conclude this possible to be done; it is one step to the doing of it. But I will also give an Instance of somewhat that may be done in every kind. And,
3. §. First, For the Imitation of an Animal Body, I will instance in Fat. Which may be made thus: Take Oyl Olivar, and pour it upon high Spirit of Nitre. Then digest them for some days. By degrees, the Oyl becomes of the colour of Marrow; and at last, is congealed, or hardened into a white Fat or Butter, which dissolves only by the fire, as that of Animals. In converting Oyl thus into Fat, it is to be noted, that it hardens most upon the exhalation of some of the more Sulphurous parts of the Spirit of Nitre. Which I effected, well enough for my purpose, by unsnipping the glass after some time of digestion; and so suffering the Oyl to dissolve and thicken divers times by successive heat and cold. Hence, The true Concealing Principle, is a Spirit of Nitre separated from its sulphur. For the better doing whereof, the Aer is a most commodious Mensstrum to the said Spirit of Nitre. Whence also, if we could procure such a Spirit of Nitre, we might congeal Water in the midst of Summer. We might also refrigerate Rooms herewith Artificially. And might Imitate all frothy Meteors. For the making of Fat, is but the Durable Congealing of Oyl: which may be done without froth, as I have shewed how.

Hence also it appears, That Animal Fat itself, is but the Cordling of the Oily parts of the Blood; either by some of its own Saline parts; or by the Nitreous parts of the Aer mingled therewith.

Hence likewise it is, That some Animals, as Comies, and Field-shears, grow fatter in frothy weather: the oily parts of the blood, being then more than ordinarily congealed, with a greater abundance of nitrous parts received from the Aer into their bodies.

For the same reason it is, That the Fat of Land-Animals is hard; whereas that of Fish is very soft, and runs all to Oyl, &c. Because the Water, wherein they live, and which they have instead of breath, hath but very few nitrous parts in it, in comparison of what the Aer hath.

4. §. Secondly, For the Imitation of a Vegetable Body, I will give three Instances; In Rosin, Gum, and a Lixivial Salt. The first may be made thus; Take good Oyl of Vitriol, and drop it upon Oyl of Anise-seeds; and they will forthwith incorporate together; and by degrees, will harden into a perfect Rosin; with the general and defining Properties of a truly Natural Rosinous Gum. Being not at all dissoluble in Water; or at least, not any more, then any natural Rosin or Gum: yet very easily by fire; as also highly inflammable; and exceeding friable. Although this Artificial Rosin, be the relict of two Liquors, both which very strongly affect the Sense, yet being well washed from the unincorporated parts, (which is to be done with some care:) it hath scarce any Taft or Smell.

The Concentration of these two Liquors, is likewise so universal, that the Rosin is not made by Precipitation, but almost a total Combination of the said Liquors; and that with scarce so much, as any visible fumes.

5. §. Again, Having taken a certain Powder and a Saline Liquor, and mixed them together in a bottle, and so digested them for some time; the Powder was at last transmuted to a perfect Oily Gum; which will also dissolve either in Oyl or in Water; in the same manner, as Galbanum, Ammoniac, and the like will do.

6. §. And Lastly, A Lixivial Salt may be imitated thus; Take Nitre, Oyl of Vitriol, and high spirit of Wine, of each a like quantity. Of these three Bodies, not any two being put together, that is to say, neither,
neither the Nitre with the Oyl, nor the Oyl with the Spirit, nor the Nitre with the Spirit, will make the least Ebullition; yet all three mingled together, make a very conspicuous one. The Spirit of Wine being as the Sulphur; and so that, and the Nitre together, standing, as it were, in the stead of an Alkaline, that is, a Sulphurous Salt, against the Oyl of Vitriol. Divers other Experiments may be shewn of the like Nature.

7. §. In the last place, for the Imitation of a Mineral Body, I will instance in two, viz. Nitre and Marine Salt; if I may have leave to reckon them amongst Mineral Bodies. As for Nitre, by mixing of four Liquors together, and then setting them to boil, I have obtained Crystals of true and perfect Salt; which have had much of a nitrous sort; and would be melted with a gentle Heat, as Nitre is; and even as easily as Buth or it self: I mean not, by the addition of any fort of Liquor, or any other Body, to dissolve it; but only by the fire.

8. §. And as for a Sea-Salt, that I might imitate Nature for the making thereof, I consider'd, That the said Salt is nothing else but that of Animals and Vegetables, freed from its true Spirit and Sulphur, and some Saline particles, specifically Animal or Vegetable, together with them. For both Animal and Vegetable Bodies being continually carried by all Rivers into the Sea, and many likewise by shipwreck, and divers other ways insinuated therein: they are at last corrupted, that is, their Compound parts are opened and resolved. Yet the Resolution being in the Water, is not made precipitately, as it is in the Air, but by degrees, and very gently; whence the Sulphurous and other Volatile parts, in their Assolution, make not so much haste, as to carry them more fixed Saline parts along with them; but leave them behind in the Water, which inhbiteth them as their proper Menstruums.

And the Imitation of Nature herein, may be performed thus: Put as much of a Lixivial Salt as you please, into a wide-mouth'd Bottle, and with fair Water make a strong Solution of it; so as some part thereof may remain unresolved at the bottom of the Bottle. Let the Bottle stand thus for the space of about half or three quarters of a year, all the time stopped. In which time, many of the Sulphurous and other Volatile parts gradually flying away; the top of the unresolved Salt will be incrustate, or as it were frosted over, with many small and hard Concretions, which, in their nature, are become a true Sea-Salt. Whereof there is a double Proof: First, that most of the said Concretions are of a Cubical, or very like Figure. Especially on their upper parts; because having a fixed Body for their Basis, their under parts, therefore, contiguous thereto, are less regular. Whereas the parts of the Salt in the Sea, being environed on all sides with a Fluid; their Figure is on all sides regular. Secondly, In that a strong Acid Spirit or Oyl being poured upon a full body'd Solution thereof; yet it maketh therewith no Ebullition, which is also the property of Sea-Salt. And thus much for the more General Imitation of Bodies.
Lect. I. The Power and Use of Mixture. 235

INSTANCE. III, & IV.

FROM the aforesaid Premisses, and by the aforesaid Manner, there is no doubt to be made, but that also the other sensible Qualities of Bodies may be Imitated, as their Odors, and Tastes. And that not only the general ones, as Fragrant, or Astringent; but also those which are specific and proper to each a species of Bodies.

2. §. Thus for Example, by mixing Spirit of Nitre or Vitriol with rectified Oyl of Turpentine, and some other Vegetable Oyls, severally, and in due Proportion and Time, I have Imitated the Smells of divers Vegetables; as of Tanf'y, of Lignum Rhodion, and others. And I conclude it feabfe, To Imitate the Taste or Smell of Musk, or Ambergrice, or any other body in the world.

3. §. Hence also we may be Taught, How to Imitate the Faculties, as well as other Qualities of Bodies. The reason is, because even these have no dependance upon any substantial Form: but are the mere result of Mixture; effected by the same Causes, whether in Nature or Art; as I think I have made to appear in the foregoing Idea. And as in the Premisses of this Discourse hath been shew'd.

INSTANCE V.

FROM whence, again, it is likewise a Key to Discover the Nature of Bodies. For how far ever we can attain to Mingle, or to Make them, we may also know what they are.

2. §. For Bodies are minglesable, either of themselves, or by some Third. As to those which mingle of themselves, we may certainly conclude, That there is a congruity betwixt them, in some respect or other. So upon various Trials I find, That Essential Oyls do more easily imbibre an Acid, than an Alkaly. Whence it is evident, That there is some Congruity and Similitude betwixt Essential Oyls, and an Acid, which there is not betwixt the said Oyls and an Alkaly.

3. §. As to those that mingle only by some third; we may also certainly conclude, That though the two extremes are unlike; yet that they have both of them some congruity with that third, by which they are united.

4. §. Moreover, We may make a Judgment from the manner or Degree of Mixture. Thus the Acid Spirit of Nitre, as is said, will coagulate Oyl-Olive, and render it coagulent. Whence it might be thought, That any other strong Acid will do the like; and that therefore, there is no great difference in the Nature of the said Acid Liquors. But the contrary hereunto, is proved by Experiment. For having digested the same Oyl in the same manner, and for a much longer time, with strong Oyl of Sulphur; although it thence acquired some change of Colour, yet not any Confidence.

5. §. Again, Because the said Spirit of Nitre coagulates Oyl-Olive; it might be expected, it should have the same effect upon Oyl of Ani-feeds; or, at least, that if other Acids will Coagulate Oyl of Ani-feeds, that this should do it best. But Experiment proveth the contrary. For of all I have tried, Oyl of Vitriol is the only Acid that doth it instan-taneously. Oyl of Sulphur, if very strong, will do it; but not so join.
nor so much Aqua fortis, and Spirit of Salt, for the present, do not at all touch it. And Spirit of Nitre itself will not coagulate it, under eight or ten hours at least.

**INSTANCE VI.**

As T L Y, and consequently, it is a Key To Discover the Medicinal Use and Operation of Bodies. Thus, for Example, by the Imitation of Rosins and Resinous Gums, we certainly know what all of them are, and when, and wherefore to be used. For what are Mafigick, Frankincense, Olibanum, Benzoin, and other like Rosins, or Resinous Gums, for their principle and predominant parts, that is, quæ Rosins are Bodies resulting from Natural, in like manner, as I have shewed, they may be made to result, from Artificial Mixture? That is to say, the oleose, and Acid parts of Vegetables, being both affixed and mingled together, per minima, in some sort of vesels in a Plant, they thus incorporate into one consistient and friable Body, which we call Rosin.

2. §. Now from hence it is, That the said Rosins, and Resinous Gums, as also Amber and Sulphur, for the same Reasons are, of so great and effectual Use against most thin and salt Rheums, as, as they are Acidulose Bodies. For by their Acid parts, which in all these Bodies are exceeding copious, they mortifie and reftact those Salt ones, which feed the Rheums. And by their oleous parts, the same Salt ones are also Imbibed. Whence, they are all, in some degree, incorporatated together; that is, The Rheum is thickened: which is the desired effect.

3. §. Whereas, on the contrary, if the Cough proceed not from a thin, and specially a Salt Rheum, but from a Viscous Phlegm; the use of many other Bodies which are also more oleous, and abound not so much with an Acid, as these do, especially some of them, is more proper: such as tinct, in this Case, proving sometimes not only ineffectual, but prejudicial. Since the very CAUSE of the said Viscousnes of Phlegm, is chiefly some great Acidity in the Blood, or in some other part, as may be proved by divers Arguments.

4. §. Many more Instances might be hereunto subjourned: and may hereafter be offered to the acceptance of such, who are inquisitive into matters of this Nature. If I shall not herein anticipate, or reiterate the Thoughts and Observations, of those two Accurate and Learned Persons Dr. Willis, and Dr. Walter Needham, as to what the one hath already published, and both have put us in Expectation of. But the Instances already given, are sufficient to evidence what I have said. And, I hope, this present Discourse to prove, in some measure, thus much; That Experiment, and the Common Notions of Sense are prolix, and that nothing is Barren, but Phansey and Imagination.
An Appendix to the precedent discourse of Mixture.

A VING, in the first Edition of the foregoing Discourse, made mention of the preparation of Essential Oysls, so as to become easily mangleable with any unsoy Liquor. I shall here acquaint the Reader, That this may be done, by digesting any of the said Oysls with about an equal quantity of the Telk of an Egg, with a very soft heat, like that of the Meridian Sun in Summer, continued for the space of three Weeks or a Month; and in the mean time, to be now and then stirred a little together. The Telk will by degrees imbibe the Oyl, and at length be incorporated with it, and become a Base as white as milk, easily dissoluble in any watery or winy Liquor.

2. § 5. I confefs, that it will be very difficult to prepare any good quantity for use, this way. But this being a sufficient proof of the possibility of such a mixture; I considered, whether the application of some other forementioned Cause of Mixture, might not supply the defect of this; and hereupon, have made several successful trials; not only for the mixing of the said Oysls, but likewise of all sorts of Rojins and Gunns with any winy or watery Liquor, in great quantities, in a short time, and without much trouble. But for the mixing of some of them, the Telk of an Egg alone will not serve, without the intervening of some other sociable Body, according to one of the Rules given in the foregoing Discourse.

3. § 6. In the same Discourse, upon certain premises, I have laid down this following conclusion.

—— By accumulating the Causes of Mixture, that is, by joyning two or three or more together; or by applying more in some cases, where Nature applieth fewer; we may be able to make, if not a more perfect, yet a far more speedy Mixture, than Nature doth. As by joyning Compression, Heat, and violent Agitation, and so confining them altogether, by some means contrived for the purpose, for the space of a Week or Month, or longer without Ceftation. Which may probably produce, not only strange, but useful effects, in the Solution of some, and the Mixture of other Bodies.

4. § 7. For the proof whereof, and that I had thoroughly weighed, and that I had the new Digester. Which is, a Balamum Marie clausum: all Inflations and Digestions made with Double Vessels, having hitherto been made with the outer Vessel, open. So that whereas by the old way of Digestion, there is no other Power made use of, but that of Heat: in this way, that also of Compression is joined therewith.
EXPERIMENTS
IN
CONSORT
OF THE
LUCTATION
Arising from the Affusion of several MENSTRUUMS
Upon all sorts of BODIES,
Exhibited to the Royal Society, April 13. and June 1. 1676.

The intent of the following Experiments is twofold. The one, to be as a Demonstration of the Truth of one, amongst other Propositions, laid down in the precedent Discourse of Mixture, &c. That it would be a Key to let us easily into the knowledge of the Nature of Bodies.

The other, and that consequently, To be as a Specimen of a Natural History of the Materia Medica: that is to say, a multifarious Scrutiny into the intrinsic Properties of all those Materials, which have been, or may be used in Medicine: for the performance whereof, the following Method is exhibited, as one, amongst others, necessary to be insisted upon. For what Dominion a Prince hath over the Moral, that a Physician hath, as one of God Almighty’s Vice-Roys, over the Corporeal World. Whom therefore nothing can more import, than a particular knowledge of the Genius of all his Subjects, those several Tribes of Matter, supposed to be under his Command.
Lect. II.

There are some known Observations of this nature: but there is no Author, I think, who hath given us a System of Experiments upon the Subject: The performance whereof is here intended.

The Experiments may seem too numerous to be of one make. But no less a number would have answered the design of an Universal Survey; which, though less pleasing, proves more instructive in the end: not being like angling with a single Hook, but like casting a Net against a school, with assurance of drawing up something. Besides the advantage of comparing many together; which being thus joined, do oftentimes, like Figures, fignifie ten times more, then standing alone, they would have done.

How far the Corollaries all along subjoined have made this good, is left to the Reader to judge. And also, to add to them, so many more, as he pleases: for I make my own Thoughts no mans Measure.

CHAPTER I.

What is generally to be observed upon the Affusion of the Menstruum; and what, particularly of Vegetable Bodies.

H.E. Bodies whereupon I made trial, were of all kinds, Animal, Vegetable, and Mineral. Amongst Vegetables, such as these, salt. Dates-stones, Ginger, Colocynthis, Pyrethrum, Hawthorn-stones, Staphisagria, Ephedrums, the Arumule in Pears, Semei Milii Solis, Tartar, Spirit of Scurvygrass, Spirit of Vine, &c.

2. §. Amongst Minerals, several sorts of Earths, Stones, Ores, Metals, sulphurs, and salts.

3. §. Amongst Animals; such as these, salt. Hairs, Hoofs, Horns, Shells, and bloody Infefts, Bones, Fleis, and the several Vifera, Silk, Blood, Whites and Yolks of Eggs, Spermo Cell, Croet, Musk, Catfur, Gai, Urine, Dungs, animal Salts and Stones.

4. §. The Liquors which I poured hereupon severally, were these: Spirit of Salt Armoniac, Spirit of Harts-Horn, Spirit of Nitre, Aquavitrius, Oyl of Salt, Oyl of Sulphur, and Oyl of Vitriol; commonly so called.

5. §. In the Mixture of these Bodies, two things, in general, are all along to be observed, viz. First, which they are, that make any, or no Lutuation. For, as some which seem to promise it, make none: So many, contrary to expectation, make a considerable one.

6. §. Next, the manner wherein the Lutuation is made; being with much variety in these few sensible Effects: 1. Bulition, when the Bodies mixed produce only a certain quantity of froth or bubbles.

2. Elevation, when, like Paife in baking, or Barm in the working of Beer, they swell and buff up. 3. Crepitation, when, they make a kind
kind of hissing and sometimes a crackling noise. 4. Efferoscence; then
only and properly so called, when they produce some degree of heat.
5. Exhalation; when not only fumes, but visible flames are produced.
7. Of all these, sometime one only happens, sometimes two or
more are concomitant. Sometimes the Luluation begins presently upon
mixture, and sometimes not till after some intermission. In some bod-
ies, it continues a great while; in others, is almost instantaneous:
Examples of all which I shall now produce; beginning with Vegetables,
as affording the least variety.
8. And first, if we take Spirit or Oyl of Salt, Oyl of Vitriol, Spirit
of Nitre, or Aqua fortis, and pour them severally upon the several parts of
Vegetables, as Roots, Woods, Stones, &c. we shall find, that they are,
generally far less apt to make a Luluation, than either Animal, or subterra-
neal Bodies. Whence, as from one argument, it seemeth evident, That
in moft Vegetables, and in moft of their parts, the predominant Salt is
an Acid. But that, on the contrary, the predominant Salt in moft
Minerals, and parts of Animals, is an Alkali: in the former, usually
a fixed; in the latter, a volatile Alkali.
9. Again, although the Luluation which most Vegetables, and most
of their parts make with Acids, be but small, yet some they make; especi-
ally with some Acids, as with Spirit of Nitre and Aqua fortis. Whence
it seemeth plain, That there is an Alkaline Salt existent in many Vege-
tables, even in their natural estate; and that it is not made Alkaline, but
only liquefiable, by the fire. Or, there is some quantity of a Salt, call
it what we will, in the said Bodies, which is so far different from an A-
cid, as to make a Luluation therewith. But to give particular instan-
ces of the several proportions, or manner of Mixture, wherein it ap-
pears to be in several Plants.
10. And first, of all vegetable Bodies, Date-stones are amongst the
least apt to make a Luluation with Acids; if they may be said to make any at
all. Hence they are not so potent Nepriticks, as many other Stones,
which make a more sensible Luluation.
11. Ginger makes a small Bullition with Aqua fortis, only observa-
ble by a Glass. Hence the pungency of Ginger lyeth in a sulphurous and
volatile Salt, which yet is very little Alkalizate.
12. Scurvygrafs' seeds make a very small Bullition with Aqua fortis,
like that of Ginger. So doth also the Seed of Purflane. Hence, although
there is much more of a certain kind of volatile Salt in Ginger or Scurvygrafs,
than in Purflane; yet there is little more of an Alkali in any one, than in an other.
13. The Pulp of Colocynth, the Fruit-stones, the stony Covers of
the Seeds of Elder, of white Bryony, of Violets, and others, with Aqua
fortis make a Bullition just perceptible without a Glass. Hence it ap-
ppears, that the great Cathartic power of Colocynth lieth not so much
in an Alkali, as in an Acid; as making a much less Bullition, than some
other vegetable Bodies, which are less Cathartic. For which reason
likewise it is, That the best Correctors, or Refractors of the force of
Colocynth, are some kinds of Alkales, as particularly that of Urtica,
as Rivevina hath somewhere observed.
14. The Root of Pyrethrum, with Aqua fortis, makes a Bullition
and burns, in a short time. Hence, the Gaue of a durable Heat, upon the
Tongue, is an Alkalizate Sulphur. For the Heat of Ginger, though
greater;
greater; yet abideth nothing near so long as that of Pyrethrum; which, as is said, maketh also a more sensible Bullition with Acids.

15. §. Kermes-berries, commonly, but ignorantly, so called, with the said Liquor, buff up to an equal height, but in a somewhat longer time. Hence they are gently astringent; see, as their Alkali binds in with some preternatural Acid in the stomach.

16. §. Hawthorn-stones, with Aqua fortis, buff up equally with the former Body; but the Bullition is not so visible. The like is also observable of Medlar-stones. Hence, as they contain a middle quantity of an Alkali, they are not insignificantly ufed against the Stone.

17. §. Seeds of Staphisagria, with Aqua fortis, make a Bullition still more visible. But it quickly ends. This confirms what was said before, §. That the cause of a durable Heat is an Alkaline Sulphur; these Seeds producing a durable Heat, as doth the Root of Pyrethrum.

18. §. The Seeds also of red Roses, Borage, and Comfrey do all with Aqua fortis make a considerable Bullition and buff; and that very quickly. So that amongst all Shells and Stones, thofe generally make the greatest Bullition, which are the hardeft and the brittleft, and to the fulleft of Salt.

19. §. Euphorbiun makes a Bullition yet more confiderable, with much froth, and very quickly. From which Experiment, compared with two of the former, it appears, That Euphorbiun is not an Acid, but an Alkaline Gum. As also, that the caufe of its fo very durable Heat, is an alkaline Sulphur, as of Pyrethrum and Staphisagria hath been faid. It seems also hence evident, that the power of all great Stermatories lyeth not in their Acid, but their Alkalius.

20. §. The Avenule or little Stone in Pears, chafeth round about the Core, with Aqua fortis, presently buff up, and make a great Bullition and Effervescence, much greater than do any of the Bodies above-named. Whence, although, as far as I know, they have never yet been used in Medicine; yet it is probable, that they are a more potent and effectual Nephritick, than any of the Bodies afofaid, fome of which are usually prefcribed. It is hence also manifest, That, according to what I have efeculfeaid, for the sweetening of the Fruit and Seed, the Tartarous and Alkaline Anis., of parts of the Sap, are precipitated into their Stones, fiony parts, and Shells.

21. §. The left Infantance shall be in the shells of the Seeds of Milium Solis; which not only with Aqua fortis, but some other Acids, make a greater and quicker Bullition and Effervescence, than any other vegetable Body, upon which I have yet made trial, in its natural estate. Hence, as well as from divers of the laft fore-going Infiances, we have a clear confirmation of what I have, towards the beginning of this Discoure, afferted, §. That there is some kind of Alkaline Salt in Plants, even in their natural estate. As also, that they are as significantly ufed against the Stone, quaternus alkalinate, as Millipede, Egg-shells, or any other teffaceous Bodies of the fame strength. To thefe I shal fabjoin one or two Examples of Vegetable Bodies which are more or lefs altered from their natural estate.

22. §. Neither Crystals of Tartar, nor Tartar it self (although they have some store of alkaline mixed with their acid parts) make any Effervescence with Acids, but only with Alkalites, as Spirit of Hart-Horn, &c. Hence the calculous sediment or Areula in Urine, may not so properly be called O o
the Tartarous part of the Urine, the parts following the mixture here-oft the aforesaid Salts, being quite contrary as will be seen in the Last Chapter.

23. §. Spirit of Scurvy-grass maketh no Luration with any Acid. Hence (as from a former Experiment was above-noted ) it seems, That there may be a kind of volatile Salt, which is neither acid, nor alkaline; such as this of Scurvy-grass and other like Plants seems to be; yet contrary to an acid; as experience shews in their efficacy against the acid Scurvy.

24. §. Redified Spirit of Wine, both with Spirit of Nitre, and with Oil of Vitriol, severally, maketh a little Luration. Which argues, that there is contained, even in this Spirit, some portion of a volatile Alkali.

25. §. Spirit of Wine, and double Aqua fortis, as the strongest is called, make an effervescence so vehement, as plainly to boil.

26. §. Besides the venomous hereof, there is another surprising circumstance. For whereas all other Liquors which make an effervescence together, will do it in any proportion assigned, although but one drop to a thousand; these two, redified Spirit of Wine and Aqua fortis, require a certain proportion the one to the other. For if, suppose, into six drops of Spirit of Wine you put two or three of Aqua fortis, they stir no more than if you put in so much Water: but drop in about seven or eight drops of Aqua fortis, and they presently boil up with very great venom. Hence we may conceive the reason of the sudden access of an acute Disease, and of its Cries. These not beginning gradually with the Cause; but then, when the Cause is arrived unto such an actor, or such a certain Proportion, as is necessary to bring Nature to the contest. And these may serve for Examples upon Vegetables.

C H A P. II.

What may be observed of M I N E R A L S.

AVING given several Instances of tryal upon Vegetables; I next proceed to Minerals, which, for some orders sake, I shall distribute into five or six sorts, 1. Earths, Stones Ores and Metals, Sulphurs, and Salts.

2. §. First for Earths. Oil of Vitriol upon Fullers Earth, doth not stir it, or cause the least Bollution. Nor upon yellow Oker. Nor upon the Oker which falls from green Vitriol. The same Oyl of Vitriol and Spirit of Harts-Horn poured severally upon Bolas Armenia of two kinds, and upon one kind of Terra sigillata, stir none of them. Hence Bolas's are the Beds, or as it were, the Materia prima, both of opacous Stones, and Metals; into which the said Bolas's are transmuted, by being concentrated with divers kinds of Salts and Sulphurs, which successively flow in upon them.

3. §.
3. §. *Aqua fortis*, and *Oyl of Vitriol* being poured severally upon another sealed *Earth*, which was covered by the name of *Terra Lemma*; they both made a very considerable *Efferveience* herewith. Whence it appears, there is no small difference in the nature, and therefore the operation of *Solus Armenia* and *Terra Lemna*. As also, betwixt the sealed Earths themselves, one making a great *Efferveiscence*, another none at all. Whereto those that use them, are to have regard.

4. §. *Next for Stones*. And first, Irish slat, with *Spirit of Hart-borne*, maketh a small, yet visible *Bullition;* and it presently ceasteth. So that it seems to be nothing else but a *Vitriolick hole*. As is also argued from its taste, which is plainly acid, and somewhat rough. Whence also it is with good reason given upon any inward Bruites. Because by coagulating the Blood, it prohibits its too copious afflusion into the affected part. Yet being but gently arshting, and so the Coagulations it makes, not great; they are likewise well enough carried off from the same part in the Circulation; by both which means an Inflammation may be either prevented, or the better over-ruled.

5. §. *Lapis Hamatites* maketh no *Efferveiscence* at all either with *Alkaliues* or Acids.

6. §. Powder of the green part of a *Magnet* with *Oyl of Vitriol* maketh some few bubbles, yet not visible without a Glass. But the powder of the black part of a *Magnet*, which is the said stone fully perfect, sheweth not with any acid. Neither doth the calined *Magnet*. Hence there is some considerable difference betwixt Iron and the *Magnet*.

7. §. *Lapis Lazuli*, with *Oyl of Vitriol*, and especially with *Spirit of Nitre*, maketh a conspicuous *Bullition*. Hence its *Calartick* virtue lyeth in an *Alkaly*. For which reason it is also appropriate, in like manner as *Steel*, to the cure of *Hypochondriacal Affections*; originated from some kind of fermenting Acid.

8. §. *Oysteollas*, with *Spirit of Nitre* maketh yet a greater *Efferveiscence*. How it comes to be so great a knitter of broken Bones, as it is reputed, is obscure. It feemeth, that upon its solution by a *Nitrous Acid* in the body; it is precipitated upon the broken part, and so becomes a kind of *Cement* thereto.

9. §. *Lapis Tinctia*, with *Spirit of Nitre*, maketh an *Efferveiscence* much alike. And with *Oyl of Vitriol* very considerably. But *Lapis Calaminaris* with *Oyl of Vitriol* grows stark; as the powder of *Alabaster* doth with water. With *Spirit of Nitre* it maketh a little *Bullition*, and quickly. But with *Aqua fortis*, a great one; beyond any of the Stones above named. Hence both *Tutti* and *Calamy* are *Ophthalmick* from their *Alkaly*. Which is also confirmed, from the efficacy of some *Alkaliues* of the like use. Hence also *Calamy* seemeth to partake somewhat of the nature of *Silver*; as by tryal made upon that also, will hereafter better appear.

10. §. *Chalk* and *Oil of Sulphur* or *Vitriol* make as strong an *Efferveiscence* as any of the rest. Whence it is sometimes well used against a *Cardialgia*.

11. §. *Whiting* makes as great an *Efferveiscence* as *Chalk*. So that it seems the faline parts are not washed away with the water, wherein the *Chalk*, for the making of Whiting, is dissolved.
12. 6. Talk will not stir in the least either with Spirit of Nitre, or Oyl of Vitriol. But the Lead-Spar maketh a considerable Effervescence with both of them severally. Hence, however this be allo called English Talk, yet there is no small difference betwixt this, and true Talk.

13. 6. To these Stones may be added petrifed bodies: As petrifed woods; which (that upon which I made trial) no acid stirreth in the least. Petrifed Soils; upon four or five several sorts whereof, Oyl of Vitriol being poured, produceth a great Effervescence. The Root or rought part of the Stone called Glofopetra, with Spirit of Nitre, makes a conspicuous Bullition. Alkalis, the Stone so called, and found in some places in England, with Oyl of Vitriol, maketh an Effervescence at the same degree. So doth the Belenites, or Thunder-Stone, both the larger and the lesser kinds. So that none of those are acid, or vitrioleth, but alkalinate Stones.

14. 6. Coraline, with Oyl of Vitriol, makes a conspicuous Bullition, yet mild and gentle: that is, with very little, if any heat, and without any visible Fumes. And red and white Coral do the like. Hence they are all of a very gentle operation, and fit for Children, as the case requires.

15. 6. Magistery of Coral (prepared the ordinary way) stirreth not in the least, either with Alkalies or Acids. Whence it is evident, That its active Principles are in its preparation destroyed and washed away: that is to say, It is an elaborate Medicine good for nothing. And thus far of Stones. 16. 6. I next come to Metals and Ores. And first for Lead; upon which Spirit of Salt, Spirit of Nitre, or Aqua fortis being dropped, it stirreth not in the least with any of them: but with Oyl of Sulphur, and especially with Oyl of Vitriol it maketh a good Bullition and froth. Hence it esteemeth to be the most alkalize Metal. Which is also confirmed by a foregoing Experiment upon the Lead-Spar, which maketh a considerable Effervescence with any sort of acid. And which likewise, being calcined, yieldeth a good quantity of Lixiviol Salt.

17. 6. Lead-Ore stirreth not at all with Aqua fortis or Oyl of Vitriol. But Spirit of Salt makes it bubble, and Spirit of Nitre makes it boil. Hence there is a considerable difference betwixt the perfect Metal and the Ore.

18. 6. Burnt Lead and red Lead, make a very small Bullition with Oyl of Vitriol, with Spirit of Nitre a far greater.

19. 6. Mercury, with Oyl of Vitriol, will not stir, nor with Oyl of Sulphur. But with Spirit of Nitre presently boilts up. Hence Mercury is a subacid Metal; Spirit of Nitre being a subalkaline Acid.

20. 6. The filings of Iron or Steel, with Oyl of Vitriol, make a fair Bullition, like that of Minuim. But Spirit of Nitre makes them boil with much celerity. Hence Iron is likewise a subacid Metal.

21. 6. Steel prepared with Sulphur maketh a far less Effervescence with the same Spirit of Nitre, than do the filings. Hence there is a great difference in their strength. So that ten grains of the filings unprepared, will go as far as fifteen grains or more of those which are prepared, as above-said. Yet in some cases the weaker and milder may be the better.

22. 6. There is one Circumstance in the mixture of Steel and Aqua fortis, which is surprizing: and that is this. That strong Aqua fortis, dropped upon Steel, will not, of itself, make the least Bullition: but if
Here the author only says a drop or two of Water, they presently boil up with very
great velocity. The Caule is obscure; yet it is well known, that
Water it self will dissolve Iron: so that it appears, as well by this, as
by some other Experiments, that even in common Water, as mild as it
is, there is some kind of corrosive Principle.

23. §. Antimony with Spirit of Nitre, and Aqua fortis severally, maketh an Efferveſcence: somewhat lower than Iron. With Oil of Vitriol the Bulldition is so small, as difficulty to be perceived with a Glass. Hence it seemeth to be of a very compounded nature; if I may so call it, a fubacid-alkaline Metal.

24. §. Antimonius Diaphoreticum, with Spirit of Nitre and Oil of Vitriol severally, makes a considerable Efferveſcence. Wherefore it is not an uſeful Preparation; as from the Calamina and Ablution uſed therein, some have thought.

25. §. Bezauditum Mineral, (that upon which I made trvall) stirreth not at all either with Alkalies or Acids. To which, let those who make uſe of it, have regard.

26. §. Tin, with Spirit of Nitre, makes so hot and vehement an Efferveſcence, that it turns presently, as it were, into a Coal. It makes also a fair Bulldition with Oil of Vitriol. And a gentle one with Spirit of Salt. Wherefore, it hath something of the nature both of Iron, Lead and Copper.

27. §. The like remarkable circumstance is seen in the mixture of Aqua fortis with Tin, as with Iron. For Tin and strong Aqua fortis of themselves will not Stir; but add a few drops of water to them, and they boil up with the greatest vehemency.

28. §. Copper, with Spirit of Salt, and Oil of Vitriol severally, stirreth not at all. Spirit of Nitre, and Aqua fortis, both boil it up vehemently. Neither Spirit of Harts-borne, nor Spirit of Salt Armoniac maketh any Bulldition therewith. But both of them, by a gentle solution, that is, gently separating its Sulphur from its Salts, turn it blue. Hence Copper hath a greater proportion of acid than any of the forementioned Metals.

29. §. Silver, neither with Spirit of Salt, nor Oil of Vitriol makes any Bulldition. With Spirit of Nitre it makes one, but tis soon over: and then continues to dissolve slowly into white Coagulations. It also maketh with Spirit of Harts-borne, or of Salt Armoniac, a full and deep blue. Hence there is a greater proportion of acid in Silver, than in Lead, Mercury, Iron, Antimony, Tin, or Copper.

30. §. Litharge of Silver maketh the greatest Efferveſcence with Oil of Vitriol. Yet some with Spirit of Nitre. And with Spirit of Salt Armoniac maketh some little hus or elevation. And being mixed with Spirit of Nitre and Spirit of Salt Armoniac both together, produceth a faint blue. Hence, although the far greater part of this Litharge be but Lead; yet, it seemeth, it hath some small mixture of Silver. But that of Gold seemeth, for contrary reasons, not to have any Gold.

31. §. Gold maketh no Efferveſcence with any single Salt I know of. But it is commonly dissolved with Aqua Regis, which is known to be an alkaline Liquor. Whence it seemeth, That as Lead is the most alkalizate, so Gold the most acid of Metals.
32. §. These things considered, and other observations added hereunto, may possibly give some directions, not only for the ordering and using, but even for the making, imitating and tranfmuting of Metals. Thus far of Metals.

33. §. I will next give one or two Inftances of tried upon Sulphur, and fift Sulphur vive, with Aqua fortis, maketh an apparent Bulition, but it is some time, before it begins. But the fulfitions or common Brimfles, maketh scarce any, if any at all. So that there is no small difference betwixt them.

34. §. White and yellow Arfencick make no Bulition either with Alkalies or Acids. Wherefore the strength of its operation on the Body, lies more in a Sulphur than a Salt; or in a Salt drowned in its Sulphure.

35. §. The ashes either of Pit-Coal, or Sea-Coal, make no Effervefence with Alkalies or Acids. Whence the fame Principle is altogether volatile, and sublimed away by the fire.

36. §. Lastly for Salts. And fift of all, borac maketh no Effervefence nor any Fumes with Oyl of Vitriol or Spirit of Nitre.

37. §. Oyl of Vitriol and Nitre make fumes or fteams, though no Effervefence.

38. §. Green Vitriol, with Spirit of Harts-Horn, is scarceft moved. White Vitriol, with the fame Spirit, maketh a confpicious buff. And Roman Vitriol a veftement Effervefence. Whence the former is the leaff acid, and the latter the moft of all. Which also confirms what I faid before of the like natures of the feveral Metals to which they belong.

39. §. Salt of Vitriol, though a fixed Salt, and made by Calcination, yet maketh no Effervefence with the firft acid; but only with Alkalies; as may be fee upon their mixture, but much better heard by holding the mixture to one ear. Hence, there are fixed Acids. Which further confirms what I have above affered concerning the nature of Gold, f. That the predominant Salt thereof is a fixed Acid.

40. §. Salt Martis, with Spirit of Harts-born, maketh a confiderable buff. Hence it is much more acid than green Vitriol; and is therefore a cooler body.

41. §. Aqua and Spirit of Harts-born make a plain Effervefence.

42. §. Saccharum Saturni, with Oyl of Vitriol, firs not at all. With Spirit of Salt, buffs a little. With Spirit of Nitre much more. Hence the acid of the Vinegar, and not the Alkys of the Lead, is the predominant Principle.

43. §. Common Salt firs neither with Spirit of Salt, nor with Spirit of Nitre; nor with Aqua fortis. But with Oyl of Vitriol it maketh a great Effervefence with noise and fteams. Hence, even common Salt, though it be not reckoned amongft alkaline Salts, yet is far nearer in nature to that, than to an acid. Hence also the Spirit of Salt is a subalkaline Spirit, and of a very different nature from Oyl of Sulphur or Vitriol.

44. §. Salt Armoniaca, with Spirit of Nitre, firreth not. But with Oyl of Vitriol it maketh a great Effervefence. Hence Spirit of Nitre is a subalkalize Spirit.

45. §. Oyl of Vitriol and Spirit of Nitre, though both acids, yet make a great fmoak; greater than that which the Spirit maketh of it felf. Which confirms the laft prece lent Corollary.
LECT. II.

with several Menstruums.

247

46. §. Oyl of Vitriol and Spirit of Salt, though both acids, yet make a strong Effervescence, with nois and flame. Which further confirms, what was noted before, f. that Spirit of Salt is a sub alkaline Acid.

47. §. Spirit of Salt Armoniac, with Oyl of Vitriol, makes an Effervescence so extraordinary quick, and as it were instantaneous, that nothing seemeth quicker. Whence it is probable, That if Gun-powder were made of Salt Armoniac, instead of Nitre, or with both mixed together; it would be far stronger, than any kind now in use. And thus far for Minerals.

48. §. I have only one Corollary to add, from the whole; which is, That whoever doth undertake the Natural History of a Country, (such as that the Learned Dr. Plot hath exceedingly well done of Oxfordshire) the foregoing Method, seemeth so facile, cheap, and indefatigable, for the finding out and well distinguishing the natures of all kinds of Metals, Ores, Salts, Earths, Stones, or other subterraneous Bodies; as cannot, I think, be supply'd, but by others of greater difficulty and expense.

CHAP. III.

What may be observed of the PARTS of Animals.

NOW proceed to the several Parts of Animals; as Hairs, Hoops, Horns, Shells and fleshy Inlets, Bones, Flesh and the several Viscera, Silk, Blood, Eggs, Musk, Caylor, Gall, Urine, Dungs, Salts and Stones.

2. §. And first of all, the Hair of a mans head, with Oyl of Vitriol, maketh no Bullition at all. Nor yet with Spirit of Nitre. So that although it contains a good deal of volatile Salt; yet it seemeth either not to be alkaline, or else is centred in so great a quantity of Oyl, that the acid menstruum cannot reach it.

3. §. Hares Fur, with Spirit of Nitre, maketh, although a short, yet very plain Bullition and buff. Hence the Hair, and therefore the blood, of some Animals, is fuller of Salt, at least of an Alkaline Salt, than that of some others. And perhaps the Hair of some men, as of Black's, may be so full of Salt, as to make a Bullition like Hares Fur.

4. §. The shavings of Nails stir not at all, either with Oyl of Vitriol, or Spirit of Nitre: only with the latter they turn yellow. But Elks Claws, with Spirit of Nitre, make a small and slow Bullition.

5. §. Horses Hoof, with Oyl of Vitriol, stirrs not of many hours. But with Spirit of Nitre, allowing it some time, makes a very plain Bullition, and buff a very high.

6. §. Cows Hoof, neither with Oyl of Vitriol, nor with Spirit of Nitre, maketh any Bullition, only turneth to a yellow colour.

7. §. Rams Horn stirrs not with Oyl of Vitriol; but with Spirit of Nitre, makes a small and slow Bullition.

8. §.
3. 6. Harts-Horn makes a considerable Bullition and buff, even with Oyl of Vitriol, which the rest of the Bodies above said, will not do. But with spirit of Nitre, it makes yet a greater. From the foregoing Experiments, and almost all that follow, what is before affected of the Salts of Vegetables and Minerals, is here also evident concerning that of Animals, feil. That it is not made, but only separated by the fire. It likewise hence appears, That the proportion of Salt in the foremencioned parts is very different; and that therefore some of them are never, and none of them but with good discretion, to be substituted one for another in Medicine. As also, that there is a different proportion of Salt in the several Animals themselves, to which the said Parts belong.

9. 8. Next for shells; as those of Lobsters, Eggs, Snails and Oysters: all which make an Effercence, both with Oyl of Vitriol, and Spirit of tre. But with Spirit of Nitre the greatest. Lobster-shells make a considerable Bullition and buff, but no noise nor steam. Egg-shells make a Bullition and buff, with some noise, but no steam. Snail-shells make an Effercence with noise and steam. Oyster-shells make one with the greatest noise and thickest steam. Hence we may judge, in what case to administer one more appositely than another. As also in what proportion, according to their different strength. Some may be better for Children, as being milder. Or for a Body whole very sharp Blood or other Humors, are more easily kindled into Ferments. Or else may be safest, to avoid a sudden precipitation of the Humors; or for some other cause.

10. 9. Oyster-shells, and the rest above-said, make a quicker Effercence, not only with Spirit of Nitre, but even with Spirit of Salt, than they do with Oyl of Sulphur, or Oyl of Vitriol. So that these bodies, as well as Metals, have their proper Menstruums whereby they are to be dissolved.

11. 9. Egg-shells calcined, make with Oyl of Sulphur, or Oyl of Vitriol, or Spirit of Nitre, a greater Effercence, than when uncalcined. As also with steams, which uncalcined, they produce not. The like is seen in calcined Oyster-shells. And the longer the Calcination is continued, the quicker and stronger will be the Effercence. This I tried at several times, from a quarter of an hour, to five hours. So that after so long a Calcination, they make an Effercence almost instantaneous. The reason hereof is, because the several Principles whereof the Shells consist, being relaxed, and the Sulphur for the greatest part, driven away by the fire; the remaining Salt lies now more open and naked to the attack of the Menstruums, so soon as ever they are mixed together. From hence it is plain, That Egg-shells, and the others above-said, being burnt, are far stronger Medicines, than when unburnt. It is hereby likewise evident, That a great portion of their Salt, is not volatile, but a fixed Alkali. To these may be subjoined all kinds of shelty Insect. I will instance in three or four.

12. 9. And first Bees, with Oyl of Vitriol, for not in the least. With Spirit of Nitre they make an exceeding small Bullition, without any elevation.

13. 9. Cockinelle (the Nuts of an Insect) makes some Bullition with Oyl of Vitriol, but very small: for the bubbles are not to be seen without a Glass. But with Spirit of Nitre the Bullition is more visible, and joined with some elevation.
14. 6. Cantharides make no visible Bullition with Oyl of Vitriol, But with Spirit of Nitre they do, and huff up rather more than Cofhinele. Yet is this done very slowly, and comparatively with many other Bodies, is not much. Hence it is not the quantity, but the quality of their volatile Salt, which makes them so strong an Episiptick. For most of those Bodies above, and hereafter named, make a greater Bullition, and yet are neither Cauffick nor Episiptick in the least. It is hence also evident, as hath been before suggested, That there are divers kinds of volatile Salts, eminently different; some being highly alkaline, others very little, and some scarce any thing fo: such as those of Scurrey-grafs, Anemone, Crowfoot, and many the like Plants; to whose Salts, this of Cantharides seemeth to be very near of kin.

15. 6. Millepedes make a Bullition and huff much greater and quicker, than any of the Inflets above named: and that both with Spirit of Nitre, and Oyl of Vitriol it self. Yet is this Inflet of a very temperate nature. Whereby is further demonstrated, That the being simply alkaline, is not enough to make a body to be Cauffick.

16. 6. Again, although Millepedes make a Bullition, greater than any of the Inflets above named; yet is it much less, than that of Osfler,Snail, or even Egg-shell; and of divers other Bodies, and hereafter mentioned. Hence, being given to the same intent, as any of those bodies, it is the mildest and gentlest in its operation of them all.

17. 6. Millepedes likewise calcined, makes a stronger Efferencesence, than when uncalcined, as do the Osfler-shell, &c. So that it appears, That all Teflaceous Salts, are at least in part, fixed Salts.

18. 6. I next proceed to Bones. And first Whale-bone makest no Bullition at all with any acid. A Cartilage, with Spirit of Nitre, makes some very small bubbles, not to be seen without a Glob.

19. 6. The Bone in the Throat of a Carp, makes a little and slow Bullition with Spirit of Nitre. The Spina of a Fijj (that which I used was of a Cod-fijj) makest a Bullition one degree higher.

20. 6. All sorts of Teeth, as Dogs, Boars, the Sea-herse, Elephant, make the like. As also the Bone of an Oxes heart. So that all these are very gentle in their operation, and fit for Children.

21. 6. Sheep's and Calves Bones both of them make a Bullition yet a little bigger, especially with Spirit of Nitre. Cocks Bones somewhat bigger than the former. Croftium humanum a little higher than all the rest.

22. 6. Bones likewise, being calcined, make a Bullition with Acids. And doth also calcined Hart's Horn. But in neither of these, is the Bullition advanced by Calcination, any thing comparable to what it is in shells. Whence it appears, That the Salt of Horns and Bones, is much more volatile, than that of Shells.

23. 6. Next for Flesse and the several Viscera. And first, dried and powdered Stomach, with Oyl of Vitriol, stands not at all. But with Spirit of Nitre makes a small Bullition and huff. Sheep's heart doth the like somewhat more apparently. Vipers flesse produceth a froth, but huffs not. Powdered Earthworms make a great froth, and huff a little. Powdered Tripe makes only a little Bullition. Lamb's-lones do the like. Kidney, Spleen, and Liver, with some elevation. Lungs, with bubbles very large, because extraordinary feowy. Dryed Brain makes also a little
and flow Bullition. Hence there is a greater proportion of Sulphur or Oyl, and less of an Alkaly in all these parts, than there is in Bones, Skells, and divers other parts hereafter mentioned. And in some of them, as in the Brain, that Alkalyne Salt which there is, may rather be lodged in some janguineous parts mixed with them, than in their own proper substance.

24. §. I proceed to instance in all sorts of Animal Contents. And first, raw Silk, with Spirit of Nitre, makes a very small Bullition, but the elevation is considerable.

25. §. The gumsous part of the blood dryed, with Oyl of Vitriol, firs but little. But with Spirit of Nitre it buffets up considerably.

26. §. Serum of Blood dryed, with the same Spirit makes a plain elevation, with a little Bullition. Herewith may be reckoned the White of an Egg, which is nothing but a pure Crystalline Serum separated from the common stock. This being dryed, with Spirit of Nitre, buffets up rather more than even the gumsous part of the blood, the Bubbles are much larger, break oftener, and the elevation sooner made. Whence it seemeth, that there is a greater quantity of a volatile Alkaly in proportion to the Sulphur, requisite to the Generation, than to the Nutrition of an Animal.

27. §. The Egg of an Egg is scarce moved with Spirit of Nitre, producing only a very few Bubbles. The Salt being either little alkalized, or else immersed in too great a quantity of Oyl, that the Menstruum cannot reach it. For the same reason Sperma Civet Shirr not with any Acid. Neither doth Civet.

28. §. Russian Castor, with Oyl of Vitriol, Shirr not. But with Spirit of Nitre makes a considerable buff and froth. Yet it requires time. Wherefore it seemeth, That Castor by virtue of its alkaline Sulphur, becomes so good a Corroborator of the acid-alkaline Sulphur of Opium: so I take leave to call it, having some reasons to believe it such.

29. §. Musk, with Oyl of Vitriol, Shirr not. But with Spirit of Nitre it makes a considerable and quick Bullition, with large bubbles, which often break and rise again. Whence there is a very eminent difference betweep Musk and Civet. Hence also, Musk is Cordial, not only from its Sulphur, but its Alkaly: by both directly opposite to preternatural Acidities.

30. §. Dryed Gall with Spirit of Nitre, for some time, is still: but at length it makes a considerable Bullition and froth. The reason why it is so long before it begins, is because the Salt, (as was observed of some other Parts) is locked up in so great a quantity of Oyl. The abundance whereof is manifest, not only from Distillation, but also from hence, In that the dryed Powder, in lying by, incorporateth all together into one body, as Mmgrh, and some other foester and oily Gums are used to do.

31. §. Extract of Urine, with Spirit of Nitre, makes a Bullition with some Efficaceness, which continues for a considerable time; and at last it buffets up with great bubbles. The Bullition begins presently: the Salt being expiurz: and the Oyl but little.

32. §. The same Extract of Urine makes a considerable Bullition and froth, not only with Spirit of Nitre, but even with Oyl of Vitriol. Hence the Salt of Urine is more alkaline than that in most of the afor precedent Contents.
Contents. From this and some of the following Experiments, it also appears, That the salt which concurs to the generation of Gravel or of a Stone in the Kidneys or Bladder, is of a very different nature from the Salt of Urine.

32. §. Next for Dung. And first, dried Goats-dung makes with Spirit of Nitre, a small Bubbling, but no elevation. That of Mice the like. And that of Cows. So that of all I have tried, these three stir the least.

34. §. Goose-dung, with Spirit of Nitre, makes a very small Bubbling and some elevation. But it requires time. Oyl of Vitriol stirs it not.

35. §. Album Gracum, with Spirit of Nitre, besides innumerable small bubbles, rises up with some great ones, exactly resembling the buffing up of Teak or Barn. Also with Oyl of Vitriol it maketh some little froth, but slowly. So that it should seem, that the Bones are a little opened by some acid Menstrum in the Dogs stomach (as the body of Steel is in its preparation with Sulphur) whereby it becomes a good mild Topick in Quinseys.

36. §. Hens dung, with Spirit of Nitre, makes a very great bullying and buff; greater and quicker, than any of the rest above-named.

37. §. But of all I have tried, Pigeons dung, with the same Spirit, maketh the greatest and the quickest Effervefence and buff; and that not without foams. Yet neither the same Dung, nor that of Hens, is moved in the least with Oyl of Vitriol. The Caufe of so great an Effervefence in these, more than in the rest, is that white part which is here mixed in a great quantity with the Dung. Which white part, descendeth not from the Stomach, but is an Excrement separated from the Blood (as the Urine in other Animals) by a peculiar Organ, which evacuates it into the Intemium reuimum; whence, together with the Stereum it is excluded. Hence it is evident, That in the said white part of Hens, and especially Pigeons dung, is contained a great quantity of a volatile Alkali.

38. §. I proceed to Salts. And first Salt of Blood and Urine both make a more durable Effervefence with Acids, than doth Salt of Wormwood, or Salt of Fern. Hence the former are more alkaline, than the latter.

39. §. Again, though divers other Animal Salts will not sir with Spirit of Salt, or with Oyl of Sulphur or Vitriol, yet the Salt of Blood will make an Effervefence with all kinds of Acids. Whence it is further argued to be highly alkaline, and very proper for the correction, of all sorts of preternatural Acids in the body. There is little doubt, but that Spirit of Harts-horn will do the like.

40. §. The Gravel which is precipitated out of Urine; with Oyl of Vitriol makes no bulilation in the least. Nor with strong Spirit of Salt. But with Spirit of Nitre, it makes a very great one, with Effervefence and foams. From hence it appears, That there is much difference to be made in the use of acid Dimeticks, Nephriticks, &c.

41. §. And that I may not altogether omit to mention, what may be so much for the good of mankind, I do here declare, That for preventing (I say not, the breaking, but preventing) the generation of the Stone, either in the Kidneys, or in the Bladder, there are not bet-
ter Medicines in the world, than some certain Preparations of Nitre, duly admitted. Whoever shall think that any kind of acid, as Oyl of Sulphur, Oyl of Vitriol, Spirit of Salt, or the like, will have the same effects, will find themselves much deceived in their practice.

42. $ I conclude with Stones. And first, Spirit of Nitre dropped upon a Stone of the Kidneys or Bladder, produceth the very same effect, as upon the Gravel in Urine. That is to say, it makes it boil and puff up, until at length it is perfectly dissolved into a soft Pulp; which neither Oyl of Sulphur, nor Oyl of Vitriol, nor Spirit of Salt will do; nor give the least touch towards its dissolution. This confirms what I said before of the use of Nitre and Nitrous Spirits, if duly prepared and administered, above any other Acids, against the breeding of the Stone.

43. $ Pearls, with any Acid, make the like Effervefence, as do Oyster-shells. But Magistery of Pearls, as usually prepared, stirs not at all, with any Alkali or Acid. So that as to the effect frequently intended by it, it is very insignificant; as of that of Corals hath been said.

44. $ Crab Eyer, with any Acid, make an Effervefence, almost as quick as that of Oyster-shells.

45. Crabb Eyes likewise calcined, make a stronger Effervefence, than when uncalcined. So that these, as well as Shells, contain a fixed Alkali.

46. $ The Stones in Writings heads make a strong Effervefence like that of Oyster-shells.

47. $ Stone of humane Gall, stirs not with Oyl of Vitriol. But with Spirit of Nitre maketh a little bullition just upon mixing, and after a considerable time, a little froth. Much less than what was observed before of the Gall it self. So that it seemeth to be generated of the Gall coagulated by some Acid, which hath already refrained the Alkali wherewith the Gall abounds. This confirms the use of those Medicines in the Jaundice, or any other bordering Disease, which destroys those Acidities by which the Gall is curdled or coagulated, and so rendered more difficulty separable into the Guts.

48. $ Since the first publishing of these Observations, Mr. William Matthews an Apothecary in Ledbury, sent me part, as I take it, of a Stomack-stone, as big as a Walnut of the largest Size, voided by a woman about 82 years of age, sometime after an Autumn Fever. It contained of the fame Strie, as the Besoar Stone: and maketh some Bullition with Spirit of Nitre.

49. $ Besoar, neither the Western nor the Eastern, doth stir at all with Oyl of Vitriol.

50. $ Western Besoar, with Spirit of Nitre, makes a very little thin froth, and that's all; and that doth very slowly. But Oriental Besoar, with Spirit of Nitre, after some time, maketh a very great Effervefence, froth, elevation, noise, and steam (as if you poured Oyl of Vitriol upon Salt of Tartar) till it be wholly dissolved by the afofied Spirit, and turned into almost a blood-red. Hence it may seem to be no mean Remedy against such fretting and venenous acids, as often times in Fevers, and other Distempers, lye about the Stomack, and are thence frequently translated to the Heart, Brain, Nerves, and other parts. The difference likewise between the Western and the Eastern Besoar, is fo great, that in any case of danger, and where the Besoar is relied upon, it is an unpardon- able
Lect. II. with several Menstruums.

able fault, for the Apothecary, or any Person, to substitute the one for the other: unless he will take ten times as much, or ten times as little of the one, as he would have done of the other: if that will serve turn.

51. §. The Stones already mentioned, (except the great Stomach-Stone) are ordinarily generated in the bodies of Animals. I have one Instance more of some other Stones which are extraordinary. In the City of Hereford lives a Maid, who often voids these Stones, and in the space of some years past, hath voided several pounds, of several colours and sizes, not only per urinarias, but also by vomit, and by noil. The first mention made to me of them, was by Mr. Diggs, a worthy Gentleman of that City, as a thing that was there much wondered at. And some of them, upon my desire, were sent me by Mr. Wellington, an Apothecary in the same place. I have tried what several acid Menstruums will work upon them; and find, That with Oyl of Vitriol, and especially with Spirit of Nitre, the great ones make a very quick and conspicuous Effervescence. But the small ones, neither the white, nor the grey, make any Bullistion in the least: for in truth, they are no other but little Pebbles and Grit-stones.

52. §. This being considered, and the various colours and mixture of any one of the great Stones, being well observed; it seemeth plain, That although the be somewhat old (above thirty years) yet may she have a kind of meatusia, or diseased Appetite to Stones, Bones, Wood-albe, Tobacco-Pipes, Chalk, and such like things; which sometimes swallowing in little lumps, sometimes grossly, or finely ground betwixt her teeth; they are in her Stomach and Bowels, more or fewer of them, cemented together, either with a piniusus, bilious, or some other more or less glutinous substance. And that by virtue also of the said Cement, or any of the said, or other like alkaline Bodies, the greater Stones, which consist of those partly, do make an Effervescence with acid Liquors. Thus far of Instances upon the parts of Animals. I shall close with some Corollaries deduced from the whole.

53. §. And first, since we find, that amongst all the Menstruums we have made use of, Spirit of Nitre, or any very Nitrous Spirit, is the most universal disolver of all kinds of Animal Bodies; the best disolver of many others both Vegetable and Mineral, and the only disolver of some: Hence it is probable, That the great Stomachick Menstruum, which either Disolves, or opens almost all Bodies which come into the Stomach, is a kind of Nitrous Spirit.

54. §. Again, Spirit of Nitre being a subalkaline Acid, and working more evidently upon Animal bodies, than other simpler Acids do, which yet are as strong; It hence follows, That most of the Salts of Animals are subacid Alkalies. How far this conclusion may further instruct us, I shall have occasion to shew in another Discourse.

55. §. Lastly, there being so many, say twenty or thirty degrees, from the lowest to the most vehement, in the Bullistion of mixed Bodies; it seemeth, That Fermentation it self, as to the formal notion of it, is nothing
nothing else: or that from the common Lactation of mixed bodies whereof we have now been speaking, it differs not in specie, but only in the manner of its causation, and in degree: the Aes, or some certain Menstruums lodged therein, being of no greater strength, than to produce a Bastition or Lactation of that low and soft degree, which we call Fermentation.

56. §. I have thus endeavoured to prove, by various Instances, how instrusive this most easie, plain and simple Method in the Mixture of Bodies, may become to us: and that merely by observing the Lactations which thence arise between them. How much more then, if a diligent remarque be made of all those various Colours, Smells, Tastes, Consistencies, and other Mutations thereupon emergent?
AN ESSAY OF THE Various Proportions

Wherein the LIXIVAL SALT is found in PLANTS.

Read before the Royal Society, March, 1676.

CHAP. I.

Of the QUANTITIES afforded by several Plants calcined in gros.

T is the part of a Physician, knowingly and artificially to use and govern Nature. And therefore by every likely Method, to inspect the State and Properties of all sorts of Bodies. One Method, is that I have taken in the foregoing Experiments; etc. by mixing them with several Meistrums or Liquors: whereby we may be assisted to judge, both of the Kinds and the Proportions of Principles in any Body; and of the manner of their Mixture in the same. Another is by Calculating them; or, as it were, by mixing them with the Fire, a potent and almost universal Meistrum. I shall here only set down some Trials for an Essay upon Plants; chiefly noting, The different Proportions of their Lixival Salts. Of these Trials, some were
were made upon the whole Plant, or some Portion of it wherein several Parts are mixed together: And others, upon some one Part of a Plant distinct from the rest. All of them answering to such Queries, as may seem proper to be proposed.

Query 1. Whether Trees or Herbs and Bulbs, quantity for quantity &c. afford the most Lixivial Salt?

For this I took Barque and Rosemary of each lb. The latter yielded 5 Scruples; the former but 32 Grains; which is three times less. I took also the same quantity of the Barque of Black-Thorn, and of Agrimony. The latter yielded 5 Scruples and 6 Grains; the former, not above 1 Scruple and 5 Grains; which is four times less.

Although the Barque of a Tree be compounded of Pithy and Lignous Parts; yet to answer the Query exactly, the Wood of these Trees should be taken with the Barque, that there may be some portion of every Part of the Tree, as well as of the Herb.

But thus far the Experiment is conclusive, That the same quantity of Lixivial Salt, doth not always follow the same General Taste. For the Barque of Abo and Rosemary, are both equally Bitter; and the Barque of Black-Thorn and Agrimony are both Astringent and bitter.

Quer. 2. Whether any Plant growing in a Garden or the Field, doth not yield a lesser quantity of Lixivial Salt, than another of the same kindred growing on the Sea-Coast; and with what difference?

For this, I took Garden and Sea-Scorzygraf, of each lb. The former yields 2 Drachms and 1 Scruple; the latter, being well washed, 9 Drachms, which is more than 4 times as much. The like may be tried upon others.

Quer. 3. Whether the same specific Plant affords more Lixivial Salt, being only dried, and then calcin'd; or after it hath first been distilled, it is then dried and calcin'd?

For this, was taken lb. of Mint only dried and then calcin'd; and another first distilled. The former yielded ½ an Ounce and 4 Drachms of Salt; the latter, 5 Drachms and a Scruple; which is almost three times more. This also should be tried on other Plants.

Quer. 4. How far the proportion follows the different Tasts of Plants? The first Experiment, relates to the same Taste in several Plants; this, to several Tasts. And so,

Of Majorana, which is aromatick, lb. affords but one Scruple of Lixivial Salt; which is but the 32d part of the whole pound.

Of Oak-Barque which is Astringent, lb. yields ½ a Drachm of Salt; or the 25th part of the whole.

Of Liquirish, which is sweet, lb. yields about the same quantity. But Anise Seeds lb. yields 2 Scruples or a 192d part.

Of Sorrel, which is sour, lb. yields one Drachm, or the 128th part. Of Garden Scorzygraf, which is Hot, lb. yields 2 Drachms and ½ a Scruple; or the 57th part.

Of Mint, which is Hot and Bitter, lb. yields 5 Drachms and a Scruple; or the 24th part.

Of Sea Scorzygraf, which is Salt, lb. yields 9 Drachms and a Scruple or 88 Scruples; which is near ¼ of the whole. A greater proportion of Salt, than in any other Plant upon which I have heretofore made Tryal: Or even in Tartar it self. Yet is it not a Marine, but true Lixivial Salt: as is evident, both from its Taste; and in that it maketh
Lect. III.

of Plants.

257

maketh an Efficience with Spirit of Salt, which Sea-Salt will not do.

For the Experiment to be fully adequate to the Query; the Tryple should be made, either all on Trees, or all on Herbs, or all on Roots; or all on Stalks, &c. Yet thus much is evident, That Sorrel yields Three as much as Majoram; Sea-Scurvygrass, Eight and Twenty times as much: Mint, Five times as much as Sorrel; and Sixteentimes as much Majoram, &c.

Quer. 5. How far the Proportion follows the Faculties of Plants?
And so, it appears, that

Majoram, a Cephalick, hath a greater Proportion of Volatile Parts, than any of the Plants above mentioned, and so far, is more agreeable to the Animal Spirits, and genus Nervorum.

Agrimony, (a) an Aperient, yields above Five times as much Lixivial Salt, as Majoram. Yet much less than many other opening Plants which are stronger.

Mugwort (b) yields two Drachms and two Scruples; or above half as much more as Agrimony. So that this Plant, though it hath no considerable Tastfe, and in that respect promiseth but little; yet yielding a good quantity of Lixivial Salt, feems no contemptible Medicine to subdue thofe Acidities which either by-cauing Obftructions, or immoderate Fermentations, frequently disorder the Female Sex.

Mint, yieldeth full a greater quantity; and is therefore, partly for the fame caufe so excellent a Stomachick; And Rosemary, (b) which is appropriated both to the Head and Stomach, yieldeth a middle quantity of Salt; more than the chief Cephalks, and less than the chief Stomachicks.

Common Mallow (b) yields 5 Drachms and 2 Scruples, i.e. the 23d part of the whole. So that this Plant, though of a very mild Tastfe, yet yieldeth more Salt than Mint itself a Bitter Plant. Whereby it no longer feems strange, that a Plant of fo soft a Tastfe, should be very Diureticke, and so evidently affeft the reins.

Rhubarb (2 Ounces) yieldeth scarce any fixed Salt, fo far as can be judged by the Tastfe of the Albes, not more than a Grain or two. So that its Salt is, in a manner, wholly volatile; and thereby apter to operate upon the Bilious parts of the Blood; which contain a far greater proportion of Volatile Salt, than do the Serous.

Of the Caput Mortuum or meer Earth, it is observable, that it was near a Quarter of an Ounce or 24th part of the whole; Which is almost Six times as much as the Caput Mortuum of Common Dock: and much more than that of any other Root I have yet calcin’d. Whereby it seemeth probable that Rubarb looth much of its Volatile Part, and therefore of its Virtue, before it comes to our Shops.

Sena (b) yields 4 Scruples and ½ of Salt; or the 85th part.

Falkip (b) yields but one Drachm and ½ Grains, or 102d part.

Colocynthis (b) of the Pulp) yields an Ounce and half of Caput Mortuum, which is almost all Salt. Yet allow half an Ounce of the Salt, and Earth to be wafted in filtration &c. the remaining Ounce is no less than 4½th part of the whole. Which is more than in any of the above named Plants, except the Sea-Scurvygrass.

Q q CHAP.
CHAP. II.

Of the QUANTITIES afforded by the Parts of several Plants distinctly calcin'd.

S H A L L next set down some Tryals, upon one Part of a Plant, as well Organic, as Content, separated from the rest; in answer to these supposed Queries.

Quer. I. What Proportion doth the Lixivial Salt of the Pith or Pithy Part of a Plant, bear to that of the Fibrous, or of the Woody Part? Or whether is there a Fixed Salt always found in either of them? A sufficient Answer to which, must be built upon many Tryals. At present I shall mention only Two; one upon Starch, answerable to the Pithy Parts; the other upon Flax, consisting almost wholly of the Nervous or Topy Fibres: of the Volatile parts whereof, chiefly, I have given some account in the foregoing Idea.

§. 50, 51, 52.

Of Starch, 

it yields not about ½ of Aper, but of Black Coal. For though it be expos'd in a Calcin'ing Furnace to a vehement fire, for 5 or 6 hours, which is longer then will serve to calcine most Bodies: yet would it not in the leaf part, be reduced to Aper; but to the last continued (though the fierceness of the Fire consumed part of it,) as black, as when it was first burnt. So strangely was the remaining part of the Sulphur fixed to the Earth; that in flying away, it did volatilize and carry that away with it. In this Coal or Cinder, there is not the least of a Lixivial or other Table. And although, upon Tryal I find, That the Pith of many Plants, as of a Cabbage Stalk, will yield some quantity of Lixivial Salt; yet it is probably, that generally, it yields less than the Wood.

Of Flax, 

it yields not above 50 Grains of Caput Mortuum or white Ashes, which are Salt. According to vulgar conceit, it would seem to be a very dry Body: yet of 153 parts, 152 are volatile, and being diffil'd would have been collected into Liquor. Hence also appears the great and unexpected Variety in the Proportion of the Earthy Parts, as well as the other Principles of Bodies. Or else, that there are divers kinds of Earths, even in Plants, of which, as well as of Salts &c. some are volatile. For of ½ of this Plant, there remaineth fixed but 50 Grains; whereas of ½ of Rubarb, there will remain near 1920 Grains, i. e. 28 times as much, as the former.

Quer. 2. In what proportion is the Lixivial Salt found in the Gunnes of Plants? and whether is it yielded, more or less, by all? For answer to which, I caused the Eleven following, of each two Ounces, to be calcin'd, and so observ'd,

That Common Resin, yields but one Grain and ½ of Caput Mortuum. So that it will yield but 12 Grains. In this Caput Mort, there is not the leaf particle of Salt, it being altogether infill'd.

Mastic yields gr. 12 of Cap. Mort. But not the least part of Salt. Of this Resin, it is observable; That being set, in a Crucible, within
the fire, before it comes to have thick fumes, it boils up with a very
great foame or froath; and is the only Gum or Rosin (of the Eleven)
that hath this property. So that I suspect, there is a great quantity of
some kind of volatile Spirit, which then flies away; and so, in break-
ing through the Oily parts, huff them up to so great a froath.

Olibanum yields half a Drachm of Caput Mortuum. But it is to be
noted, That the weight is encresed by certain little Spar-Stones, which
in the burning of several parcels, I always found mixed with this Gumm.
These being picked clean out, the Cap. Mort. weigheth not much more
than that of Mafstick. And is in like manner inflidp, when the said
Stones are picked out.

From hence it appears, how proper those Gums are for the Con-
cojtion of Salt Rheuma; according to what I have formerly suggested
from another Experiment.

It may also be noted, that Rosin and Mafstick, seem to be more
purely Acidulous Gums; not only from their consistence which is uni-
form; and their Smell, which is less strong and more pleasant: but
also from the Acid Liquor they yield by Distillation; and in that the
young Leaves of Fir, and especially of Pine, are fower; and is prob-
able that tho of Mafstick, are fo likewise. Whereby there, and
other like Gums are more especiallly fitted for the abovefaiid purpose.
But Olibanum seems, besides its Acidity, to contain some Volatile Alkaly,
and so to be an Acid-Alkaly Gum. For as it hath a stronger Smell
than the former, fo a hotter Taffe; both the ordinary effects of an
Alkaly Sulphur. And being infused in several Menstrua, appears
to confist of two Bodies, one of them more Resinouf than the other.
Of which, it is probable, that the one is made by the Acid parts as the
other by the Alkaly. Whereby it is very well adapted in fome Caeors,
as in a Pleurerife, for removing the Coagulations of the Blood, or its
difposition thereunto.

Asa ficiida yields no lefs than half its weight or an Ounce of Caput
Mort. that is 8 times as much as that of the other Gumas, and 48 times
as much as that of fome of them. Yet doth it not contain one grain of
Salt, fo far as can be judged by its Taffe. Yet the Strength and Loath-
someflis of the Smell and Taffe of the Gumm do argue it to be highly im-
regnated with fome kind of Volatile Alkaly proper to arret thofe
offensive Vapours (to use the vulgar word) which flying, either by
the Blood or Nerves, from part to part, do often prove fo trouble-
fone.

Gumm Arabick yields one Scruple of Cap. Mort. whereof, by the
Taffe, about 1/4 part is Salt.

Euphorbium yields one Drachm of Caput Mort. of which, by the
strength of the Taffe, two Scruples seem to be Salt. Which confirms
a former conjecture (a) of its being an Alkaly Gumm.

Myrrh also yields a Drachm of Cap. Mort. and at leaff two Scruples
of Salt. Of the Eleven, these two Gums have the greateft quantity of Bodies,
of a fixed Alkaly.

Opium yields half a Drachm of Cap. Mort. whereof the one half
is Salt.

Also yields a Drachm of Cap. Mort. containing about one Scruple of
Salt.
Scammony yields two scruples of cap. mort. of which, about half a scruple is salt.

Gutta Gymba yields but half a scruple of cap. mort. of which four or five grains are salt.

So that considering the dose of any cathartic gum, the quantity of the fixed alkali, is extrem small with respect to the volatile parts: In which, therefore, its cathartic power doth chiefly reside.

Yet none of the cathartic gums are without some portion, more or less, of a fixed alkali; though some of the rest are. Which seemeth to prove, That the fixed itself, hath some interest in the business of purgation: as by being a clog to the volatile, and so preventing its being deleterious; or some other way. But the manner of their operation will better be understood, when the volatile parts have likewise been examined.

It may also be of good import, to know, what different quantities of salt are afforded by the tartars of all sorts of wines whereby, partly, as well as by the quantity of the tartar, we may be enabled the better to judge of the nature of wines.
A DISCOURSE

Concerning the

ESSENTIAL and MARINE

Salts of Plants.

Read before the Royal Society, December 21, 1676.

CHAP. I.

In which is shewed the way of making both an ESSENTIAL and a MARINE Salt, out of the LIXIVAL Salt of a Plant.

SOMETIMES since, I took the boldness to present my thoughts to this Honourable and Learned Body in a Discourse concerning Mixture. Wherein I have endeavoured to lay such a Foundation, as might hereafter reduce the Doctrine hereof to Experience and Practice; and to demonstrate the Power and Use of Artificial Mixture. And in further proof of what is therein asserted, I have since made a continuation of Experiments upon the same Subject, in Two Methods. One in the Mixture of several Materia, both Acid and Alkaline, with all Sorts of Bodies. The Other, by calcining them, or, as it were, mixing them with the Fire.

2. §. I shall now proceed to a Third, which is, the mixing them with the Air or expelling them to it; another of Natures grand Materia, which goes sometimes further than the Fire it self, in the dissolution.
solution of Bodies. This I have formerly mentioned for the Imitation
Discourse of Nature, in producing a Marine or Muratick Salt out of the Lixiviial
of Mixture Salt of a Plant. But some Learned Persons then present, seeming to
Ch. 5. Inf. doubte of the Experiment; I thought it requisite to prosecute the same
a little further; so far, if possible, it might become clear and unquestionable.
And because that Method was imperfect, and required half a
year, or a longer time: I thought my self of an other way; which
proved far better, and more expeditious. And which, withall, afforded
me, not only a true Marine Salt, out of the Lixiviial Salt of a Plant; but also another kind of Salt, different from them both; which
may not be improperly called, an Essential Salt or Nitre of Plants. The
History or manner of the production of them both, is as follows.

3. Dec. 15. 1675, I took about half a pound of a strong
Solution of the Lixiviial Salt of Firns; and pouring it into an Earthen
Pan, well glazed, broad and short, expoued it therein to the open
Air, in a Chamber Window, to evaporate of itself.

4. This Solution or Lee, although it was very clear before, and
having stood corked up in a bottle many days, had no Sediment; yet
standing now in the open Air, within the space of 4 or 5 days, it began
to let fall a very white Sediment, like fine Chalk; which increased daily
for 8 or 10 days; amounting at last to about half a Drachme of white,
light and meer Earth, altogether insipid, and when it was well wallked,
shifting not upon the Affusion of Acids.

5. Within the space of a day or two after this white Sediment
began to fall to the bottom; there was also gathered on the top, a
kind of soft Scum or Cremor, wherewith the Solution was covered all
over.

6. Within 8 or 9 days after the first exposing of the Liquor, or
2 or 3 days after the gathering of the Cremor; that Salt, which I take
leave to call, an Essential Salt of Plants, began to appear; shooting
into several little Crystals. Thesè Crystals, as they grew bigger, began
to sink, and at last fell down to the bottom of the Pan.

7. Upon their first generation or shooting, the said Cremor pre-
sently breaks, leaving a bare space round about each Crystal; and upon
the bounds of every space is indented; the space growing bigger and
bigger together with the Crystal in the Centre. And so, by that time
the Crystals are grown to a considerable number and bigness, the Creme-
or vanishes away, the several Circles or bare places breaking at last
one into another all over the Surface of the Lee. After which, it ne-
ver comes again.

8. From whence it seemeth, That the several Circles or bare
Spaces about the Crystals, are made for the more free admision of the
Air, requisite to their Generation. For as there is no Crystal begins to
be formed before there is a breach made in the Cremor; so that breach
is enlarged together with the Crystal. So that as the falling of the
Sediment and the gathering of the Cremor, sheweth that the Air, ans Men-
strum separates some part from the Lee; so the breaking of the Cremor
afterwards, that is a Vehicle, it brings something to it; both in order
to the Generation of the crystals. Nature taking a Method for the Gene-
ration of simpler Bodies, as well as of those which are Composed and
Organical.
9. §. The Figure of these Crystals is angular and oblong, most of them about the fifth, sixth or seventh of an Inch; but none of them very regular. Yet we are not hence to conclude, but that with the help of some Circumstances which might be wanting in the shooting of these; some portion of regular ones may be obtained from this, as well as other Lixivial Salts hereafter mentioned.

10. §. They are somewhat transparent, and of a dark Amber Color, or like that of brown Sugar-Candy. Of a quite different Taste from that of the Solution or Lee out of which they are bred; being not at all Lixivial, but very weak and mild; not Salt, but Bitter in a good degree.

11. §. It is also observable, that Alkaline and Acid Salts being both poured severally upon these Crystals, they fix not, nor are any way affected with either of them. So that these Crystals are no Sort of Tartar, or Tartaraceous Salt. As is plain, from the manner of their Generation; Tartar being still bred in close Vessels these never, but by exposing the Liquor to the Air. As also from their Taste, being not Sweeter, in the leaf, but bitter. And in that Tartar will make a Bollition with Alkaline Salts, which these will not do. Upon which accounts it appears, that they are a Salt different in Nature from all other Salts hither to known, or a new Species added to the Inventory of Nature.

12. §. These Crystals within the space of about a fortnight after their first Generation, did also cease to shoot any more, but only increased a little in their Bulk. After which time, I daily expected to see the production also of a true Marine Salt. And about two months after the said Essential Crystals had done shooting, and not before, this also began to shoot, in many small Crystals, and at the top of the Solution, as the other did; still falling to the bottom as they grew bigger.

13. §. The Size of most of them was near that of the Flakes or Grains of Bay-Salt. The Colour of some of them white, of others transparent; and of others white in the Centre, with transparent Edges; as is also usual in the Crystals of Common Salt.

14. §. The Figure of most is a perfect square, and of very many coming near to a Cube; which is also the Figure of Common Salt, and seldom an exact Cube. An exact Cube, being the constant property of no Marine Salts, that I know of, except that of the Dead Sea. Divers Tab. 83, of them were also raised as it were by several steps from a deep Centre to the Top; as is often seen in the common shooting of Common Salt; and not in any other. Their Taste is neither Lixivial, as that of the Solution out of which they shoot; nor bitterish, as that of the Essential Crystals; nor fowerish, as that of Tartar; but the perfect Taste of Common Salt.

15. §. It is also to be noted, That if Oyl of Vitriol, and some other strong Acids, be poured upon this artificial Sea-Salt, they make an Efficence together: but if Spirit of Salt or Spirit of Nitre either be poured on it, though it be never so strong it liareth it not. In both which, and all the formentioned respects, it answers to the Properties of a Marine or Common Salt, which no other Salt doth. I conclude it therefore to be a true Marine Salt produced by Art in the imitation of Nature.
HAVING made the Experiment, that both an
Essential and Marine Salt may be produced out
of the Lixival Salt of a Plant. I thought it
probable, that neither the one nor the other,
was always the same, but that as they had their
general properties which made them to be of
two general kinds; so they might have some
special property, for the distinguishing of each
kind into several Sorts. And withal, that
Wherein is shewed, That the said E S S E N T I A L
and M A R I N E Salts of Plants are both of different
Sorts.

in a warmer season, than before taken, the Tryal hereof might be
finished in a shorter time.

2. §. For the making of which, I conceived it requisite to remove
an Opinion which seemed to lie in my way; &c. That there is little
or no difference between the several Lixival Salts of Plants, as some
Learned men have thought. But either there is a difference, or not: if
not, it should be proved; and if there be, it should then be justly stated,
what that difference is. For the doing of which, I chose this Method; I
took an equal quantity of the whitest and purest Salts of divers Plants,
all made by an equal degree of Calcination; and dissolved them all se-
verally in an equal quantity of water. And pouring likewise an equal
quantity, as about 10 or 12 drops of each into a spoon, I tasted them
severally. Whereby it was very evident, that they were not all of one
Kind, but of very different ones, both as to strength and kind; and
therefore different in Nature also. The Salts I made tryal of were
those of Sorrel, Anise, Wormwood, Mallow, Ash, Tartar and others:
and upon half a Drachm of each I poured 3½ of water. The Solu-
tions are here present to be tasted. By which the differences will ea-
asily be observed, and particularly that the Salt of Wormwood or Scru-
vygras, is almost as strong again as the Salt of Anise, or Sorrel: and that
the Salt of Ash is above twice as strong, and that of Tartar above
thrice as strong, as that of Sorrel, and almost thrice as strong as that of
Wormwood or Scruvygras, So that he who shall give half a Scruple,
suppose of Salt of Tartar; instead of half a Scruple of Salt of Worm-
wood, or other like Salt: he may as well give a Scruple of Rose of
Tulip, for a Scruple of the powder, or almost three Drachms of Rhu-
barb, or other like Purge, instead of one. And the like is to be said
of other Lixival Salts in their degrees.

3. §. Having observed thus much, I proceeded to repeat the for-
mer Experiment, with some of the aforesaid, and some other Vegetable
Salts, the best calcined, and the purest, that could be made for this
purpose, being these Six Salts, &c. of Rosemary, Garden Scruvygras,
Black
IV. Salts of Plants.

Black Thorn, Common Wormwood, Afs, and Tartar. All which dissolved severally in fair water, I exposed in a Chamber window, and not in Winter, as before, but in the heat of Summer, &c. on the 19 of July, to evaporate of themselves.

4. §. The Effect was, That the third day after their being expos'd, the Essential Crystals began to shoot in three of the Solutions, &c. in that of Rosemary, of Garden Scourgrasj, and of Black Thorn. On the fourth day, in that of Wormwood. On the fifth day, in that of Afs. In that of Tartar, not at all.

5. §. These Essential Crystals began, in all, to shoot at the top, and then to fall to the bottom; as in the Experiment before. But as there was very little of the white Sediment before mentioned, that preceded; So no Scum or Creamor at all. Which although a more perfect Calculation, it seems, did here almost prevent; yet did not in the least destroy the aforesaid Essential Salt, but rather make way for its more speedy and copious Production; exhibiting likewise a distinct Species in several of the Solutions.

6. §. For first, the Crystals of Rosemary (the largest of them) were about the bigness of a Rice-Corn. In Figure almost like a Tip-Cat, which Boys play with, split down the middle. Each Tip being cut into 5 sides all ending in a point: the middle part divided into 7, all drawn by parallel Lines; the topmost with the lowermost but one, on each side, being three exact Squares.

7. §. The Crystals of Black Thorn are most of them pointed with just six sides of Equal Measure: very like to the shooting of true Crystal it self. From the topmost of which six Sides, a Line being drawn out, runs parallel to a broad Base, wherein each Crystal stands, So that they are in some sort of a Rhomboid Figure.

8. §. The Crystals of Scourgras have also a very elegant and regular Figure, which is in a manner compounded of the two former now described. But they are nothing near so big as the largest of them, being no bigger than a Grain of that which we call Pearl Barley.

9. §. The Crystals of Wormwood have also very many of them a regular Figure; but quite different from that of the Crystals before mentioned: each Crystal being a little Cylinder, having that it is constantly somewhat smaller at one end than the other: as it was one half of a Rowling-pin. And not evenly Circular, but cut out by Six Sides of equal Measure: almost as in the Crystal of Nitre. So that contrary to what is seen in the forementioned Crystals, the ends of these of Wormwood are not pointed, but flat; and cut at Right Angles with the Sides.

10. §. The Crystals of Afs, though by their properties they appear likewise to be Essential; yet are nothing near so regularly figured, as all the forementioned.

11. §. The Colour also of the said Crystals is somewhat different: Those of Afs being of a brown transparency, almost like those of Firn. Those of Wormwood being also brownish, but paler. Those of Rosemary and Scourgras having some little Tinifure, yet very clear. But those of Black Thorn without the leaf Tinifure, and as clear as Crystal it self.
12. §. None of these Essential Crystals have any hot fiery Taste, but are very mild, and sensibly Bitter; especially, about the Root of the Tongue: as is also observable of some Plants hereafter mentioned, in speaking of the different Tastes of Plants.

13. §. Oyl of Vitriol dropped upon these Crystals doth not affect them in the leaft: yet dropped into the several Solutions out of which the Crystals are produced, immediately causeth a great Effervescence.

14. §. Of the Solutions above named, that of Salt of Tartar was the 6th. Whereof it is remarkable, That having waited several Months together, I could not observe the leaft Essential Salt to be therein produced in all that time. Whether there be any other Vegetable Salts, besides this of Tartar, which will not yield the Essential above described, I have not yet experimented.

15. §. In the mean time, it is very probable, that most of them afford more or fewer of the said Crystals. In regard they are Plants of a very different kind, which I made trial upon: as Garden Scourgrafs, very Hot; Rosemary, very Aromatic, Wormwood very Bitter; Black Thorns, Afringent and Sour. And it is also plain, That the said Essential Salts contained in the Liquor, are not altogether one and the same, but of divers Sorts.

16. §. ABOUT 7 or 8 days after the Essential Crystals were produced; the Marine Salt did also begin to flow; first in Rosemary; quickly after, in Scourgrafs; Next, in Black Thorns and Wormwood, &c. after the space of a week or 10 days more. And in all of them with some difference of Size and Figure.

17. §. The plainest of all, was that produced out of the Salt of Black Thorn, consisting for the most part of very small Crystals, not above the 15th of an Inch square, as also thin, shaped like a Dach Tile used for Chimneys. Many others were very thick, and near to a Cube. Most of which were a little hollowed in the middle, like a grinding Marble or Salt-Cellar; and the hollow bounded by 4 plain and equal Sides, all descending a little towards the Centre; and measured by two Cross Lines, which laid upon the four Angles of the Square, and so cut one the other at Right Angles. Both which Properties are likewise usually seen in the Crystals of Common Salt.

18. §. In Wormwood, many of these Crystals, besides the plain ones, were figure’d crossways like a Dagger-Hilt. Which was sometimes naked, and sometimes inclosed in a square and almost Cubical Box. Many others were figure’d into Sprigs made up of four chief Branches standing crosswise, and those subbranched; and all the Branches made up of little square Crystals, clustered together in that Figure. The sprigg Figure of these Crystals is not accidental, but hath constantly come after they had been three times dissolved, and the Solution exposed to evaporate.

19. §. The Marine Salt of Rosemary hath also some variety. For besides the plain ones above described, there are some thick Squares, which have also a square hollow descendit by five, six, or seven narrow steps, towards the Centre; being in Figure, having these Steps, somewhat like the Hopper in a Mill.

20. §. Upon a second Solution of the same Salt, there fliotes another sort of Square; which is not plain on the edges, as the above-named, but scalloped or florid all round about, not unlike the Leaves of some Plants.
21. §. The Crystals of Marine Salt of Scorzygrafs are somewhat like to those of Rosemary now described.

22. §. As for the Lixivial Salts of Ash and Tartar, though in a Month or Five Weeks Space, they yield some Crystals of very clear Salt: yet of Marine Salt neither of them yieldeth the least particle. So that of these Six Lixivial Salts, &c. of Rosemary, Scorzygrafs, Black Thorn, Wormwood, Ash and Tartar, all, but that of Tartar, yielded an Essential Salt. And all, but those of Ash and Tartar, yielded a Marine, such as is above described. All which salts both Essential and Marine, together with their Models, made of white Alabaster, I have here ready to be seen.

23. §. Of those that yield these Salts, or either of them, it is further to be noted, That there is a considerable difference in the Proportion or Quantities which they yield. The Rosemary yields store both of Essential and Marine, but more Essential. Wormwood and Scorzygrafs more Marine. Black Thorn left of Either. The Ash no Marine, and the Tartar neither the Essential nor Marine, as hath been said.

24. §. From what hath been said, I deduce only at present these Three Corollaries. First, That a Lixivial Salt, is not only a compounded Body, &c. of Salt, Sulphur, Air and Earth; but even a compounded Salt, containing both a Vegetable Nitre, and a true Sea Salt.

25. §. Secondly, That the Exposing of Bodies, in the manner above shewed, may justly be accounted one Part of Chemistry hitherto Deficient, and much farther to be improved for the Discovery of the Nature of Bodies. For as Nature chiefly compoundeth Bodies by Digesting them, and do either shutting out or keeping in the Air: So the Discovereth them by Exposing, and do neither shutting in the Air, nor keeping it out, but leaving it free to come and go; and thereby to bring, and carry off whatsoever is necessary for the Separation or Solution of Bodies. For the Sea itself (to confine the similitude to our present case) is but as a Great Pan, wherein all kinds of bodies being long exposed, were thoroughly resolved, ultimately yielding from the rest of their visible Principles, that which we call Sea Salt.

26. §. Lastly, if by Exposing and Dissolving we can make one Salt; then by Compounding and Digesting we may make another, yea any other Salt; either a Fixed of a Volatile, or a Volatile of a Fixed. That is to say, a Volatile Salt may be so separated from other Bodies, as to become Fixed; or a Fixed Salt may be so mixed with other Bodies as to become Volatile. For that any Salt should of itself become Fixed or Volatile, is a Fixion not grounded upon Experiment.

27. §. As for the Virtue of the Essential Salts above described, I believe they will be found upon triall, not contemptible in some Cases. For which amongst other reasons, I have been the more particular
28. §. When I made the Experiments for this and the foregoing Discourse, not having so good convenience at home for making the salts I used: I procured them all (except that of Firme, which I made myself) to be purposely prepared by Mr. John Blackstone a London Apothecary, who assured me of his great care herein; and particularly, that he added no Nitre to whiten any of the salts with, as is commonly done for that of Tartar.

I do declare, That all the Lixivial Salts mentioned in this and the foregoing Discourse except that of Firme, were faithfully prepared by me.

John Blackstone.
A DISCOURSE
OF THE
COLOURS
OF
PLANTS.

Read before the Royal Society, May 3, 1677.

CHAP. I.

Of the COLOURS of Plants in their Natural Estate.

AVING formerly made some Observations of the Colours of Plants; I shall now crave leave to add some more to them of the like Nature. None of which, nor any of the Conclusions thence deduced, will, if duly considered, appear contrary to the Hypothesis and Experiments of Mr. Boyle, Mr. Des Cartes, Mr. Hooke, Mr. Newton, or any other, concerning Colours. As not having respect to the Colours of all Bodies in general. Nor to the Body of Colour, which is Light; Nor to the formal notion of Colours (ad extra) as the Rays of Light are moved or mixed: But to those Materials, which are principally necessary to their Production in Plants. Concerning which, the present Discourse shall be reduced to these Three general Heads, fel. 2. 9.
The Colours

2. §. First, of those several Colours, which appear in Plants in their natural Estate.

3. §. Secondly, As they appear upon the Infusion of Plants into several Sorts of Liquors.

4. §. Thirdly, As upon the Mixture of those Infusions, or of any one of them with some other Lignor, or other Body.

5. §. As they appear in the Plants themselves, it may be observed in the first place, That there is a far less Variety in the Colours of Roots, than of the other Parts; the Parenchyma being, within the Skin, usually White, sometimes Yellow, rarely Red. The Cause hereof being, for that they are kept, by the Earth, from a free and open Air; which concurreth with the Juices of the several Parts, to the Production of their several Colours. And therefore the upper parts of Roots, when they happen to stand naked above the Ground, are often dyed with several Colours: so the tops of Sorrrel Roots will turn Red, those of Mullen, Turnips and Radishes, will turn purple, and many others green. Whereas those parts of the same Roots which lie more under Ground, are commonly White.

6. §. As Roots are most commonly White; so the Leaves, Green. Which Colour is so proper to them, that many Leaves, as thistles of Sage, the young sprouts of St. Johnswort, and others, which are Reddish when in the Bud; upon their full Growth, acquire a perfect Green.

7. §. The Cause of this Colour, is the action of the Air, both from within, and from without the Plant, upon the Juices thereof, whereby it strikes them into that Colour.

8. §. By the Air from without, I mean that which surrounds the Body of the Plant: which is the Cause of its Greens, not merely as it is contiguous to it, but as it penetrates through the Pores of the Skin, thereinto; and so mixing with the Juices thereof, plainly deys or strikes them into a Green.

9. §. By the Air from within, I mean, that which entering, together with the Aliment, at the Root, thence ascends by the Air-Vessels, into the Trunk and Leaves, and is there transfixd into all the several Juices, thereby likewise concurring to their Verdure. Whence it is, that the Parts of Plants which lie under Water, are Greens as well as those which stand above it; because, though the ambient Air, contained in the Water be but little, yet the want of it is compensated, by that which ascends from the Root.

10. §. And therefore it is observable, that the Stalks of Mallow, and some other Plants, being cut transversely, though the Parenchyma in the Barque be white, yet the Sap-Vessels which lie within that Parenchyma, are as Green as the Skin it self; so that, because they stand close to the Air-Vessels, the Parenchyma, I say, which is intercepted from the Air, without, by the Skin; and from the Air within, by the Sap-Vessels, is white; but the Skin, which is exposed to the Air without, and the Sap-Vessels which are next neighbours to that within, are both equally Green. So likewise if a Carrot be pluck'd up, and suffered to lie sometime in the open Air; that part which standeth in and near the Centre, amongst the Air-Vessels, will become Green, as well as the Skin, all the other Parts continuing of a Reddish Yellow, as before. The Air therefore, both from without, and from within the Plant, together with the Juices of the Plant, are all the concurrent Causes of its Verdure.
11. §. BUT how doth the Air concur to the Greeness of Plants? I answer: Not as it is merely either cold or dry, or moist, nor yet quiescent Air; but as it is a mixed, and particularly, a Saline Body: that is, as there is a considerable quantity of Saline Parts mixed with those which are properly Aereal. It being plain from manifold Experience; That the several kinds of Salts, are the grand Agents in the Variation of Colours. So that, to speak strictly, although Sulphur be indeed the Female, or Materia Substrata, of all Colours; yet Salt is the Male or Prime Agent, by which the Sulphur is determined to the Production of one Colour, and not of another.

12. §. If then it be the Air mixed with the Juices of a Plant, and the Salt of the Air, that makes it Green; It may further be asked, what kind of Salt? But this is more hard to judge of. Yet it seemeth, that it is not an Acid, but a Subalkaline Salt; or at least some Salt which is different from a simple Acid, and hath an Affinity with Alkalies.

13. §. One reason why I do judge, is, Because that although all Plants yield an Alkalie, or other Salt different from an Acid, and some in good quantity; yet in most Plants, the Predominant Principle is an Acid. So that the Supply of an Acid Principle from the Air, for the Production of a Green Colour, as it would be superfluous; So also ineffectual: a different Principle being requisite to the striking of this, together with the Sulphur, into a Green Colour.

14. §. I suppose therefore, That not only Green, but all the Colours of Plants, are a kind of Precipitate, resulting from the concurrence of the Saline Parts of the Air, with the Saline and Sulphurous Parts of the Plant; and that the Subalkaline, or other like Saline Part of the Air, is concurrent with the Acid and Sulphurous Parts of Plants, for the Production of their Verdure; that is, as they strike altogether into a Green Precipitate. Which also seemeth to be confirmed by divers Experiments hereafter mentioned.

15. §. THE Colours of Flowers are various; differing therein not only from the Leaf, but one from another. Yet all seem to depend upon the general Causes aforesaid. And therefore the Colours of Flowers, as well as of Leaves, to result not solely from the Contents of the Plant, but from the concurrence likewise of the ambient Air. Hence it is, that as they gradually open, and are exposed to the Air, they fill either acquire, or change their Colour: no Flower having its proper Colour in the Bud, (though it be then perfectly formed) but only when it is expanded. So the Purple Flower of Stock-July Flowers, while they are in the Bud, are white, or pale. So Butcher's Buttons, Blow Bottle, Poppy, Red Daisies, and many others, though of divers Colours when blown, yet are all white in the Bud. And many Flowers do thus change their Colours thrice successively; as the youngest Buds of Ladies-lookinglfs, Englofs and the like, are all white, the larger Buds are purple or murrey, and the open Flowers, blow: according as they come still newer, and are longer exposed, to the Air.

16. §. But if the Colour of the Flower dependeth on the ambient Air; it may be asked: How it comes to pass then, that this Colour is various, and not one, and that one, a Green? that is to say that all Flowers are not Green, as well as the Leaves? In answer to this Three things are to be premised.
17. §. First, What was said before, is to be remembered, that here the Aer is not a solitary, but concurrent Cause. So that besides the Efficacy of this, we are to consider that of the several parts of the Plant, by which the Contents both Aerereal and Liquid are supplied to the Flower.

18. §. Secondly, That in the Lympheduits of a Plant, Sulphur is the predominant Principle, and much more abounding than in any other part of a Plant, as also hath been formerly shewed.

19. §. Thirdly, That it appears, according to what we have observed in the Anatomy of the Flower, that the quantity of Lympheduits with respect to the Aer-Vessels is greater in the Flower than in the Leaf:

20. §. It seems therefore, that the Aer-Vessels, and therefore the Aer, being predominant in the Leaf; Green, is therein also the predom-inant Colour. I say predominant, because there are other Colours lye vailed under the Green, even in the Leaf, as will hereafter appear more manifest.

21. §. On the contrary, the Lympheduits, and therefore the Sulphur, being more, and the Aer-Vessels and therefore the Aer, less, in the Flower than in the Leaf; the ambient Aer alone is not able to con-trole the Sulphur so far, but that it generally carries the greatest porc in the Production of the Colour. Yet in different degrees; for if the proportion betwixt the Lympheduits and the Aer-Vessels be more equal, the Flower is either White or else Yellow, which latter Colour is the next of kin to a Green. If the Sulphur be somewhat predominant, the Flower will shew it self Red at first; but the ambient Aer hath so much power upon it, as gradually to turn the Red into a Blew. But if the Sulphur be much predominant, then the Acid of the ambient Aer will heighten it to a fixed Red.

22. §. Hence it is, that Yellows and Greens are les alterable, upon the drying of Plants than other Colours; so. Because the Aer being pre-dominant in their Production, they are the less lyable to suffer from it afterwards. Whereas Reds and Purples, in the Production whereof Sulphur is predominant, are very changeable. So the Red Flowers of Lysimachia, upon drying, turn Purple, and the young purple Flowers of Gloxin turn Blew. So likewise the Purple of Bilberries, and the Crimson of baked Damaclae, both turn Blew. For being gathered, and so wanting a continued supply of fresh Sulphur, to bear up the Colour against the force of the Aer; it strikes it down at last from Red to Purple or Blew. I conclude therefore, that one Principal Cause of the Variety of Colours in the Flower, is the over proportion of the Lympheduits to the Aer-Vessels, and therefore the dominion of the Sulphur over the Aer, therein.

23. §. If it be objected, that the Aer doth not deepen, but heighten the Colour of the Blood: I answer, First, That I am not now speaking of Animal, but of Vegetable Bodies; the same Aer which heightens the Colour of Blood one way, may deepen that of a Flower, another: nay and may heighten that of some Flowers too, some other way.

24. §. And therefore, Secondly, it is to be considered, That as there is not one only, but divers Saline Principles in the Aer; so are there also in the several Parts of one Plant; as in the Root, of one sort; in the Leaves, of another; in the Flower, of another; and so in the other Parts. For since the Figuration of the Parts of a Plant dependeth chiefly
chiefly upon the Saline Principles: and that the Flower hath a different Figure from that of the Leaf: it follows, that there is some Saline Principle in the one, which is not in the other, especially, all in such Flowers, whose Figures are cut out by a greater Variety and Complication of Lines. The Leaves therefore, though variously shaped, yet agreeing so far in one common Figure, as usually to be flat; it therefore seemeth plain, that there is a Saline Principle in them all, so far one, as to be the chief Cause of that common Figure: and in concurrence with the ambient Air, to be likewise the chief Cause of one common Colour, sc. a Green.

25. 6. Whereas the Figure of the Flowers, and therefore their Saline Principle, being more various, and commonly distinct from that of the Leaf; it will easily concur with as a great Variety of Salts in the Air, whether Acid, Alkaline, Nitrous, Urinous, Armoniacal, or any other therein exsistent, to the Precipitation of the Sulphur into the like Variety of Colours. Thus far of the Colours of Plants as they appear in their Natural Estate.

## Chap. II.

Of the Colours of Plants by Infusion.

The next general Inquiry, proposed to be made, was this. After what manner the Colours of Plants shew themselves, upon their Infusion into Liquors. The Liquors I made use of for this purpose, were three, sc. Oyl of Olives, Water, and Spirit of Wine. The Water I used was from the Thames, because I could not procure any clear Rain Water, and had not leasure at present to distill any. But next to this, that yields as little Salt as any,

2. As for Oyl, it is known, that most Plants either by Cordion or long Infusion, will give it their Green Colour. I have likewise tried some Tennes, and find they will do indifferently well; as Saffron, which, by Infusion in Oyl, gives it a light golden Tincture.

3. Divers Aromatic Plants, as Mint, Majorane, &c. being dried and infused in Oyl give it a double Tincture, both green and yellow; one drop of the Oyl flowing greens; but a good quantity of it held up against a candle looketh redish or of a deep yellow.

4. But there is no Vegetable yet known which gives a true Red to Oyl, except Alkane Root; with which, some colouring either common or other Oyl, vend it under the name of the Red Oyl of Scorpions.

5. §. These things confirm what we have said concerning the Cause of Colours in the Leaves and Flowers of Plants, upon this twofold Consideration. First, that Oyl is the most proper Mixtura of Sulphur. Secondly, that Oyl have a greater congruity with Acids than with Alkalis; as I have formerly shewed. 6. §.
6. §. I say therefore, that in Blows, Purples and especially Reds, the predominant Principles being Sulphur and Acid, the Oil either absorbs the Sulphur of it, or at least, unlocks it from the Acid parts; whereby both of them are bestowed seperately to their like parts in the Oil; upon which their disunion the Colour varieyes: that depending, not upon either of them alone, which of themselves are Colours, but upon both united together.

7. §. On the contrary, a Green Colour not depending on a predominant Acid, but an Alkaly, or some Saline Principle different from an Acid; this will not so easily be imbibed separately into the Pores of the Oil, but only by mediation of their Sulphur. So that being both imbided without any disunion, they still retain the same Colour they had before in the Plant.

8. §. Hence also it is, that red Roses being dried and infused some time in Oil of Anise Seeds, a more potent Mensrurum than Common Oyl, they wholly lose their own Colour, and turn white; the Oil remaining Limpid, as at the first. That is the Sulphur or that part of it on which chiefly the Red depended, is absorbed separately by the Oyl, and so the Colour vanishes.

9. §. A SECOND Mensrurum I made use of, was Water. And First, Alkane Root, which immediately tinctures Oil with a deeper Red, will not colour Water in the least.

10. §. Next it is observable, That Water will take all the Colours of planets in Infusion except a Green. So that as no Plant will by Infusion give a perfect Blow to Oyl, so to their is none, that I know of, which, by Infusion will give a perfect Green to Water.

11. §. But although the Green Leaves will not give their visible Colour, by Infusion in Water; yet they will give most other Colours, as well as the Flowers themselves. So the Green Leaves of Cinquefoil, give a Tincture no higher than to resemble Rhenish Wine; those of Hyssop, Canary, of Strawberries, Malaga; of Mint, Muscadine; of Wood-Sorrel, Water and some drops of Claret; of Blood-root, White and a daith of Claret; and those of Barren make a Tincture near as red as ordinary Claret alone. All Aromatic hot Plants, give a yellow-red Tincture, or colorum ex luteo rubrum. All Plants with a yellow Flower give either a pale citrine or yellowish Tincture; and the like. Yet all give not their Tincture in the same space of time; some requiring a fortnight, others a week, others five, three or two days, and some but one, or half a day. From hence it appears, that the Colours of most Flowers are begun in the Leaves; only Green being therein the predominant Colour, as a veil spread over them, conceals all the rest. But passing on into the Flower, where the Acr-Poises, as is aforesaid, are under the dominion of the Lympheducts, they flew themselves distinctly.

12. §. A THIRD and the last Mensrurum I made use of, was Spirit of Wine. And here it is to be remarkeid: That as Oyl rarely takes a Red, there being but one known Infusion of it; nor Water, a Green: So neither Spirit of Wine, a Blow. I have tryed with several blow Flowers, as of Lark-heel, Violet, Mallow, Borage, and others, whereof it will not take the least Tincture.

13. §. Again though no Blow Flowers, that I know of, will give a Blow Tincture to Spirit of Wine: yet having been for some days infused in
in the said spirit, and the spirit still remaining in a manner Limpid, and void of the least Ray of Blow; if you drop into it a little Spirit of Sulphur, it is somewhat surprizing to see, that it immediately strikes it into a full Red, as if it had been blew before; and so, if you drop Spirit of Sal Armoniac or other Alkali upon it, it presently strikes it Green. Which further confirms what have been before said of the Causes of Vegetable Colours.

14. §. It is also observable, That the Green Leaves of Fennel, which give a Mucilaginous Red, with some Rays of Claret, to Water, gives a pure and perfect Green to Spirit of Wine: and is the only Plant of all that I have yet tried, which doth the like.

15. §. It is likewise to be noted, That both Yellow and Red Flowers give a stronger and fuller Tincture to Water, than to Spirit of Wine; as in the Tinctures of Cowslip, Poppys, Clove-July-Flowers and Roses, made both in Water and Spirit of Wine, and compared together, is easily seen. So that for Tinctures made with Flowers, whether for Medicines, or other purposes, Water, with respect to the Colour, is the better Mensurum. I say for Tinctures made with Flowers; for there are some other Parts, especially Gummos, as Camphora, Myrrh and Aloes, which give their Tinctures full and clear, only to Spirit of Wine. Some of which are used by Leather-Gilders, and others, for the washing over of Silver, so as to give it the Colour of Gold. Thus far of the Colours of Plants as they appear upon Infusion.

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Chap. III.

Of the Colours of Plants produced by their Mixture with other Bodies.

The last general Enquiry proposed to be made, was this. After what manner they would exhibit themselves upon the Mixture of those Infusions, or of any one of them with some other Liquor.

2. §. A strong Infusion, or the Jusye of the Lees of Rose-Tree, Raisins, Strawberry, Cinquefoil, Gooseberry, Primrose, Jerusalem Cowslip, Bear's-foot, Bear's-foot, Penny, Briot, Laurel, Goats-board, dropped upon Steel, make a Purple Tincture. But that of Vine-Leaves scarce maketh any Tincture at all. So that there is something else besides Somewhats concurring to the Purple upon Steel.

3. §. Saccharum saturni dropped on a Tincture of Red Roses, turneth it to a saffron pale Green.

4. §. Salt of Tartar dropped upon the same Tincture, turneth it to a deeper Green.
5. §. Spirit of Harts Horn dropped upon a Tincture of the Flower of Lark-heel and Borage turn them to a verdigris Green.
6. §. Spirit of Harts Horn dropped on molt green Leaves doth not change them at all. The like Effects have Aq. Calcis, and Spirit of S. Armoniac.
7. §. These Experiments seem to confirm, That it is some Alkaline or other like Salt in the Aer, which is predominant in the production of Green in the Leaves of Plants.
8. §. Salt of Tartar dropped on the white Flowers of Daisy, changeth them into a light Green. Which as it further confirms the aforesaid Position; so likewise argues, That Whiteness in Flowers, is not always from the defect of Tincture: but that there may be White, as well as Yellow, Green, Red or Blow Tinctures.
9. §. Spirit of Sulphur dropped on the green Leaves of Adonis Flower, Everlasting Pease, and Holy Oak, turns them all Yellow.
10. §. Spirit of Sulphur on a Tincture of Saffron changeth it not.
11. §. Spirit of Sulphur on the Yellow Flower of Crowfoot alters them not. Neither are they changed by the Action of Alkalies.
12. §. So that it appeareth, that in all Yellows, the Sulphurous Acid and Alkaline Parts are all more equal.
13. §. Spirit of Sulphur on a Tincture of Violets turns it from Blow to a true Lacch, or middle Crimson.
14. §. Spirit of Sulphur upon a Tincture of Clove-July-Flowers makes a bright blood Red. Into the like Colour, it heightens a Tincture of Red Roses.
15. §. So that as Alkali, or other Analogous Salts, are predominant in Greens, so Acids in Reds, especially in the brighter Reds, in the Leaves and Flowers of Plants. Hence it is, that Spirit of Nitre dropped upon the Blow Flower of Ladies Looking-Glass, Larkspur, Borage, turns them all Red, &c. into the Red of Common Lychnis. But (which is particularly to be noted) being dropped on the said Red Flowers of Lychnis, alters them little or nothing: because, that very Colour is therein produced by a copious admixture of the like Principle.
16. §. The Summ therefore of what hath now been said, of the Causes of Vegetable Colours, is this: That while their Sulphur and Saline Principles, only swim together, and are not as yet united into one Precipitate, no Colour results from them, but the Contents are rather Limpid, as usually in the Root, and many other Parenchymous Parts.
17. §. When they are united, and the Alkaline are predominant, they produce a Green.
18. §. When the Sulphur and the Alkaline are more equal, they produce a Tann.
19. §. When the Sulphur, Acid and Alkaline, there a Yellow.
20. §. When the Sulphur predominant, and the Acid and Alkaline equal, there a Blow.
21. §. When the Sulphur and Acid are predominant to the Alkaline, then a Purple.
22. §. When the Sulphur predominant to the Alkaline and the Acid to them both, a Scarlet.
23. §. Lastly, When the Acid predominant to the Alkaline, and the Sulphur to them both, a Blood-Red : which is the highest and most Sublimious Colour in Nature.

24. §. From the Premisses, divers Rules do also result for the making of Tinctures, either for Medicines, or for any other purposes.

25. §. I shall only add one or two Notes. As first, that of all Colours, Yellows are the most fixed and unfading. As for instance, if you drop either a Solution of Tartar, or of Spirit of Sulphur upon a Tincture of the Yellow Flowers of Crawford, of Adonis, or of Saffron, neither of them will alter their Colour. Which shews the strength of most Yellows, to resist all manner of Impressions from the Aer.

26. §. Again, that the use of Salts, is not only to heighten or deepen Colours, but also to fix and make them permanent. As for instance, The Tincture of Clove-July-Flowers, made either with Water or Spirit of Wine being exposèd to the Aer, will oftentimes turn into a Blackish Purple. But the addition of a few drops of Spirit of Sulphur, doth not only heighten the Colour, but renders it stable and permanent.

27. §. Likewise, of Salts themselves there is choice to be made. For there are some, which although they fix the Colour, yet, will a little give, as we say, and not hold throughly dry; as most Lixivial Salts, and Stilatious Acids. But there are some Salts, which will not give in the least, as Alum, that in Lime-Water and some others; which latter, is so far from being mofitified, that it is rather petrifled by the Aer. For which reason I take it to be one of the best Liquors for a stable and permanent Green, and some other Colours.

28. §. Amongst all Water-Colours, the rarest, and most difficult to make clear bright and permanent, is a Blew. There are many Flowers of an excellent Blew, as those of Buglos, Lark-heel and others, but they easily fade. And there are very few Flowers that will strike into a Blew by any Liquor; being almost all changeable into Green, Purple or Red. Yet some few there are, in which this Colour may be produced. As for instance, the Flower of Lathyrus or Parjeverlasting, which upon the affusion of Spirit of Harts-Horn is changed from a Peach, to as pure a Blew, as the best Ultramarine: that which hitherto is, I think, wanting in Water Colours. Spirit of Harts Horn was the Liquor I used; but I question not, but that other Alkalies, and particularly Lime-Water, will have the like Effect, and so render it the more stable.

29. §. From what hath been said, we may likewise be confirmed in the use of the already known Rules, and directed unto others yet unknown, in order to the variation of the Colours of Flowers in their Growth. The effecting of this, by putting the Colour desired in the Flower, into the Body or Root of the Plant, is mainly talked of by some: being such a piece of cunning, as for the obtaining a painted face, to eat good store of white and Red Lead.

30. §. The best known Rules are these Two: First, that the Seed be used above any other part, if the variation of the Colour be intended. One reason whereof is, because that part being but very small, the Tincture of the Soy will have the greater proportion to those of the Seed. Besides, the tender and Virgin Seed, being committed to the Soy, will more easily take any peculiar Tincture from it, then an other
other Part, which is not so susceptible, and hath been tinctur'd already. All the strange varieties in Carnations, Tulips, and other flowers are made this way.

31. §. The other Rule is, To change the Soil, or frequently to transplant from one Bed to another. By which means, the Plant, is as it were, superinpregnated with several Tinctures, which are prolific of several Colours; which way is taken for Roots and Slips.

32. §. The consideration whereof, and of the foregoing Experiments, may direct us not only in changing the Bed, but also in compounding the Soil, as by mixing such and such Salts, or Bodies impregnated with such Salts, I say by mixing these Bodies in such a proportion, with the Soil, as although they have no Colour in themselves, yet may be effectual to produce a great variety of Colours in the Plants they nourish; supplying the Plants with such Tinctures, as shall concur with the Air, to strike or precipitate their Sulphur into so many several Colours, after the manner above explicated: and so to bring even Nature's Art of Painting, in a great part, into our own power.
A DISCOURSE
OF THE
DIVERSITIES and CAUSES
OF
TASTS
CHIEFLY IN
PLANTS.

Read before the Royal Society, March 25. 1675.

CHAP. I.

Of the several Sorts of SIMPLE and COMPOUND
DED Tafts; and the DEGREES of both.

HAVE formerly published some Notes, concern-
ing Tafts. Since then, I have made other Observa-
tions upon the same Subject: and these have pro-
duced further Thoughts. I will sum up all in giv-
ing an account, First, of the Diversities; and then,
of the Causes of Tafts, chiefly in Plants.

2. §. The Diversities of Tafts are so many, and
so considerable; that it seemeth strange, to see the matter treated of
both by Philosophers and Physicians, with so much scantness and defect.
For the Subject is not barren, but yieldeth much and pleasant Variety.
And doth also appear to be of great import unto Medicine. Besides,
it is preposterous to discourse of the Causes of Tafts, before we have
taken an account of their Diversities; Whereof therefore I shall in the
first place, exhibit the following Scheme.
The Diversities

3. **TASTS** may be distinguished by these Three general ways. First, with respect to the **Sensation** it self. Secondly, with respect to its **Duration and Terms.** Thirdly, with respect to its **Subject.**

4. **The Sensation** it self is differed two ways, by its **Species,** and by its **Degrees.** With respect to the **Species, Tastes are Simple, or Compounded.** By **Simple Tastes,** I mean not such, as are never found in conjunction with other Tastes: but the **Simple or Single Modes of Taste,** although they are mixed with others in the same body. As for example, the **Taste of a Pepper,** is **Acidulous; of Rhubarb, Astringens;** and therefore **Compounded** in both. Yet in the Pepper, the **Acid** is one **Simple Taste,** and the **Sweet another;** and so in Rhubarb, the **Bitter** is one **Simple Taste,** and the **Astringent** is another.

5. **Two faults** have here been committed: the defective ** Enumeration of Simple Tasts;** and reckoning them indifferently among some others which are **Compounded.**

6. **SIMPLE Tastes,** (of which, properly so called, there are commonly reckoned but Six or Seven Sorts,) are, at least Sixteen. **Fifth, Bitter,** as in Wormwood: to which, the contrary is **Sweet,** as in Sugar. **Thirdly, Sour,** as in **Vinegar:** to which, the contrary is **Salt. Fifthly, Hot,** as in **Cloves:** whereto, the contrary is **Cold.** For we may as properly say, a **Cold Taste,** as a **Hot Taste:** there being some **bodies,** which do manifestly impress the **Senses of Cold upon the Tongue,** though not by **Touch.** So doth **Sal Prunelle,** although the **Liquor wherein it is dissolved,** be first warmed.

7. **Seventhly, Aromatic.** For it doth not more properly agree to an **Odour,** than a Taste, to be **Aromatic.** And that an **Aromatic Taste,** is distinct from an **Hot,** is clear; in that, there are many **bodies** of a **Hot Taste,** some meanly and others vehemently **Hot;** which yet are not in the least **Aromatic:** as amongst others, is apparent in **Euphorbium.** So that although an **Aromatic Taste** be often conjoin'd with **Heat;** yet it is not that **Heat** it self, but another distinct **Sensë.**

8. **Eighthly, Naufeous or Malignant, contrary to the former.** Such as is perceived, together with the **Astringent and Bitter,** in **Rhubarb;** or with the **Bitter,** and **Sweet,** in **Aloe.** It may be called **Malignant,** because diftasteful although mixed in a low degree with other Tasts: whereas other Tasts will render one another grateful.

9. **Again, Tasts may properly be said, to be Soft or Hard.** A **Soft Taste,** is either **Vapid,** as in **Wary Bodies, Whites of Eggs, Starch, Fine Boiles, &c. Or Unctuous,** as in **Oyle, Fat, &c.**

10. **A Hard Taste is Fourfold, as Penetrant, Stupificant, Astringent, Pungent.** Contrary to a **Vapid,** are **Penetrant and Stupificant.**

11. **Penetrant,** is a kind of **Taste,** which worketh it self into the **Tongue** (as some **Injuncts into the Skin**) without any **Pungency;** as in the **Root and Leas of Wild Cucumber.**

12. **Stupificant,** as in the **Root of Black Hellebore.** Which being **chew'd,** and for sometime retain'd upon the **Tongue;** after a few minutes, it feemeth to be bemum'd and affecteth with a **kind of Paralytic Stupor;** or as when it hath been a little burnt with eating or supping of any thing too hot.

13. **Contrary to an Unnatural Taste,** are **Astringent, and Pungent:** as in **Galls,** and **Spirit of Sal Aromantic.**
14. §. Again, Tafts are either Continual, as most commonly: or Intermittent; as that of Dracontium, especially in the Root. For after it seems to be lost and extinguished; it will then again (chiefly upon the Collision of the Tongue and Gums) be plainly heightened and revived.

15. §. Lastly, Tafts are either Still, as usually; or may be called Tremulous, as the Heat produced by Pyrethrum. Distinct from that of Clove, Ginger, and many other Hot Bodies, in that there the Heat is fixed; but here in Pyrethrum, 'tis joined with a kind of Vibration: as when a Flame is brandished with a Lamp-Furnace. Thus far of the Sorts of Simple Tafts.

16. §. COMPOUNDED Tafts are very numerous; being made by the various Conjunction of Simple Tafts, as Words are of Letters. Sometimes of two, as in Saccharum Saturni, of Astringent and Sweet. Sometimes three, as in Alces, Malignant, bitter and Sweet; in Rhubarb, Malignant, Astringent and Bitter. Sometimes four, as in Agarick, Malignant, Astringent, Bitter and Sweet. And in some Bodies, five or six Species may be joined together.

17. §. For the more accurate Observation whereof, there are these Rules. That not too many be tasted at one time; least the Tongue being furcharged, become less critical. That the Mouth be wasthed with warm water betwixt every tasting. And that those things be first tasted which produce a less durable Taste; so that one may be thoroughly extinguished, before another be try'd.

18. §. Of the numerous Conjunctions of Tafts, which may thus be observed, there are only Six to which the penury of Language hath allowed (if I may call them) Proper Names, &c. Acrhis, Aurerus, Acride, Muriaticus, Lixious, & Nitrues. Most of which are commonly taken in to make up the number of Simple Tafts. But very improperly; being all of them Compounded and Decompanied Tafts: to which Class they ought therefore to be refer'd. For

19. §. Auredus, is Astringent and Bitter; as in the green and soft Stones of Grapes.

20. §. Acrhis, properly so called, is Astringent and Acid; as in the Juice of unripe Grapes.

21. §. Acrhis, is also Companied. For first, simply Hot, it is not: because there are many Hot Bodies, which are not Acris; as the Roots of Zedoary, Tarrow, Contrayeria. Nor Secondly, is it simply Pungent, because there are all Bodies, which are Non-acris pungens; of which kind is the Root of Arum. Wherefore Acrhitude, is Pungency joyned with Heat.

22. §. Muriatic, is Saltness joyned with some Pungency; as in common Salt.

23. §. Lixious, is Saltness joyned with Pungency and Heat.

24. §. Nitrues, is Saltness joyned with Pungency and Cold.

25. §. Besides these Six, or perhaps one or two more, there are, as is said, a great number of Conjunctions, for which we have no Proper Names. For admit that there were but Ten species of Simple Tafts, sc. these Ten; Amarus, Dulcis, Acidus, Salus, Calidus, Frigida, Aromaticus, Malignus, Astringens, Pungens. And of these Ten, but Two, or at most, but Three to be compounded together in any one body. If only Two, they produce 45 Compounded Tafts. For the First, may be
be compounded with all the 9 following; the Second, with all the 8 following; and so, the rest: which together make 45. But if the same Ten be compounded by Three together; they produce no less than 120 Variations: as by the Table made of them all doth plainly appear.

26. §. Some few of the Conjunctions therein set down, may not be found actually existent in Nature. The abatement of which, will be much more than compensated two ways. First, by the other six Species of Simple Taste, which are also sometimes compounded. And by other more complex Conjunctions, as of many Quadruplex, and perhaps some Quintuple or Sextuple ones. Thus far of the Simple Species, and Conjunctions of Tastes.

27. §. The Degrees of Tastes are also numerous; and each Species, in every Conjunction, capable of Variation herein. For the more accurate observing whereof, it will be best, To take those Bodies, whose Tastes are, as near as may be, the same in Species: and that those be first tasted, which are least strong; whereby the true Degree will be more precisely taken.

28. §. The Taste of Bodies will thus appear to be varied, in most Species unto Five Degrees; and in some of them, unto Ten. So the Root of Tangelock, is bitter in the First Degree; of Gentian, in the Tenth. The Root of Cardus Benedictus, is Hot in the First Degree; the Green Pits or Seed-Cases of Clematis peregrina, in the Tenth. So that, allowing some to vary under Five; yet by a moderate estimate, we may reckon every Species, one with another, to be varied by at least Five Degrees. Which being added to the several Species of Tastes, in all the Treble Conjunctions of the aforesaid Table, come to 1800 sensible and defineable Variations of Taste. And these are the Diversities of Taste, with respect to the Sensation it self.

CHAP. II.

Of the DURATION and several TERMES of Tastes.

The next general way of distinguishing Tastes, is by their Duration, and their Terms, or their Motion of Intension and Remission from one Degree to another. For there are many Tastes, which have their Motions analogous to those of Diseases; and by those may be distinguished in the same manner. For as of Diseases, so of Tastes, there are Four Times, as Physicoms call them, or Terms of Motion; or, Principium, Augmentum, Status, & Declinatio.

2. §. For the distinct observing of which, those Bodies which are hard, and so their tastable parts least easily extractable by the Tongue, should be reduced to a fine Powder: otherwise, the true measure of the
Princepsium will be left. And for the precise measuring of all the Four Termes, it should be done by a Minute-Watch or a Minute-Glass. For so it will appear, that the Variations of each, are divers and remarkable.

3. §. To instance first in those of the Princepsium. Which I call, That space of time, betwixt the first Contad of the Body to be tasted, and the first manifest Perception of the Tafse. For Example, thofe Bodies which are Acid, or Bitter, as Vinegar or Wormwood, are presently perceived; quatenus Acid or Bitter, upon the first Contact; or have Princepsium breqiifimum. Thofe Bodies which are Aria, have their Princepsium somewhat longer. So the Seed-Cafe of Clematis peregrina, although they have a vehement Acriude, even in the Tenth Degree; yet is not that Acriude so soon tafted, as the Bitterness of rofs, which is but in the second. But the Princepsium of Hot Tafes, is generally longer than that of any other. So the Bitterness of the Root of Black-Helebo, which exceedeth not the second Degree, is yet presently tafted: but the Heat proceeding from the fame Root, and which perfecteth to the third Degree, is not perceived at all, till after two full Minutes. And to the Bitterness of Emula, which exceedeth not the 4th Degree, yet is sooner tafted than its Heat, which perfecteth to the 8th.

4. §. Next, in those of the Augment. Which I call, That space, betwixt the first Perception of the Tafse, till it come to the height. So the Heat of Galanga, is not only presently perceived, but arifteth to the height within half a Minute. But the Heat of the Root of Emula, comes not to the height till after a whole Minute. And the Heat of Black-Helebo, not till after four full Minutes from the first Contact.

5. §. The Status, or space wherein the Tafse continues in its height, is also divers. So the Heat of the Seed-Cafe of Helleborasfer, comes to its height, and begins to decline within half a Minute; that of the Root of Garden-Scareyglaufs, not till after a Minute; and that of the Root of Atronum, not till after two full Minutes.

6. §. And lastly, the Declination, or that space betwixt the first Remission of the Tafse, and its total Extinction. For instance, The Laurus of Millefolium, are Bitter in the 4th Degree, and Hot only in the 1st. yet the Heat continues for sometime, and the Bitter presently vanifhes. Calamus Aromaticus is Bitter in the 4th Degree, Hot in the 1st, and Aromatick in the 3d; yet the Bitter quickly vanifhes, the Heat continues two Minutes, and the Aromatick seven or eight. The Heat of the Root of Contraferra, is extended, almost to two Minutes; the Purgency of Tafp, almost to six; the Heat of Garden Scareyglaufs, to seven or eight. And even the Bitterness of Wild Cucumber, to near a quarter of an hour. But the Heat of Euphorbium dureth much longer, as also that of Black Helebo, 6s. above half an hour.

7. §. So that the Augmentum, is seldom extended beyond Four or Six Minutes, from the first Contad: but the Destination, sometimes to Thirty, Fourty, or more. Thus far of the Terms of Taf, or the manner of their Intenion and Remission.

Tt 3  CHAP:
CHAP. III.

Of the SUBJECT or SEAT of Tastes.

The Third and Last way of distinguishing Tastes, is by their Subject, or the Part or Parts where they are either wholly or chiefly perceived. And so, Tastes are either Fixed, or Movable.

2. §. A Fixed Taste, is that which keepeth within the compass of some one Part, all the time of its Duration; as upon the Tip, or the Root of the Tongue, or other Part.

3. §. A Movable Taste, is either Diffusive or Transitive.

4. §. A Diffusive Taste, I call that, which by degrees spreads abroad into divers Parts; and yet in the mean time, adheres to that Part in which it is first perceived. So the Bitterness in the dried Roots of black Hellebore, is first felt on the Tip of the Tongue; from whence it spreads it self to the middle of the same. And the Bitterness of the Leaves of Wild Cucumber, spreads from the Tip, to the Root of the Tongue.

5. §. A Transitive Taste, is that, which after sometime, wholly quitting the Part wherein it is first perceived, is thence transferred into some other Part: as the Bitterness of Gentian, immedately from the Tip, to the middle of the Tongue. And most of the Diffusive, are also Transitive.

6. §. The several Parts these ways become, and with some latitude may be called, the Seats of Tastes, are, the Lips, Tongue, Palate, Throat and Gullet.

7. §. Upon the Lips, the Root of white Hellebore, as also of Pyrethrum, being chewed, make a sensible Impression; which continues (like the flame of a Coal betwixt in and out) for 9 or 10 Minutes. But the Heat in other Parts much longer.

8. §. Upon the Tongue, Tastes are perceived in Three places, as hath been intimated. On the Tip or Cone of the Tongue; as most commonly. On or near the Bases of the Tongue, where the Taste of the Leaves of Wild Cucumber chiefly fixeth it self. Or on the Vertex or middle of the Tongue; in which place it is observable, that the Taste of Gentian, Colocynthis, and divers other Bodies, is then considerably strong, when not at all perceived at the Tip of the Tongue or in any other Part.

9. §. Upon the Palate or Roofe of the Mouth, the Root, as I take it, of Deadly Nightshade makeeth its chief Impression; and there continues about four Minutes in some degree.

10. §. The Throat, or the Oesula, Larynx and other adjacent Parts are oftentimes the Seat of Tastes. For there are many Bodies, which although they have scarce any Taste upon the Tongue, or any other of the aforesaid Parts, yet make a strong Impression on the Throat: as the Leaves of little Daisies, little Celandine, and of Pimpinell; as also the Roots of Jalap, Mercury, Asparagus and others. Which being chewed makelittle or no Impression on the Tongue, but their juice being swallowed,
11. §. And that this Taste or Sense, is truly distinct from either the Heat, Pungency, or Acridity upon the Tongue, it is hence further manifest; in that Pyrethrum, which is very Hot, and Cortex Winterana which is very Pungent upon the Tongue; yet their Juice being swallowed, causeth no Heat, Pungency or Exasperation in the Throat.

12. §. Lastly, if we will take the word (Taste) in a larger sense, the Oesophagus it self may be said to be sometimes the Subject thereof; as of the Heat produced by the Root of Common Wormwood. For of this heat it is remarkable, that being first perceived on the Tip of the Tongue, it thence maketh its transit to the Root of the Tongue, and so into the Throat, and by degrees descends into the very Gullet; where it seemeth to warm the Stomach; and so continues, in some degree, almost 1 of an hour. And the Transition and Defcend of this Heat is made, although none of the Juice be swallowed. And in this maner Tastes are distinguished with respect to their Subject.

13. §. So that the general Diversities of Tastes are these. With respect to their Species, they are Simplexes vel Compositi; To their Degree, Remissi vel Intensis; To their Duration, Breves vel Dinturni; To the Terms of their Motion, Celeres vel Tardi; and lastly, To their Subject, Fixi, Diffusivi et Transivii.

14. §. I HAYE thus endeavoured to draw up a Scheme or Inventory of the several forts of Tastes. In which, one may think, that I have over done; and that as Galen hath been cenured for being too curious in the Distinctions of Pulsæ; so have I been, in thee of Tastes. Not to enquire now, how far the Differences of the Pulse may be extended; or be fit to be taken notice of; I shall only say, That we have not so much reason to cenure him, if he hath given us some few which are coincident; as we have to thank him, for observing so many which are really distinct.

15. §. By the Scheme of Tastes here representated, we may be able, so to enumerate the Modes of any Taste, as to make a Scientific Definition of it. Which is pleasant Instruction to any inquisitive mind; these things being all matter of Sense and demonstration; wherein lyeth, though not always the most plausible, yet the most satisfying Philosophy; and where men, after they are grown weary with turning round, are oftentimes contented to rest.

16. §. But the usefulness of this Scheme will further appear, in two respects; 1. In conducting us to a clearer and more particular Explanation of the Causes of Tastes; and the Investigation of the Virtues of those Bodies in which they reside. Whereof in the following Chapters.

CHAP. 
CHAP. IV.

Of the CAUSES of Tafts.

To speak of the Causes of Tafts, before we have well enumerated and distinguished them 5 is to provide Furniture for a House, before the Rooms have been counted and measured out. But the varieties of Tafts having been first laid down, it will induce us to believe, and investigate as great a variety in their Causes.

2. Now, the Causes of Tafts, particularly of the Tafts of Plants, whereof we chiefly speak, are, in general, these Four or Five, &c. The Bed out of which they grow; The Air in which they stand; The Parts of which they consist; The several Fermentations under which their Jusces pass; And the Organs by which their Tastable Parts are perceived: as will appear upon Inspection.

2. &c. But the immediate Causes, besides the Organs of Tafts, are the Principles of Plants. As many of which, as come under the notice of Sense, we have already supposed to be these Seven, Alkaline, Acid, Air, Water, Oyl, Spirit and Earth. The Particles both of Alkaline and Acid Salts, are all angular and pointed. Those of Air, properly and strictly so called, are Elastic or Springy; and therefore also Crooked; as I have likewise formerly conjectured. And I find the Learned Borelli, in a Book of his since then published, to be of the same Opinion. Those of all Fluid Bodies, qua Fluid, and therefore of Water, Oyl and Spirit, I conceive to be Globular, but hollow, and with holes in their Sides. Those of Water, to be larger Globes, with more holes; those of Oyl, to be less, with fewer holes; and those of Spirit the least. Lastly, that the particles of Earth are also Round, yet angular and nearer to a solid.

4. &c. These Principles affect the Organs of Sense, according to the variety of their Figures, and of their Mixture. So those which are sharp or pointed; and those which are springy; are fitted to produce any stronger Tast; and those which are round, are apt, of their own Nature, to produce a weaker or faster one. And so by the diversities of their Mixture, not only with respect to their Proportion, but also the very Mode of their Conjunction. Hence it is, that many Bodies which abound with salt, as Ambar with an Acid, and the Bones of Land-Animals with an Alkaline, have notwithstanding but a weak Tast; the Saline Parts being in the former drowned in the Oyl, and in the latter also buried in the Earth.

5. &c. The same is further confirmed by an Experiment mentioned in a former Discourse; &c. the Transformation of Oyl of Anise-seeds, with the help of Oyl of Vitriol, into a Rasin. For both those Liquors, though so strongly tafted, apart; yet the Rasin made of them, being well washed, hath a very mild Tast, and without any snacl of that
in either of the Liqueurs. Whence it follows, that the very Mode of Mixture is sufficient, not only for the variation of the Degrees in any one Species of Tafs; but also for the destroying of one Species, and the introducing of another.

6. §. THESE things being premised, I conceive, That as an Unctuous Tafı depends upon Oyl; so a Vapid either on Water, or Earth: or upon such an intimate Mixture of other Principles, as renders them indif soluble by the Salts, and so, in a manner, untastable.

7. §. That a Pungent, is made either by an Alkaly or an Acid sharpened or whetted; that is, cleared from the foyal of other Principles, as in the Spirit of Sal Aromoniac or of Sulphur. And so in those Plants which have a Pungent Tafı, whose Jovces or Timiures, although they conifit of divers Principles, yet all so loosely mixed, that being dissolved by the Salts, the saline are hereupon left naked. Where fore biting Plants, quæ biting, are Nitrous Plants. So that the Jovce of fuch Plants, is a kind of Spirit of Nitre, made by the several Parts of the Plant. Hence Arom grows belt under a Hodg, where the Ground, not being expoed to the Sun, but the Aer only, like those Rooms in Hovres, which are covered, is impregnated with a greater quantity of Nitrous Salt. And those Roots which are Biting, have but few or but small Aer-VeAfels; whereby fewer parts of the nitrous sap are carried off into the Trunk. For the fame Cause, it is no wonder, that many Aquatics are Biting, Water being, though it felt cold, yet the Mercuria, by which all Salts are imbibed most eafily, and in larger quantifies of Commixture with other Principles.

8. §. Permeant (something flower than pungent) is made by any Salt that is also foiled or guarded with Earth. Sover, by an Acid only foiled with Earth. Salt, by an Acid guarded by an Alkaly, and foiled with Earth. Cold, by an Acid drowned in Water, and foiled with Earth.

9. §. In all thefe, the Salts are predominant; In Heat the Oyl or Sulphur. The particles whereof being Sperick and bared with koles; thofe of Salt ftick in them, as the Spokes do in the Hub of a Wheel, or as the Quills in the Skin of a Porcupine. Whereby, as in Common Fire the Sparks of Sulphur being agitated and whirled about by the Aer, with the help of the Salts, which flck in them, tear in pieces all kinds of Bodies: fo here, being agitated by the Circulation of the Blood, they make a kind of hurry or combustion; and fo, according to the degree and strength of their Motion, tear in pieces fewer or more of the Fibers of the Tongue; and in a greater quantity, would raise a bitter upon it: the common Effed of Fire, or any strong Epiftatick. So that a Hot Tafı, is produced by Sulphur toothed or armed with Salts. Wherefore all Stillation Oyls are Hot; being strongly impregnated or armed with the Essential Salts of the Plants from whence they are distilled. And as thofe Plants which are very Parenchymous, from the predominancy of their Volatile Acid, are biting: So thofe which are Liqueurs, that is, have a good quantity of Lymphedeck, from the dom inion of their Sulphur are commonly Hot. For the fame reafon it is, that many both Biting and Hot Plants, as the Roots of Dragon, Garden-Radif, Onion, Iris, Rape-Crowfoot, &c. being corked up in a bottle with Water, and let in a Cellar or other cool place; they do all of them turn Sover in a few days: The fame Fermentation, as once fullying
fully the Salts of the one, and disarming the Sulphur of the other. But some, wherein the Sulphurous parts are more copious, will hardly ever become Sower. Hence also, some Plants, whose Roots are neither Hot, nor of any strong Tjuice, as those of Wild Asparagus; yet their Leaves and Flowers are plainly Caustich: So that it seems, that as their Juice rife up into the Trunk or Stalk, and are therein further fermented, the Sulphurous Parts thereof, are at the same time relaxed from the other Principles, and acuated with an Aerial Salt.

10. §. A Stupefiecent Tjuice (as the Impression which some Flatt Plants make upon the Tongue may be called) is in some fort, analogous to the mortifying of any part of the Body by the application of a Caustic. For as there the mortification succeeds the burning pain, so here, the Stupefaction, neither comes before, nor with the Heat, but follows it.

11. §. Sweetness is produced, sometimes by an Alkali; smoothed either by a Sulphur, as in Lime-Water; or by both a Spirit and a Sulphur, as in the Stillatitious Oils of Animals. But most commonly, by a smoothed Acid, as in Malt, Sugar, Honey. Hence a Sweet Tjuice, is generally founded in a Sower; so Sower Apples, by mellowing, and harsh Fears, by baking become sweet; the Spirit and Sulphur being hereby at once separated from the other Principles and brought to a nearer union with the Acid. So the Sower Leaves of Wood-Sorrel, being dry'd, become sweet: and those of a lower Codlin, while they hang on the Tree, and even of a Crab-Tree, are neither Astringent, nor fower, but sensibly sweet. And so commonly, wherever the said Principles are a little exalted by a soft Fermentation; as in the Juice of the Stalk of Maze or Indian Wheat, which is a sweet as Sugar; and in the green Stalks of all sorts of Corn and Grasfs, in several degrees. So likewise Tulp's and some other Roots, being taken up, in open weather, sometime before they sprout; if tasted, are as sweet as Liquiiish or Sugar; and at no other time: not only Fruits, but many Roots, Seeds, and other Parts, upon their first or early Germination, acquiring a curious Mellowness, wherein, all their Principles are resolved, and their most Spirituous Parts exalted and spread over the Acid. Wherefore also most Roots, which are not meely long, but grow deep in the ground, have at least some of their Juices of a sweet Tjuice; as Liquiish, Byron, Hoasts-Tongue, Garden-Parsnip, Black Henbane, Deadly Nightshade, &c. Even the Juice of Horfe Radish, which bleeds at the Lymphatics, is of a sweet Tjuice. And of the fame kindred thofe which grow the deepfl, are the sweetefl; as a Parsnip is fweeter than a Car-root, especially if you tafl the bleeding Sap; and the Root of Common Tall Trefsyl taffeth somewhat like Liquiish, but is not near fo fweet. For all deep Roots, are fed with a lefs Nourious Aliment: and being removed from the Air, their Juices pass under much more soft and moderate Fermentations.

12. §. Bitterness is produced by a Sulphur well impregnated, either with an Alkali, or an Acid Salt, but also thackled with Earth. And therefore the Bitterest Plants, commonly yield the greatest quantity of Lixivial Salt. So also many Stillatitious Oils digested with any Strong Acid, will acquire a Bitter Tjuice. Wherefore this Tjuice is often founded either in a Hot Tjuice, or a Sweet. Hence it is, that the Leeves of all sweet Roots are Bitter. And that the Fig-Tree, which bears a sweet Fruit, bleeds a bitter Milk. So likewise thofe Plants, which bear a Bitter
Bitter Stalk, have not Bitter, but Hot Roots, as in Yarrow, Primroses, Wormwood, Rue, Carduus benedictus &c. is manifest. So the Coats of the Seeds of Viola Luraria are of a hot and biting Taste; but the Seeds themselves, in which the Salts, though copious, yet are also immered in a greater quantity of Oyl, are Bitter. And that the Earthy Parts do also contribute something more to this, than to most of the forementioned Tasts, is argued from its being more Fixed; that is, the Body in which it is contained, is either more Fixed, or else flyeth not away in that same state of conjunction, by which it maketh a Bitter Taste. For whereas Hot, Bitter, and divers other Plants lose the strength of their Taste, by drying; most of those which are Bitter, do hereby increase it. And although the Extract of Dandelion and some other Roots, which are very bitter, hath scarce any Taste; yet generally, they are bitter Plants, which are best for the making of Extracts. And the distill'd waters of Plants which are Hot and Bitter, notwithstanding that they always taft high of the Heat, yet rarely and very faintly of the Bitter.

13. 6. Astringency, is made, partly, by the further increas and more intimate union of the Earth. And therefore this is scated still in a more Fixed Composition, than a Bitter. And partly, by the diminution of the Sulphur. And therefore the Acid Parts ingredient to it, either by Fermentation or otherwise, are easily exposed. Astringency being the Womb or Bud of a Swee. For all or most Astringent Roots bear a lower Leaf, or a lower Fruit: as those of all Docks and Sorrels, Black-Thorn, Dog-Rose, and others. Wherefore also, Astringency is often found in conjunction with Bitter, Sweet, or Swee; but scarce ever with Pungent, or Hot.

14. 5. An Aromatic Taste, seems to be produced, chiefly, by a spirituous, acid, and volatile Sulphur; as in Amber-grievs, Cardamon-Seeds, many Stillatious Oyls &c. A Nauseous, by a Sulphur less spirituous and volatile, and more Alkaline; as in the Root of Dog-stone, Sheeps-Foots, the young and green Leaves of Coriander, or the Seeds of Cumin. The Spirit, as it enters the Nerves, carrying the alkaline Sulphur along with it: as when a City is betrayed by one of its Inhabitants to an Enemy.

25. 6. An Intermittent Taste, as in Arum, seems to have its dependance upon a simple and very pure Nitre, which by its subtility enters into the very Concavities of the Nervous Fibers of the Tongue: and so being lodged there, is little affected or stirr'd, by the Motion of the Blood; but only when the Tongue itself is moved, at which time it causeth a kind of prickling Taste.

16. 5. A Tremulous Taste, as in Pyrethrum, dependeth probably, upon an Aereal Sulphur; which being agitated by the Blood in its Circulation, the spirits Motion or Vibration of the Aereal Parts produce that Taste.

17. 5. A Taste is Lingual, Guttural, &c. according to the grossnes or finenes or other difference of the Membranes into which the tastable parts are admitted. For Tasts are made not meery by the outward Contact, but the Ingress of the tastable parts. Now the outer Skin of the Tongue, which is commonly observ'd to pill off in boiling, like the Cuticula in other Parts, hath either no fineness, or much less than that which lies under it: and is therefore, but a Screen or Strainer to the tastable parts. So that being of different finenes in the several parts of the Tongue,
Tongue; it hereby comes to pass, that according as the tastable parts of any Plant are more or less penetrant, subtile, or dissoluble, they are admitted into one part of the Tongue, and not another. And in the Throat, the outer Skin is self, seems to be the immediate Sensory; and so, to be evidently affected with the juice of some Plants, from which the Tongue receiveth little or no sensible Impressio.

18. §. When the Taist is Permanent and Fixed in some one Part; it is a sign, either that the Gustable Parts are less dissoluble or more subtile, so as to enter the Concavities of the Fibers; and that there is an admixture of an Aerial Salt, or a like Sulphur; some of the parts whereof, being crooked, hang like Hooks on the Fibers of the Tongue. For the reception of such a Taste, is not to be looked upon as a wound made with a Lancet, and so the Lancet taken away; but with the Lancet sticking in the wound; until in time, 'tis carried off by the Circulation of the Blood; which like the Stream of a River in a Flood, carries all before it, but those things last, which stick in the Mud.

19. §. But when the Taste, though Permanent, yet is Diffusible or Transitive; it seems probable, that as there is a less admixture of Aer; so a greater subtilty of the Tastable Parts, whereby they are conveyed, through the Nervous Fibers, from one Part to another.

**CHAP. V.**

Of the Judgment which may be made of the VIRTUES of Plants, from their Tastes.

By duly observing the Tastes of Plants, we may be directed to understand their Canes. So also the Use and Virtues of those Plants or Parts of Plants in which they reside. For the proof whereof, an Instance might be fetched from every particular difference of Taste before set down. But it may be enough, to give these which follow.

2. §. And first, we may make no ill guesses ex Analogia, or where we find the same Taste, that there the same Virtue in some kind, and in some degree, may reside. So Jalap, Mercury, and Daffy, have all of them that exasperating Taste in the Throat before described; and they are all three more or less Cathartic. Wherefore, we may believe, that other Plants which make the like Impressio on the Throat, and there are many others which do, that they are in some degree alike Cathartic. Those Plants which are reckoned amongst the chiefest cephalick's, cause rather a durable, than a vehement Heat upon the Tongue, as Pyrostom, Emploribum, Black-Hellebore, &c. It seemeth therefore reasonable to rank with these, any other Plant, though not used, which produce the like durable Heat. The young Roots of Tarrow, or Millefolium,
have the same Tafle, as the Root of Contra!eras; and may therefore be
used for the fame pofufe, with a probability of the like success; if
not a better, becaufe they may be gotten cheaper. But by drying the
Root, the Tafle and Virtue, which lie in its exhaliabie parts, are much
 loft. The Seeds of the lefier Cardamom, and of Zedoary Root, if found,
have both a fimilarity of the Tafle of Campbife. They may therefore all,
so far, reach the fame Caffa.

3. "Again, as we may make no ill conjecture from the fameness of
Tafle in Plants of feveral Tribes; fo from the diversity of Tafle, in thofe
of the fame. So the Flowers of all the Docks are evidently Astringent,
and not fower; except thofe of the Rhea-pottick, which are extrem
flower, even in the 5th degree. Which is no mean Signature of fome
more than ordinary Virtue in it, besides what it hath in common with
the reft of the Tribe. The Flowers of Pancy have a kind of fulfome
Tafle, plainly different from that of Violets; and in fome Hypochondri-
cacal Caffes may be more ufeful.

4. It likewife importeth much to obferve the difference of Tafle
in the feveral Parts of the fame Plant. So the Barque of Saffafies is three
times as strong, as the Wood: and the like may be obferved in any
other commonly known Tree. If therefore we could obtain the Barques
of Santalum, Lignum Rhodiun, Lignum Aloe, &c. they would doubt-
les, moft of them, be of much greater ufe. And as the Tafle is some-
times stronger; fo, much more grateful, in one Part than in another:
as in the Flowers or Yellow Attire in the Heads of Cardamus Benefidens;
which being infufed in Spirit of Wine, or other convenient Liquor,
mak"7e a pleafant Cordial. Nature having laped up the Virtue in the
Leaves, as in a brown Paper; but in the Flowers, as in Leaf-Gold.

5. As alfo, how far the Tafle of any Plant may alter, either in
preferving, or preparing it. So the Root of Arum, when taken fresh,
out of the ground, is notably Pungent: but being thoroughly dried,
and especially kept for fome time, hath no more Tafle, and therefore
in all likelikhood, no more Virtue, than a Lump of Starch. The like
we are to judge of all other Plants, whose Virtue lieth in their exhali-able
Parts. The Stillations Oils of many Plants, are stronger than the
Leaves or other Parts from whence they are drawn: but fome there
are, which are weaker; as is that of Euphorbium, in which the Heat is
neither perminaceous, as in the Gun it felf, nor fo great.

6. We may make, moreover, a judgment from the Nature of the
Tafle. So thofe Roots which are Bitter, and not Hot, as of Chicory,
and the reft of the Intybuus kind, may be accounted Nitro-Sulphurate;
and fo, to be Abfeftive without any Heating Quality. The Marum
Auffricum, which is extrem Pungent, as well as Aromatic, may be
looked upon as the beft Cephalick of that Tribe. Because we find,
that Jalap hath a fpecial property of imitating the Glandulous Parts
of the Mouth, and Throat; we may gather, That it is a better
Purge to all the other Glandulous Parts, than moft other Cathartic.
Which is alfo one reafon of its operation, for the molt part, with
at leat a tendency to vomit; the Stomach itfclf being Glandulous as well
as the Throat, and thereby anfwerably affected with it. A strong Infu-
sion of white Sarsaparilla in Water, boiled up, and kept in a Cellar for
the space of two months, becomes extrem flower; far beyond any
thing obferved in the Tafles of the Juices and Infusion of divers other
Plants.
Plants kept as long and in the same manner. Which shews, how well
Nature hath adapted a Plant of so mild a Taste, either by limnitude of
parts, for the carrying off of any preternatural Acid, or by contrariety,
for the curbing of an exorbitane Salt. The Barque of the Root of
common Wormwood, which impresseth a pertinaceous and diffusive Taste,
which descendeth from the Tongue into the Gullet, as is before describ'd;
may be justly ranked with the most excellent Stomachicks; and
upon trial, I find it one of the best; besides, that it is neither unpleasant,
or affecteth the Head, as the Leaves. Yet the Gardener, and
every Body throws it away, as good for nothing.

7. 6. I shall conclude with one note, which is this; That the Spec-
cific Virtue of Medicines, which some Physicians positively deny, and
most dispute; from some of the aforementioned Differences of Taste, as
well as for other reasons, may seem, at least, to be probable. For
why should not a Medicine make an impression upon one Part, and not
upon another, within the Body, as well as we find it doth within the
Month; especially, since the Parts of the Month, are of a less different
Nature, than some of the Viscera.

An Appendix.

Of the ODOURS of Plants.

HE Senses of Tasting and Smelling being so nearly
aly'd; many things already explained concerning the
Diversities and Causes of Taste in Plants, may
easily be transferred to those of their Odours. I
shall now therefore only remark some particulars,
not commonly taken notice of hitherto, and leave
them as a Specimen to be Improved by other Hands.

9. 2. The Root of Rape-Crowfoot being cut, and held to the Nose,
when it is newly taken out of the Ground, smelleth almost like
Spirit of Sal Ammoniac, or fresh Scouring-grits Juice. And hath the pro-
erty of making the Eyes to water, as Oinions do. Horse-Radish Root
is not so Pungent to the Nose, but gets pretty much into the Eyes. But
that of Dragon, doth neither affect the Eyes, nor the Nose.

3. §. The Succulent Roots of Dogflees, and most of that Tribe,
have a rank Smell. And that of Crown Imperial, being rub'd a little,
smells as like a Fox, as one Fox smelleth like another.

4. 9. The Root of Passion digested with Water, in a warm Room,
for the space of three weeks, smells like Spirit of Harts Horn, or other
Vincas Spirit. Of Red Dock, almost like Aqua fortis or Spirit of Ni-
tre. That of Dragon bottled up with Water, and let in a Cellar, about a
Month, stinks like the put of the most Fetid Ulcers. At the end of five
Months, more abominably, than either to be endured or expressed.

5. §. The Leaves of Mountain Calaminth, smell like Penny Royal,
Those of Umaria, like Walnut Pilles. Of Yellow Laminum, like a Bai-
fame. Of Sena, a good quantity being held to the Nose, of a rank
Smell
Swell betwixt that of Sweat and Urine. Of Coriander, when green and young, stinks so basely, that they can hardly be endur'd. Sometimes the Leaves have a stronger Smell, than the Flower, as in Borage, and sometimes the Stalk, a stronger than the Leaves, as in Ulmiata.

6. Rue Leaves cork'd up in a bottle and set in a Cellar for about ten weeks, smell like Spirit of Harts Horn, or of Urine. The green Leaves of Roses infus'd in water, have a mild, but pleasant Smell. Neither is that of Sawwine unpleasant, upon the like Infusion.

7. Scourgrasst Juice kept about a year in bottles, with the green Sediment, in a warm Room, stinks like Humane Excrements. And Scourgrasst Wine, made only of the juice, smells like some Liqueur.

8. The Flowers of Tarrow, smell not much unlike to those of Southernwood. And the Flowers of Crowfoot almost like those of Scourgrasst. Some Flowers are of a weaker Smell in the Bud, as those of Mallow. But many have a stronger, than when they are blown open; as those of Lavender, Rosemary, &c.

9. The Buds of Veronica Mallow, while they are young, and the Flowers unseen, have a very pleasant Smell, like that of Geranium Moschatum; but when afterwards they are opened they have an unpleasant Smell. Common Mallow Flowers dried and bottled up for some time, acquire, though not a strong, yet very noyson Smell.

10. The Purple Pouch of Dragon which covers the Seed, being broken, smells just like a Lobster. But permitted to lie in a warm Room for some days, smells exactly like Carrion; and scent the Room with the same Smell.

11. Some Seeds as those of Cuminum, Dactyl, being powdered and laped up only in Papers, do notwithstanding retain their Smell. But many others, as of Sweet Fenil, in a short time, lose it. Some Seeds, when they first begin to sprout, become Odorous, which were not so before; as the Garden Bean.
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EXPERIMENTS IN CONSORT UPON THE Solution of Salts IN WATER.

Read before the Royal Society, January, 18. 1676.

CHAP. I.

In which is shewed, the Compleat or Utmost Impregnation of WATER with several kinds of Salt, both together, and apart.

In discourse upon a Lecture formerly read, concerning the Lixivial Salts of Plants; it was mentioned, as a thing affirmed by some Philosophers, that Water having been fully impregnated with one kind of Salt, so as to bear no more of that kind; it would yet bear, or dissolve some portion of another; and so of a third. And it was referred to Me by this Honourable Chair, to examine and produce the Experiment. The doing whereof brought into my mind divers other Experiments heretofore relating:

2. §. As next, With what difference of quantity this superimposition would be made, upon the solution of different Salts?

3. §. Thirdly, Whether the Solution of a smaller quantity of several Salts, doth conflict with the non-increase of the bulk of the Water? Because this also is affirmed by some.
4. §. Fourthly, What quantity of the several kinds of Salt, may be dissolved several, in the same quantity of Water?

5. §. Fifthly, Whether by dissolving a Salt in Water, there be any Space gained, or not? That is, whether the Bulk of the Water be greater, before the Salt lying in it be fully dissolved, than it is afterwards? Or if a Cubick Inch of Salt be dissolved in nine Cubick Inches of Water; Whether the Water will then fill a Vessel of ten Cubick Inches content?

6. §. Sixthly, Whether the Space be equally gained, by an equal encircle of the same Salt?

7. §. Seventhly, Whether upon the Solution of several kinds of Salts, be gained so many several quantities of Space? That is, if the Solution of common Salt gains, suppose, an Inch, whether the Solution of Salt Armoniac gains as much, or more, or less? and so for other Salts.

8. §. Eighthly, What that just space may be, which any Salt gaineth with respect to its own Bulk, or that of the Water?

9. §. And first, for the Superimprognation of Water; I put into a bottle 3/4 of fair Water; adding thereto, first half an Ounce of Nitre; and afterwards more, as the Water would dissolve it, and (that I might be sure the Impregnation was full) some portion above what the Water would bear. Then having separated this remaining portion: I put to this Solution of Nitre, two Drachms of Sal Armoniac; which wholly and easily dissolved in the said Solution; though it would not bear a grain more of Nitre. I then added a third Drachm of Sal Armoniac, after that a fourth, and a fifth; all which, within the space of half an hour, were perfectly dissolved in the said Solution, without any precipitation of the Nitre.

10. §. In the making of this Experiment, two things, to render it insalubrious, are to be noted. That the said Salts were not dissolved by the help of Fire, but only by a strong and continued Agitation. And that this was done upon a warm day: which I mention, because that even the changes of the weather will somewhat alter the Solubility of the Salts.

11. §. Having made the Experiment upon two Salts, I proceeded to repeat it upon three. And first I dissolved as much common Salt as 3/4 of Water, as that quantity would bear. Then having separated the fubliming portion; I put to the Solution, no less than five Drachms of Nitre, which by a continued Agitation, was wholly dissolved therein, neither the Nitre nor the common Salt being in the least precipitated. Then adding a Scruple more, it would not dissolve, but fublimed. This second fubliming portion, I again separated; and then put to this Superimprognation, near 31 of Sal Armoniac, which was also dissolved as the former. And if as many more Salts had been added, 'tis probable that the same Water would have borne some quantity of them all.

12. §. From this Experiment, it is a Conclusion demonstrated, That not only the visible Crystals, but the very Atomes of every Salt, at least those Particles which are ultimately dissolved in Water, have a different Figure one from another. Because that if they were all of one Figure; there would be no Superimprognation, but the Pores of the same Water, would imbibe as much of one Salt, as answers to the total of two more Salts imbied; that is to say, it would as well imbibe two Ounces of common Salt, as one Ounce of common Salt and another
another of Nitre: which yet is contrary to the Experiment. And it is the same thing, whether we suppose the Pores of Water to be also different, or not. Because, that if the Figure of all the said Atomes be the same; then their respect to the Pores of the Water must be the same, how different so ever those Pores be: which is also contrary to the Experiment. Besides it is a great presumption, to say, that the Pores, and therefore the Atomes of Water have different Figures; and yet not those of Salts.

13. §. From the same Experiment we may go upon good ground in Compounded Infusions; whether of Purgative, or other Materials. As not doubting, but that the same Menstrua may be highly impregnated with several Ingredients at once, whose operative parts may be therein copiously dissolved, without hindring either an Extraction, or causing a Precipitation one of an other.

14. §. The Second Enquiry is, With what difference this Superimpre
gination of Water is made? which I find considerable. For a Solution of above five Drachms of Nitre may be superimpregnated with no less quantity of Salt Ammoniac. And a Solution of five Drachms of common Salt, may be superimpregnated with as much Nitre. Yet neither a strong Solution (as of five Drachms) of common Salt, will bear above two Scruples of Salt Ammoniac: nor will a strong Solution (as of five Drachms) of Salt Ammoniac, bear above a Drachm of common Salt: for if above the said quantities of either of them be mixed together: they are both copiously and forthwith precipitated to the bottome of the Glass.

15. §. Whence, notwithstanding the former Experiment, yet are we admonished, not to infuse all manner of Ingredients in any proportion. Because though some do not, yet others will precipitate one another.

16. §. The Third Enquiry was this, Whether the Solution of a smaller quantity of several Salts, doth confit with the non-increase of the Bulk of the Water? For this I took a Bolt-head with a slender Neck, containing about a pint and a quarter of Water; and dissolved therein about 138 of Nitre. And marking the place to which the Water ascended in the Neck of the Bolt-head; I then dissolved in the same Water about a Drachm of Sal Guanina: which little quantity, raised the Water above half an Inch higher then it was before. The like I observed in the addition of Nitre to a Solution of Salt Ammoniac. So that to suppose the variation of the Salt doth prevent the increase of the Bulk of the Water, is a manifest Error.

17. §. From the same Experiment it also appears, That the ascend of the Water upon a Superimpregnation, is the same, by whatsoever Salt the first Impregnation be made. For instance, Let a Solution of Nitre ascend in the Neck of the bolt-head, suppose, to 10 Inches, then add ½ an Ounce more of Nitre, so as to raise the Water, suppose, 12 Inches or more, or less, according to the Bore of the Neck. In like manner, let a Solution of Salt Ammoniac reach to ten Inches: then add again half an Ounce of Nitre: and it will reach just 12 Inches, or more or less, as before.

18. §. The Fourth Enquiry is, What quantity of the several kinds of Salt, may be dissolved severally in the same quantity of Water: that is to say, by agitation alone, without the help of fire, as I noted before.
before. And upon trial it appears, First, that two Ounces of Water will dissolve three Ounces of Loaf-Sugar and no more, except the Water be heated.

19. §. The same quantity of Water that is, two Ounces will dissolve above two Ounces ofSalt of Tartar. I say above, for how much more, want of a greater quantity of Salt which I could confide in, made me that I could not finith the Experiment.

20. §. The same quantity, fe. two Ounces of Water, dissolveth an Ounce and a Drachm of Green Vitriol.

21. §. The like quantity dissolveth six Drachms and a Scruple or above 4 of an Ounce of common Salt.

22. §. Of Nitre, Five Drachms two Scruples and an half.

23. §. Of Sal Armeniac, five Drachms and two Scruples.

24. §. Of Alum, not above two Drachms and a Scruple.

25. §. And of Borax, not above a Drachm and half a Scruple.

26. §. Of these note, That although Common Salt be very dissolvable, and will presently catch the moisture of the Air: yet a much greater quantity not only of Salt of Tartar, but even of Loaf Sugar, and of Green Vitriol it self, may be dissolved in Water than of Common Salt.

27. §. Again, as the great Solubility of some, so the less Solubility of other Salts is also observable, as of Alum, and Borax. For the same quantity of Water will dissolve near four times as much of Green Vitriol, as it will of Alum. And of Sugar more than ten times as much. Of Green Vitriol near eight times as much as of Borax; and of Sugar, twenty times as much.

28. §. From this Experiment we are likewise cautioned, not only in the Infusion of several Ingredients together, but of any one singly; that such a proportion thereof to the Menstruum, be not exceeded. For all that is over and above what the Menstruum will bear, is either not extracted, or will be precipitated. As is evident not only in the Dissolution of the Salts above named, but in the Infusion of Plants themselves; as, for instance; of Senna; two Drachms whereof will impregnate four Ounces of Water as strongly, as if twice the quantity were infused; because the Water will bear no more of the Purgative Parts of that Body.

29. §. There is only one Salt more remaineth to be spoken of under this Experiment; and that is, the Crystalls of Tartar. Whereof, it is somewhat strange to observe, that it will scarce at all dissolve in Water: not more, than even divers Resinous Gum, as Mastick, Tolu, Taccoanabaco, and some others will do. For if two Drachms, supposed of these Crystalls, of Tartar (commonly sold for Cremor Tartari) be put to one Ounce of Water, scarce five Grains thereof will, by Agitation, be therein dissolved.
In which is showed, that by the Solution of Salts in Water, some certain space, more or less, is gained. That the space is different according to the Nature of the Salt. And what the just space is, which is gained.

The Fifth Enquiry is, Whether by dissolving of a Salt in Water, there be any space gained, or not. That is, whether the Bulk of the Water be greater before the Salt lying in it be fully dissolved, than afterwards. For tryal whereof, I took a Bolt-head with a flender Neck, holding somewhat more than a pint; and filling it up to a certain place in the Neck; I then put in an Ounce or two of Salt. And observing the height of the Water, both before it was dissolved, and afterwards; it plainly appeared, that there was some, and that a considerable space, gained by the Dissolution; the Water thereby sinking several inches below the place, where it stood after the Salt was first put into it.

1. §. From this Experiment it is plain, that there are Vacuities in Water. That is to say, that all the parts of Water are not contiguous, but that either betwixt, or in the Atomes of the Water themselves, there are certain Pores, either absolutely void, or at least filled up with another more subtle body which is easily excluded by the particles of Salt; by poisselling the room of which the above said space is gained.

2. §. The Sixth Enquiry is, Whether the space be equally gained, by an equal encrease of the same Salt.

3. §. For this I made two trials; the first was this. Two half Ounces of Salt Armoniac, being successively dissolved in the same Water; both of them raised up the Water in the Neck of the Bolt-head, equally; the first 3 Inches; and to the second.

4. §. The other was this. Four half Ounces of Nitre, being successively dissolved in the same Water, they all of them raised up the Water in the Neck of the Bolt-head, equally; the first a little above two Inches, and the 2d, 3d, and 4th, just as much.

5. §. The Seventh Enquiry is, Whether upon the Dissolution of several kinds of Salts, be gained so many several quantities of space. For this I made trial upon Eleven several Salts, &c. Salt of Tartar, Common Salt, Sal Gummus, Roman Vitriol, Nitre, White Vitriol, Green Vitriol, Alum, Borax, Loof-Sugar, and Sal Armoniac; of all which, I dissolved an equal quantity; two Ounces, in an equal quantity of Water; severally; that is, taking fresh Water for every Solution. The success was, that the Sal Armoniac raised the Water 15 Inches. The Loof-Sugar, 13 Inches and 3d. The Borax, a Foot. The Alum 11 Inches, and 5th. Green Vitriol, 9 Inches and 7th. White Vitriol, 9 Inches and 6th. Nitre, 8 Inches, and 5th. Roman Vitriol, 7 Inches and
and 7th. Sal Gemma, 6 Inches, and 8th. Common Salt, 6 Inches and 9th. Salt of Tartar, not above 4 Inches and 10th. All which differences are plain, and most of them very remarkable: Two Ounces of Sal Armoniac raising the Water near four times as high, as the same quantity of Salt of Tartar.

7. §. From this and the fourth Experiment, compared, it also appears, That the several spaces gained by the several Salts, though sometimes they do, yet do not always answer to the Solubility of the said Salts. As to give some Instances; Loaf-Sugar is the most dissoluble of any other Salt; yet it gaineth less space than all the rest, save only Sal Armoniac. So Green Vitriol is more dissoluble than either Nitre or Common Salt; yet gaineth less space than either, especially than the latter. And Sal Armoniac, which is more dissoluble than Alum or Borax, yet gaineth less space than either of them. The Cause whereof is not easily assigned.

8. §. Note also, that by the same Experiment, as well as by the Table and other Circumstances, it is plain, That sal Gemma is nothing else but Common Salt, coagulated or Crystalized under Ground.

9. §. Again, as the Fifth Experiment sheweth, That there are Vacuities in Water: so doth this Laft, that those Vacuities, are of differing kinds. Because, otherwise, it should seem, That the Bulk of the Water would increase, more or less, according to the Solubility of every Salt, and not be alternately differentiated as it is; Some Salts, more dissoluble, increasing the Bulk of the Water less, and others less dissoluble, increasing it more. I say, that this difference dependeth not only upon the different Figures of the Atomes of Salt; but because then every Salt, which is more dissoluble, would (quantity for quantity) take up less room in the Water; which is contrary to the Experiment.

10. §. From the same Experiment, howsoever paradoxical it may seem, yet it is also manifest, That although Water be a Fluid, yet the Particles thereof are hard and constant, and unalterable in their Figure. Otherwise it is plain, That all manner of Salts would be dissolv'd in the same manner, and take up the same room in the Water. For let the Figures of the Salts be never so various, yet if the Particles of Water were themselves Fluid or Inconstant and Alterable, they would always so conforme to those Figures, as to fill up all Vacuities; and so upon the Solution of several Salts, if of equal quantity, the Water would still retain an equal Bulk. As supposing an Ounce of Iron were drawn into Wyrs, another beaten into Plates, a third made into Hooks, a fourth into Needles, a fifth into Nails; every one of these five Ounces, being put severally into Water will enlarge its Bulk equally. I conclude therefore, That the Atomes of Water are hard and unalterable.

11. §. The Eighth Enquiry was this, What that just space might be, which any Salt gaineth upon Dissolution, with respect to its own Bulk, or the Bulk of the Water? For the making of this Experiment, Water will not serve, nor yet Spirit of Wine; because they both of them dissolve more or less than those Salts, which are put into them; whereby the Observation of the true Bulk of the Salt, and consequently of the just space it gaineth by Dissolution, is lost. I took therefore Oyl of Turpentine, and pouring it into a Bolt-head, marked the place of its ascent in the Neck. Then pouring likewitli into it two Ounces of Common
Experiments in dissolving

Lect. VII.

Common Salt, I marked the second ascent of the Oyl and found it to be 10 inches and 6 eighths. Repeating the Experiment in like manner with two Ounces of Nitre, I found the ascent of the Oyl to be 11 inches and 4 eighths. Repeating it again with two Ounces of Alum, the ascent of the Oyl was 12 inches and 2 eighths. And making it once more with Sal Armoniac, the Oyl ascended to 15 inches: the said several ascents of the Oyl being the true spaces which the Four above said Salts take. From which, the space which the same Salts take upon Dissolution, being deducted; the remainder is the space gained by that Dissolution. And so it appears, first, that Sal Armoniac gaineth nothing; being the only Salt of all I have tried, which causeth the equal ascent both of the Water and the Oyl, i.e. just 15 inches in both. Alum causeth the ascent of the Oyl to 13 2/3, of the Water, to 11 inches and 4 eighths; so that it gains about 1 inch and 1/4 out of 13. Nitre causeth the ascent of the Oyl, to 11 inches and 2/3, of the Water, to 8 inches and 2 eighths. So that Nitre by Dissolution gets almost the space of 3 inches in 11. Common Salt causeth the ascent of the Oyl, to 10 inches and 4 eighths of the Water, 6 inches and 4 eighths. So that Common Salt gains by Dissolution 4 inches in 10, which is very considerable.

12. §. By this way the Specific Gravity of all kinds of Salts may be easily taken, and the difference betwixt them is somewhat surprizing. For it appears by the ascent of the Oyl, that Nitre, quantity for quantity, is about a 22\(\frac{1}{2}\) part lighter than Common Salt. Alum about a 6\(\frac{1}{2}\) part lighter. And Sal Armoniac, almost a 4\(\frac{1}{2}\) part lighter than Common Salt. The like estimate may be made of the Gravity of all other Salts.

13. §. By the same Experiment it also appears, That according to the Specific Gravity of Salts they are many times at least more or less Volatile; as in the four last Salts is plain. For Common Salt which of all the four is the most fixed, is also the heaviest. Nitre which is somewhat less fixed is somewhat lighter. But Alum which is still less fixed is much lighter. And Sal Armoniac which is wholly Volatile, is the lightest of all the Salts above mentioned.

C H A P.
CHAP. III.

Wherein, from the Experiments in the foregoing Chapter, is shewed, the Cause of the Motion of the Mercury in the Barometer.

O R the doing of this, it will first be acknowledged, That not only several sorts of Sulphur, but also of Volatile Salts, are continually sublimed from most Bodies into the Air. So Lightning, from the celerity of the ascension, appears to be made of a Meteor, which is Nitro-Sulphurous. Snow dependeth upon a Mixture of Nitrous, and other Salts; as is evident, from the regularly and differently Figure'd Parts, which compose the whole Body of a Snowy Cloud, before it clusters into Flakes. And one reason, why Rain is the best Water for any Soil, is because it is impregnated with divers Volatile and Fruitful Salts. And so from other Meteors.

2. And next, that these Salts, are not always in the same Quantity, Proportion, and State, in the Air: but that sometimes they are more copious; at others, less; sometimes, one more copious, than another; sometimes, more plentifully dissolved; at others, more sparingly; and that, either as they are more or less pure and dissoluble; or according to the quantity of the Vaporous Parts in the Air, in which they are incorporated or dissolved.

3. Thus much being granted, from the Experiments in the foregoing Chapter compared together, we may resolve our selves about some Phenomena in the Baromètre. Which seems to vary, not so much with the meer Weight of the Air, which hitherto hath been supposed; as by the different pressure it makes, in being crowded more at one time, than at another. That is, according as certain Nitrous, or other Saline Bodies, take up less space in the Air, when dissolved in the Watery Parts therein, than while they are undissolved.

4. And therefore it is especially to be observed, That as the Mercury commonly riseth in the Cylinder for some days, but always for some time, before the change of the Weather, whether for Snow or Rain: So, that then it presently falleth again, even before the Snow or Rain falls. Whereas, if the Weight of the Air were the only, or the chief Cause of the ascent of the Mercury; than as it riseth all the while the Weather is gathering, so it would keep its standing or height, until the Weather breaks and falleth down: which yet it never doth, but always falls before it; sometimes no less than a whole day. The Cause whereof is, in that all the while the Mercury riseth in the Cylinder, the Air is crowded with more and more Saline Parts, which by
the Winds, or otherwise, are carried into it; and so causeth it to press upon the Mercury in the Box; but after that in some time the Salts are dissolved or incorporated in the Aqueous Parts of the Aer, as in Rain or Snow; so soon as that is done, there is some space gained; and so, before any Weather falleth, the Aer is left crowded, and presseth left upon the Mercury in the Box, which gives way to its descent in the Cylinder.

5. 6. From hence also it is, that the Mercury riseth higher with Cold Winds, than it doth with those which are Warm. Both because that in cold Winds there is the greatest quantity of Nitre: and that the coldest Winds are usually the driest. So that the Nitre wanting Mouiture fully to dissolve it; it takes up so much the greater space; and so causeth a greater presiture in the Aer, as hath been laid.

6. 6. Lastly, For the same reason it comes to pass, that the Mercury first riseth higher, and then falleth lower before Snow, than it doth before Rain. Because that for the production of Snow, the Aer is crowded with a greater quantity of Nitre, or some other like Salts, which before they are dissolved, take up so much the more space; and afterwards so much the less, even before the Snow falls: as hath been proved.
AN INDEX OF THE CHIEF MATTERS.

In which, Id. signifies Idea. An. Anotmy. The Figures before §. the Page. The Figures following §. the Section in that Page.

A.

Alkaline Salt, in many plants in their natural estate. 240. § 9.
This the predominant Principle of the true Wood of a Plant, Id. § 52.
Anagallis, of what Taste, 284. §.
Angelica Roots, when dry, full of Rose, Id. § 41.
Anatomy of Plants, why fit to be made, Id. § 17.
In what manner, § 18.
What to be observed thereby, § 19.
Of what use, § 20.
Animals, their Parts mixed with several Menstruums, 247 to 253.
Cantharides, of what nature, 249.
Antimony, of what nature, 245.
§ 23.
Apertures of Seeds, An. 2. § 5. & 200. § 1.
Apple described, An. 40. § 2. & 179.
Aprecock, 148.
Arfinart, coted, how its Seed ejaculated,
The Index.

Cautchures, their nature, 249. §. 14.
Café of the Seed, of several manners, An. 45. §. 2. & 186.
Cardus green Leave, their scent, Id. §. 28.
Caltor, 250. §. 28.
Celandine, little, where tasted, 284. §. 10.
Cherry, 185.
Claspers, An. 27.
Clématis peregrina, the Seed-Cafe of what Tafü, 283. §. 3.
Coats of the Seed, see Seed.
Where tasted, 284. §. 8.
Colours of Plants, To what Parts of Plants they belong, Id. 26.
How to be observed, Id.§. 27.
Colours of Roots, An. 94. §. 65. & 270. §. 5.
Of Leaves, 270. §. 6.
Of Flowers, 271. §. 15.
By their Mixture with other Bodies, 375.
By Cultivation, 277.
Their Causes summed up, 276.
Compression a Cause of Mixture, and of Disjolusion, 229. §. 232.
§. 4. & 237. §. 3. 4.
Contents of Plants, in what Method to be examined, Id. §. 21 to 26. & 31 to 47. of what kind, §. 21.
Confidence, §. 25.
How made in the several Parts of a Plant, An. 92. §. 57.
What in the Seed, 288. §. 15.
Contrayervâ, of what Tafü, 283. §. 6.
Convolution of the Trunk æ Magnetick.
D.

Daisy Leaves, where tasted, 284. §. 10.

Defect of the Root, how made, An. 34. §. 3.

Diametral Rays, see Roots.

Digester, the nature of that invented by Mont. Pappin, 237.

Dilution of bodies promoted by Compressio, 237.

Dilimniar Leaves, see Leaves.


Dung of Pigeons, 251. §. 37.

E.

Earth, how to be examin'd, as relating to Vegetation, Id. §. 57.

How nature prepares it for the growth of Plants, 11. §. 8.

Empalement, see Flower.

Emulations, sometimes for Glysers, Id. 39.

Emula, of what Taste, 283. §. 3, 34.

Essential Salts of Plants, see Salts.

Evergreen, 156. §. 2.


F.

F. At, how made by Art or Nature, 233. §. 3.

Fermentation, 253. §. 55.

Fibers of the Leaf, see Leaves.

Of the Seed, see Seed.

Figures, of Plants, Id. §. 11.


Of Trunks, 135. Of Leaves, 150. §. 1.

Of Seeds, 195.

Figs, their Sugar, Id. §. 41.

Flax, its nature, 258. Query 1.

Flower, its Empalement, An. 35. §. 2. §. 163.


Flower, when formed, 175. Colours of the Flower, 271. 

How by the Flower to find out what for a Plant belongeth, 175. §. 13.

Focus, see Seed.

Foulds of Leaves, see Leaves.

Formation of the Root, see Root.

Fruits; Apple, An. 40. §. 2. §. 179.


Pear, An. 41. §. 3. & 182.


The Use of the Fruit, An. 44. §. 10. 

The Index.
The Index.

§ 10. Of its Parts to its self. 189. To the Seed, 191, & 209. When the Fruit formed, 192.§. 9. Furr of a Hare, 247.§.3.

G.


H.


I.


L.


M.

The Index.

Membranes of the Seed, see Seed.
Membranum of the Stomach, 253.

Metals; Lead, 244. § 16. Mercury, 244. § 16. Steel, 244. § 20.

Milks of Plants, Id. § 21 & 26.
How made, An. 67. § 19. & 93. § 60. & 133. § 12.

Milk-Vessels, their Structure, 112.
§ 35.

Millipedes, 249. § 15.

Minerals of all sorts, how easily tried, 247. § 48.

Mixture; the received Doctrine hereof, 222.

Motions, Of Plants, Id. § 16. Of Roots, and other Parts, see Roots, and other Parts.
Of the Sap, see Sap.
Of the Acr, see Acr.

Mucilaginous, An. 66. § 18.

Musk, its nature, 250. § 29.

O


Oranges, how to be observed, Id. § 28.

Some Influences how made, An. 44. § 46. Imitated, 235.

Olibanum, its nature, 258. Query, 2.


P

Arenchyma or Cortical, Pithy, and Palpy parts of a Plant, their predominant Principle, Id. § 48. Described in the Root and other parts, see Root, &c.

How formed, see Roots and Leaves.

Peach, see Fruits.
Pear, see Fruits.

Pearls, their magistery, 252. § 43.

Philosophy, begins and ends with Theology, 79. § 1.
Pimpinell, where tailed, 284. § 10.
Pith, its Structure, 76. § 7, & 120. § 11, &c.

Plants, their Natural History how far cultivated, Id. § 3. Wherein defective, § 2. Fit to be further improved, § 3, &c § 63. What to be enquired of, § 6. The usefulness hereof § 8.

Plants, their Nature and Virtue how judged of, see Virtues.

Plants, their places of Growth, Id. 15.

Propotions, § 13.

Plants, their Parts only Two Essentially distinct, 47. § 14.

Plants; the general Structure of their Parts, 120. § 11, &c.

Plants, their Principles how to be observed, Id. § 48.

For what purpose, § 53. What

Z

predo-
The Index.

Predominant therein, 240. § 2.
Plants, how to find out to what kind any one belongs, 174.
Plum, see Fruits.
Principles of Body, 223, which predominant in the true wood of a Plant, Id. § 52.
Principles of Principles, Id. § 62.
Protections of the Leaf and Flower. See Leaf and Flower.
Pyrethrum the Root, of what Taste, 281. § 623. § 284. § 72.

R.

Radicle, see Seed.
Raisins, their Sugar, Id. § 41.
Roots; their Original, 57. § 1.
Shapes or Figures, & Sizes 58. § 4. & 89. § 41. Motions, An. 15.
91. § 54.
Parts, the Barque, its Skin, An. 11, § 2. & An. 61.
Root, how it grows, An. 14, § 23.
The Sap, how imbibe and distributed to its several Parts, 82. § 15 &c. How circulated, An. 17. § 29.
How all the parts are formed, § 85. § 26. &c. And differently disposed, § 88. § 38. &c. The Colours of Roots, 170. § 5. How made, § 94. § 65.
Root of Wormwood, where tasted, 283. § 12.

Rosin, how made by Art, 233. § 4.
Rosin in dried Roots of Angelica, Id. § 41.
Common Rosin, its nature, 258.
Query 2.

S.

Salt aerial, Id. § 60.
Salt Alkaline, in many Plants in their natural estate, 240. § 9.
Salt ammoniac, 246. § 44.
Salt fixed, of what use in Purgation, 260.
Salt Lixivial of Plants, how imitated, 233, § 6. of different nature, 264. § 2.
Salt Marine of Plants, how made by Nature or Art, 234. § 8. 263 § 12, &c. 266. § 16. Of several sorts, influenced in those of Rosemary, Scourey-grafs, Black-Thorn, Wormwood, 266. § 17 &c.
Salt of the dead Sea, 263, § 14.

Saps
The Index.

Saps of Plants, how to be observed, Id. 21. to 26. and 31. to 47.

Sap, how imbied, and distributed to the several parts of the Root.
An. 82. § 15 &c. Its Circulation therein, An. 17. § 29. where, and how it ascends in the Trunk,

Sap and other contents of the several Parts how made, An. 92. § 57 &c. § 131. How a Milky Sap,
An. 67. § 19. & 93. § 60. § 133. § 12 &c. How a Honey, 93 § 62. & 132. § 3 &c. How one very
Only, 132. § 6 &c.


Seasons of Plants, Id. § 14.
Secundine see Seed.

Seeds; their Caes or Utens, An. 45. § 2. of several manners, 186.
Figures, An. 45. § 3. &c. 195.

Plumes or Bud, An. 3. § 13 & 206.
Skin, An. 4. § 16. & 207. § 9.

Shape of Roots, and other Parts, see Roots and other parts.

Skin, see Seed and other Parts.
Smell of green Cardamum, Id. § 28. of the Pestil of Annu. Id.
Soyl, see Earth.
Sperme of Plants, see Flower.
Spirit of Salt, 247. § 46.
Spirit of Sal ammoniac, 247. § 47.

Spirit of Pear-Cod, Id. § 30.

Spirits urinous, how made less offensive, Id. § 45.


Stalks, see Trunks and Branches.

Steel, its nature, 244. § 20. Mixed with double Aqua fortis, what thereupon remarkable, 244. § 22.

Stillarious Oyls, how mixed with water, 232. § 7. & 237.

Stomachick menstruum, 253. § 53.

Stones; a strange one bred in the Horse, 252. § 48. Others probably bred there, 253. § 51. of the Kidneys or Bladder, of what nature, 251. § 32. How presented, 251. § 41. & 252. § 42.

Gall Stone, its nature, 252. § 47.

Bezoar, its nature, 252. § 49.

Lead-Spar, 244. § 12.

Lapis Calaminaris, 243. § 9.

Tuhna, ibid.

Lazul, 244. § 12.

Structure of a Plant, 120. § 11.

Sugar of Rafigs and Figs, Id. § 41.

Sulphur predominant in the true wood of a Plant, Id. § 52.

Sun, its Influence on Plants how to be examined, Id. § 61.
The Index.

T.


Table of Arum Root, 281. §


Texture of a Plant, 120. § 11. &c.

Thorns, their kinds, An. 33. § 1. Timber, see Trunk.

Tin, its nature, 245. § 26.

Tin mixed with strong Aqua fortis, what thereupon observable, 245. § 27.


Tincture of Corals, a cheat, Id. § 28.

Trunks, and Branches several described as they appear to the naked Eye, &c. of Indian Wheat, Dandelion, Borage, Colewort, Holly-oak, wild Cucumber, Scorzonera, Burdock, Endive, Vine, Sumach 103, &c.

Trunk, skin, An. 19. § 2. & 107. § 2 to 5.


Veils, 108. § 8. to p. 113.

The Lymphatics their Structure, 111. § 3, &c. &c.

Milk-Feusel, their Structure, 112. § 35, &c.

Different Surface of the Barque bow made, 129. § 4.


True wood, 114. § 10. & &c.

How dilated, An. 22. § 22. 23. and why, § 24, &c.

Air-Veils, An. 20. § 8, 9, &c. 115. § 16, &c.

How less in the Trunk, than in the Root, and whence formed late in the year &c. 130. § 10. & 131. § 16.


Trunks, their different Structure whence, 129.

Shapes, whence, 135.


Trunks, how fitted for Mechanick uses, 137.

Trunks, of their Bleeding, Id. § 23. & 124. § 3, &c.

Trunk-Roots, An. 27. 28.

Turnep, described, An. 13.

Valves,
The Index.

V.

Alves, no where in Plants, An. p. 21. s. 16.
Vegetables, see Plants.
Vegetation of the Seed, see Seed.
The manner of Vegetation, how judged of, Id. s. 53.
Vessels of the Root and other Parts, see Root and other Parts.
Virtues of Plants, how to be observed and judged of, Id. s. 12, 30, 47. & p. 236, 290.
Imitable, 235.
The reason of them, how knowable, Id. s. 55.
Vitriols, their nature, 246. s. 38.
Utens of Plants, stely or membranous, 186.

W.

Allnut, 185.
Water, how to be examined as relating to Vegetation.
Water, how mingled with distillations or other Oys, 237.
Wood of the Root and other Parts, see the Parts.
Of Oak, Ibid.
Its predominant Principle, Id. s. 52.

Y.

Arrow Leaf, their Taste, 283 §. 6.
The TABLES to the First BOOK, are Four.

**TAB. I.** Figurc 1, a, The Foramenc.

F. 2, a, the Radicle lodged in the Body of the Inner Coat.

F. 3, a, the Radicle, b, the Plume or Bud.

F. 4, the Seed covered; c, the Seed open; e, the same magnified.

F. 5, a, the Corn covered; c, marked and a little magnified.

F. 6, a, b, the two Lobes; c, the Radicle; d, the Radicle and Bud; d, the Hollow in which the End lies.

F. 7, a, the Seed covered; c, marked; e, open.

F. 8, a, one Lobe; --b, the End; b, magnified.

F. 9, the Slice a little magnified.

F. 10, The Radicle d, cut transversely c.

F. 11, The Plume or Bud a, cut transversely c.

F. 12, Cut by the Length.

F. 13, A Lobe cut transversely.

F. 14, Both the Lobes pared by the Length, to shew the Seminal Root.

F. 15, a, the convex side of one Lobe, shewing the Seminal Root without cutting; c, the flat side.

**TAB. II.** F. 1, 2, & 3, shew the gradual conversion of the Lobes of the Seed, into Leaves.

F. 4, a, the Radicle cut by the length; b, transversely.

F. 5, The white Wedges, are the Insertions; the black, are the Wood; the pricks are the Aer-Vessels; and the black half ovals, the Lymphadnae in the Barque.

F. 6, The three black Rings, are the terms of three years growth.

F. 7, a, the upper parts; b, the lower.

F. 8, A Turnep cut transversely, and part of the Rind cut off.

F. 9, sheweth the gradual growth of the Pith.

**TAB. III.** F. 1, The Bud cut transversely, and part of the Radicle by
The **Explication of the Tables.**

by the Length, in a Bean newly sprung up.
F. 2. Jeweth the Wood as it appears to the naked Eye.
F. 3. the Cane split down.
F. 4. the Corn newly sprouted.
F. 5. A Branch of five years growth.
F. 6. a, a piece of the Stalk; b, magnified.
F. 7. a, a piece of Oak wood cut transversely; b, the same magnified.
The white Lines are the lesser and greater Infections. The Prickes, are the Wood. The little and great Holes two sorts of Aer-Vessells.
F. 8. Part of a Branch ten years old, with the Barque stripped off, and cut both transversely and down the length, to show how the Barque is interfered into the Wood.

**TAB. IV. F. 1.** Showing how the Infections appear, in a piece of Beech-Tree split down, to be traced or woven in together with the Wood.

F. 2. to 11. show the different position and Figure of the Ligno-Fibers.
F. 12. a, one of the Three Sempiterniformes in a Lily, with the permatich Powder therein, as apparent to the naked Eye.
F. 13. a, one of the Suits in the Florid Attire, as it appears to the naked Eye; b, the Floret; c, the Sheath; d, the Blade.
F. 14. Wherein the white Pentagonal Acetar is bounded by the Calculary.
F. 15. The Branches which run through the Stone to the Flower and Seed.
F. 16. The Innermost Cover of the Seed, as shaped when it is ripe.
F. 17. The Coats cut open.

The **TABLES to the Second** Book are Thirteen.

**TAB. V.** Jeweth the generation of Roots out of the Descending Trunk. So F. 6. is a treble Root of three years descent; the lowermost, half-rooted off.

**TAB. VI. F. 1.** Jeweth the Surface of the Barque.
F. 2. the middle part.
F. 3. the Barque stripped.
F. 4. the Root cut down the length.
F. 5. the Barque stripped off.
F. 6. the Network both of the Lympheduffs, and of the Aer-Vessells.
F. 7. the Generation of a Bud.
F. 8, 9, 10, 11. The Root split down, to show the Position of the Vessels, and the Figure of the Pith at the top of the Root.

**TAB. VII.** The Roots all cut transversely, and their Varieties described, in the second Book, as they appear to the naked Eye.

**TAB. VIII.** Other Roots cut transversely, and the varieties of their Parts also described in the second Book.

**TAB. IX.** More Roots cut transversely.

**TAB. X. F. 1.** A Slice of the Root cut transversely; but a little too big for the life.
F. 2. AA, One half of a like Slice.
F. 3. b, The Skin.
F. 4.AADD, The Barque or all that part of the Root analogous to it.
F. 5. GD, The Lympheduffs on the inner edge of the Barque.
F. 8. TT, The Pith.

**TAB. XI. F. 1.** The Neck of the
The Explication of the Tables.

The Root cut transversely.

F. 2. One half of the same split down.

F. 3. Magnified.

AB, The Skin.

AE, The Barque.

EE, The Lymphedemns.

The black Columns under them, are the Wood.

The Holes in the Columns are the Aer-Vessels.

The white Columns EL, are Inser-
tions between the Barque and the Pith.

L e, The Pith.

e e, The angular bladders of the Pith.

TAB. XII. A, one half of F. 1.

magnified.

A b, The Skin.

A G, The Barque, or all that part of the Root which answers to it.

In which the round black spots, are the Medulla.

DG, The common Lymphedemns.

DT, The Pithy Part of the Root.

TT, More Lymphedemns.

In both which, the black Holes are the Aer-Vessels.

TAB. XIII. A, one half of F. 1.

magnified.

A C, The Skin.

AG, The Barque, or that part of the Root which answers to it.

DD, The Milk-Vessels placed in Rings.

EE, The Parenchymous Kings between them.

GT, The Bladders streaming in Rays, by the mixture of the Lymphedemns with the Lecells.

GG, To the Centre, the Wood.

In which the Holes are the Aer-Vessels.

TAB. XIII. A b, The skin, which should have been thicker.

AF, The Barque.

Gb, The Bladders in the outer part of the Barque, oblong and postured circularly.

SS The Bladders in the inner part, standing in Arches.

FF, A Ring of Sap-Vessels.

d d, Parenchymous Injections.

d d l, The Wood.

In which, the Holes edged with white Rings are the Aer-Vessels.

TAB. XV. A A, The Skin.

AB, The Barque.

BL, The Sap-Vessels in the form of a Glory.

BE, The Wood.

In which, the Holes are the Aer-Vessels.

GE, A Ring of more Sap-Vessels.

EE, The Pith.

TAB. XVI. Ab, The Skin.

AC, The Barque.

In which the round Holes B, are Balsame-Vessels.

BC, Parcels of Lymphedemns.

In which there are more Balsame-
Vessels.

CD, Parenchymous Injections.

DE, Parcels of Wood.

In which the Holes are the Aer-Vessels.

TAB. XVII. A, The Skin.

AB, The Barque.

L S, A parcel of Sap-Vessels.

L I, A Parcel of Wood.

In which the Holes great and small are Aer-Vessels.

BB, Parenchymous Infections between the parcels of Wood.

DD, Others within them.

The TABLES to the Third BOOK are 23.

TAB. XVIII. Hereof see the Description in the Third Book, Chap. 1.

TAB. XIX. F. 1. A Branch of Corin Tree.

A, shown the surface of the Barque.
The Explication of the Tables.

B, Of the wood.
F. 2. Stalk of Sonchus split down.
F. 3. Branch of Vinc split down.
In both, the several Stories or Chambers of the Pith.
F. 4. Branch of Walnut. A, an older, B, a younger; in both, the Pith parted into transverse Membranes.
T A B. XX. F. 1. Sheweth the Surface of a Walking Cane.
And the Clusters of Aer-Vessels, surrounded with Rings of Succiferous.
F. 2. The surface of the Skin of Borage Stalk.
F. 3. The Turpentine Vessels running through the length of the Barque, one of them cut down the middle, the other entire.
F. 4. The milk-Vessels bled in the same manner.
T A B. XXI. Sheweth the Wood, and Aer-Vessels by the length of the Branch, part of the Barque, and wood, being taken away.
T A B. XXII. A B, The Skin.
A C, the Barque.
Q, the Parenchymous part.
H I, Parcels of Maculae in a Ring.
D C, Common Lymphedulis.
C D E F, the Wood of 3 years growth.
K L M N, The second years growth.
O, the great Infections.
P, the smaller.
XX, Lignous parcels.
Within which the Holes are the Aer-Vessels.
E F G, the Pith.
T A B. XXIII. A B, the Skin.
A C, the Barque.
Q, the simple Parenchyma.
H I, a Ring of special Vessels.
P, common Sap-Vessels.
C D E F, the Wood of 3 years growth.
K L M N, one years growth.
X, great Infections.
P O, lesser between them.

The black parcels are the wood.
In which the Holes are the Aer-Vessels.
E F G, the Pith.
T A B. XXIV. A B, the Skin.
A B C D, the Bark.
N N, the Parenchyma.
H I, a Ring of special Sap-Vessels.
D M C, Parcels of Lymphedulis.
C D E F, the Wood.
E F L K, one years growth.
K P Q L, the larger Aer-vessels in the several parcels of Wood.
O S, the lesser Aer-vessels.
M T, the infections.
E F G, the Pith.
T A B. XXV. A B, the Skin.
A B C D, the Barque.
H I, Special Sap-Vessels in arch-ed parcels.
O O, the common Sap-Vessels which begin to turn into Wood.
C D E F, the Wood.
K L M N, one years growth.
The Holes are the Aer-vessels in the wood.
O O, the true wood.
O Z, O Y, the Infections.
E F, other Sap-vessels.
E F G, the Pith.
T A B. XXVI. A B, the Skin.
A B C D, the Barque.
Q Q, the Parenchyma.
H I, Special Sap-Vessels in arch-ed parcels.
D C, a Ring of common Lymphedulis.
D C F E, the Wood.
K L M N, one years growth.
The Holes are the Aer-vessels.
O O, the greater Infections.
P O, the smaller.
E F, other Sap-vessels.
E F G, the Pith.
T A B. XXVII. A B, the Skin.
A B C D, the Barque.
W V, the Parenchyma.
H I, round parcels of Sap-Vessels.
D C, the common Sap-Vessels.
D C F E, the Wood of 3 years growth.
B b b Q R F E,
The Explication of the Tables.

QRFE, one years growth.
XX, the true wood.
The Holes both great and small
are the Aer-Vessels.
SS, The great Injections.
TS, the smaller.
EFG, the Pith.
TAB, XXVIII. AB, the Skin.
ABCD, the Barque.
HTI, special Sap-Vessels in
round Parcels.
DSC, common Sap-Vessels.
DCEF, the Wood of five years
growth.
e e, the true wood.
KL, &c. the great Aer-Vessels.
DC, the smaller.
SS, the Injections.
EFS, the Pith.
TAB, XXIX. ABCD, the
Barque.
AB, a Ring of Sap-Vessels in
round parcels next the Skin.
HI, the Parenchyma.
Another Ring of round parcels.
DOC, Common Lymphedufs.
DCEF, the wood.
MNEF, one years growth.
SS, the true wood.
KL, the great Aer-Vessels.
PQ, the lesser.
OO, the Injections.
EFG, The Pith.
e, the Bladders of the Pith.
TAB, XXX. AB, the Skin.
ABCD, the Barque.
RR, the Parenchyma.
HRI, two Rings of special Sap-
Vessels.
DC, Common Lymphedufs.
DCEF, the wood of four years
growth.
d d, the true wood.
Q d, part of it whiter, by the
mixture of special Sap-Vessels repre-
sented by the transvers Lines.
MN, the great Aer-Vessels.
ce, parcels of lesser ones.
EF, a Ring of other Sap-Vessels.
EFG, the Pith.
TAB, XXXI. ABCD, the
Barque.

mm, the Parenchyma.
HI, milk Vessels in arched par-
cels.
DKC, Lymphedufs.
DCEF, the wood of one years
growth.
ST, probably milk Vessels herefo-
re.
The Holes in the Aer-Vessels.
KK, the Injections.
E v F, other Milk-Vessels.
EFG, the Pith.
TAB, XXXII. ABCD, the
Barque.
MN, The Parenchyma.
DLG, The Lymphedufs.
HI, The Vessels which carry the
Turpentine.
DCEF, the Wood.
LL, the Injections.
EFG, the Pith.
The greater Holes both in the Wood
and Pith, are more Turpentine Vess-
els.
TAB, XXXIII. ABCD, the
Barque.
XY, The Parenchyma.
KXXY. Special Vessels in round
parcels.
HI, others in a Ring.
DC, Common Lymphedufs.
DCEF, the wood.
SZT, probably one sort of Sap-
Vessels herefore in the Barque.
QM, small Aer-Vessels.
MN, great Aer-Vessels.
RQ, the small Injections.
QQ, the great ones.
EFG, the Pith.
TAB, XXXIV. ABCD, the
hairy Skin.
ABC, the Barque.
HI, the Parenchyma.
DMC, the common Lymphedufs.
KL, the Milk Vessels. v, one Vess-
els.
HI, Another sort of Lymphedufs,
arched over the Milk Vessels.
XX, seems to be a third sort of
Lymphedufs.
DCEF, the Wood.
The Explication of the Tables.

MM, the Infections.

XX, the true Wood.

The Holes therein are the Aer-Vessels.

EF, a Ring of Lymphedulas.

EFG, the Pith.

TAB. XXXV. ABCD, the Barque.

AM, the Parenchyma.

HMI, Balsam Vessels.

KL, another sort of Sap-Vessels in parcels.

KLDH, Lymphedulas.

DC, The Wood.

In which the Holes are the Aer-Vessels.

MM, the Infections.

EF, more Balsam Vessels.

EFG, the Pith.

TAB. XXXVI. a, a part of a Vine-Branch cut transversely, and also split half way down the middle.

BB, The same magnified. Shewing the Position of the Bladders in the Barque and Pith in perpendicular Rows; in the Infections, in Horizontal Rows.

And the Vessels or Parcels of Wood not raced as in many other Trees.

TAB. XXXVII. Sheweth the bracing of the Vessels. And how the several Parcels of Vessels or Wood are interwoven with the Infections.

TAB. XXXVIII. ABCD, the Barque.

HI, The Parenchyma.

c, c, A sort of Sap-Vessels.

aa, Another sort.

c, c, Milk Vessels.

DCEF, the Wood.

VV, the Aer-Vessels.

tt, More Lymphedulas.

ff, More Milk Vessels.

at, The Infections.

EFG, The Pith, composed of angular Bladders, the Bladders of Threads, and the Threads of single Fibers.

e, One of the single Fibers.

TAB. XXXIX. Sheweth the Structure of the Lymphedulas or of the Lignous Fibers both in the Barque, and the Wood.

F. 1. a, & F. 2, A single Vessel in the Barque of Flax, composed of a great number of other Lignous Fibers; with which also the Parenchyma are intermixed. Not visible, except very highly magnified.

F. 3. A parcel of the same Vessels in Wood.

F. 4, & F. 5, shew the manner of the Ascent of the Sap, both in the Lymphedulas, and in the Laticiferous and other larger Vessels.

TAB. XL. The Fibers which hang down from the Barque are the Lymphedulas, one of which is composed of a great many other smaller Fibers.

The large Tubes are the Milk-Vessels composed of Bladders.

The Fibers which hang down from the wood, are some of them the old Lymphedulas torn'd to wood.

And some, Aer-Vessels unroof'd.

The thin Plate between the two wedges of wood, is one of the Infections, composed of Bladders, and those Bladders of Threds.

The remainder, is part of the Pith, composed of Threds or Fibrous Bladders.

The TABLES to the Fourth BOOK are 42.
The Explication of the Tables.

magnified.

F. 4. a b, the Leaf rowed up, inward. c, a little magnified and cut transversely, to shew the Rowl.

F. 5. a, the Leaf rowed up, b, magnified and cut transversely.

F. 6. a, the Leaf rowed backwards, b, magnified and cut transversely.

T A B. XLIII. F. 1. sheweth the Tender-Hooks, by which the Leaf climbs.

F. 2. sheweth the Globules, turned to a white powder.

The Leaf of Jerusalem Cowslip, sheweth the Way of the Inseks under the Skin.

T A B. XLIV. & XLV. sheweth the Measures of Leaues by the Circumference.

T A B. XLVI. & XLVII. sheweth the proportion between the chief Fibers; and also the Angles they usually make together.

T A B. XLVIII. F. 1, 2, & 3, shew the Apertures in several Leaues.

F. 4. sheweth the same. And likewise, the peculiar composure of the Bladders and Fibers of the Leaf.

T A B. XLIX. sheweth the difference in the Bladders, and in the Position of the Lignous Fibers in the Stalks of Leaues.

T A B. L. sheweth the Pulp of a Borage-Leaf and many others composed of Bladders; the sides of which Bladders, are made of other smaller ones.

And the distribution of the Lignous Fibers (and of the Aer-Vessels breathed within them) not like that of Veins in Animals, but of the Nervs, &c. See the description of the Leaf.

T A B. M. F. 1. The appearance of the Aer-Vessels like Cobweb in the naked Eye, upon breaking the Leaf.

F. 2. A small piece cut off of the Leaf.

F. 3. The same magnified in which the same Vessels look like spiral Myers stretched out.

F. 4. The same as they stand entire within the Wood.

T A B. LII. Representeth the Aer-Vessels of Scabious, as in Tab. LI.

T A B. LIII. Showeth the manner of the Generation of the Leaues chiefly by the help of several Salts, where-with the Sap is impregnated.

F. 5. (1) The Foundation of the work.

F. 6. (1 & 2) strengthened.

F. 7. (1 & 3); in which (3) is set with the square end to end; and with the point-side of one, to that of another.

F. 8. The same, directing the Position of the Lignous Fibers at very Acute Angles.

F. 9. At left Acute Angles.

F. 10. The greater Fibers at Acute, and the smaller at Right Angles.

F. 11. The greater at Right Angles with the help of (1) (2) or (3).

F. 12. (3) directing the Fiber in the Edge of the Leaf into a greater Circle.

F. 13. Into a left, and with divers Diameters.

F. 14. (4) directing the Parenchymous Fibers in making the Bladder.

F. 15. In winding from one Bladder to another.

F. 17. Or about the Lignous Fibers.

F. 16. In making the Aer-Vessels.

T A B. LV. sheweth how Nature manages the Fields of Flowers according to their Shape.

T A B. LV. F. 1. sheweth the Edges of the Leaf fattened by their Indented Hairs.

F. 2. The Balfamick Knots in the place of Hairs.

F. 3. The number 5 running 3 times into its self in 13.

F. 4. And five times in 21.

F. 5. &c. The Semiiforme Attire in Clematis Auftineia. With one of the
The Explication of the Tables.

The Three magnified, of which, there are about 30 or 40 in one Flower.

F. B. &c. The same in Blattaria, with one of the Three magnified, of which there are about 5 in one Flower.

T. A. B. LVI. The same in yellow Henbane.

With one of the Three magnified, of which there are about 5 in one Flower.

And the Column on the top of the Seed-Cafe, T. A. B. LVII. The same in St. John's Wort, entire, together with the Seed-Cafe or Uterus.

T. A. B. LVIII. The Varieties of the Spermatick Particles in the Seminiform Attire.

T. A. B. LIX. The Florid Attire of Golden Rod; in which, the several parts consist but of two pieces. And of which Attire, the Flower doth almost wholly consist.

T. A. B. LX. F. 1, &c. The same Attire in French Marigold or Flos Africanus, with one suit magnified, of which, there are about 12, in one Flower; and every suit consisting of 3 Pieces.

F. 5. One of another Flower, consisting also of 3 Pieces.

T. A. B. LXI. One suit of the same Attire in Marigold, and Knapweed, each of them consisting of three Pieces.

F. 5. a. The Attire of one Piece, proper to each Leaf in a Marigold Flower, besides that in the bose of the Flower.

F. 8. A b. the Seed-Cafe or Uterus at the bottom of every suit.

T. A. B. LXII. The Attire (of 3 Pieces) proper to each Leaf in the Flower of Galberry.

T. A. B. LXIII. Showeth the Flower of Mezereum perfectly formed in all its Parts, in the year before it appears. But differs in Shape, as a Fetus doth when newly formed.

T. A. B. LXIV. Showeth the same in the Flower of Atarum.

T. A. B. LXV. Showeth the position of the 20 chief Branches in an Apple.

Their Production from the Stalk, to the Seeds and Flower.

And a part of the Parenchyma magnified, &c. that which is prickled off from the Coar to the Skin, shewing the oblong Figure of the Bladders, and the Divisions in every Bladder.

T. A. B. LXVI. F. 1, &c. Showeth the Bladders in the Rind of a Lemon containing the Oyl.

The Bags and Bladders of the Pulp, containing the sooner Juice.

And the position of the Vessels belonging to the Fruit, Seed, and Flower.

F. 5. Showeth the same Vessels, and treble Parenchyma in a Cucumber.

T. A. B. LXVII. Representeth the Parts of a Pear.

The position and production of the Vessels.

The Chanel from the top of the Pear to the bottom of the Coar.

The Tartarous Knots.

And the Bladders radiated to them.

T. A. B. LXVIII. See the Descriptions of Fruits; and the Left Chapter of the Generation of the Seed.

T. A. B. LXIX. F. 5. Showeth the Parts of a Gooseberry.

The darker part is the lower Rind, consisting of two sorts of Bladders, of which some very small, and others very great.

The white pieces on the circumference of the Berry, are the Lignum Fibers.

The two opposite white and radiated Bodys are the Middle Parenchyma.

And the oblong Bags round about the general Seeds or Seed-Cafes, are the sweet Pulp.

T. A. B. LXX. Showeth the Seed-Cafe of Radish opened, and the Seeds hanging on two Ropes.

That of Poppy both entire, and Cce
The Explication of the Tables.

split down the middle.
A slice of the Seed of Garden-Bean, white very young, and therein the Bladders and Threds of the Spongy Parenchyma.

And the gradual ripening and opening of that of yellow Henbane.
TAB. LXXV. Sheweth the Seed of Tulip entire, cut transverse, and split down.
A slice of Thorn-Apple, or of the Seed-Cafe of Stramonium, while young.

That of Piminel naturally divided into two hemispheres, with the Bottom, on which the seeds grow, eroded in the middle.

The manner of the ejaculation of the seed, in Coded Airmart.

And the Costs of the Seed of Azarium formed the year before it ripens.
TAB. LXXVI. Sheweth the measures of Thorn-stones.
The Apertures, and Divisions, of the covers of the Seed.
The Seed and Seed-Cafe of Hart-tongue, opened with a Spring.

And other contrivances both for the Motion, and Arrest of other Seeds.
TAB. LXXIII & LXXIV. See the Descriptions.
In Tab. 74. the corners and edges of that of Fox-glove should have been rounder.
The Figures are all done pretty near a Scale.

TAB. LXXXV. The Belly and Back of a Date-stone, and the small sprouting Node taken out of the Hole in the back cut open.
The Shapes and Foulds of divers Seeds.
The Vitellum of Orach, and Raphontick.

in great blow-Lupine, d, the Navel, b, the defending part of the Radicle.
TAB. LXXXVI. Flag. 1, the Seed. 2, split open. 3, the true Seed which lies in the hollow made in the Cover (2) 4, one half of 2) magnified. 5, the Seed (3) magnified.

Purgung Angola Nut. 1, with the Shell on.
2. taken off. 3, the soft Cover split down. 4, the Seed which lies in it; the Lobes being answerable to two Leaves, and Radicle to the Stalk.

And so in the rest.
TAB. LXXXVII. Coffee Berry stone. 1, the belly of the Stone. 2, the black, 3, pared a little. 4, the Kernel taken out of it. 5, the same magnified.

Googras. 1, the entire Seed. 2, the back of the hard Cover. 3, the belly. 4, cut in two. 5, the same magnified. 6, the true Seed taken out of it.
Staphisagria. 1, the entire Seed. 2, the hard Cover. 3, Split in two. 4, the true Seed taken out of it. 5, The same magnified.

Peony. 1, the Seed commonly so called. 2, one half of it split down. 3, the other half. 4, the true seed taken out of it. 5, the same magnified.

Stramonium. 1, the Seed entire. 2, the inner thick cover. 3, the same split in two. 4, the true seed taken out of it. 5, half the thick Cover (3) magnified. 6, the Seed (4) magnified.

TAB. LXXXVIII. Some examples of the Buds of Seeds before they are four.
Senec. 1, the naked Seed. 2, the Lobes divided to show the Bud. 3, one Lobe with the Bud magnified.
Cardaus Benedicti, 1, the entire Seed. 2, with the outer Covers off. 3, naked. 4, divided. 5, that half with the Bud, magnified.

Hemp. 1, the naked Seed divided. 2, 3, the same magnified.
Almond. 1, one half of the Kernel. 2, the Radicle and Bud at the bottom of it. 3, the same broken off. 4, magnified. 5, opened.

TAB. LXXXIX. F. 1, ab, Part of the outer Coat.
The Explication of the Tables.

c d, Part of the Inner Coat.

c d c, one Lobe cover'd with the Skin.

f g, the other, with the skin and part of the Parenchyma pared off.

f t, the Skin.

h h, the Parenchyma.

i i, the Seminal Root.

k k, the Radicle.

k l, where it is cut off from the Lobes.

M, the Plume or Bud.

N, The Cavities in which it is lodg'd.

F. 2. Showeth the Barque, Vessels and Pith of the Radicle.

TAB. LXXX. F. 1, A Slice of a young Apricot, cut transversely, near the lower end; showing the duplicature of the Skin half way through the Stone.

F. 2, A Slice, cut near the upper end; showing the duplicature of the Skin quite throw the Stone.

F. 3, A well-grown Apricot cut by the length.

F. 4, 5, The Membranes of a Filbertfall ripe.

F. 6, The Membranes of a young Apricot, with part of the Seed-branch.

F. 7, The two Membranes cut by the length.

TAB. LXXXI. F. 1, The outer and middle Coats or Membranes; with the Chunnel, oval at both ends, now formed in the latter.

f. 2, Part of the same, with the upper oval grown larger, and the innermost Cover now also formed therein.

f. 3, the same with the innermost cover grown larger.

f. 4, the Innermost Cover more magnified, and the hollow in the smaller end, laid open, to show the Seed it self, newly begun in a round Node.

f. 5, the same; in which the Node begins to be divided into two Lobes.

f. 6, 7, 8, the gradual forming of the Lobes.

f. 9, next the forming of the Radicle.

f. 10, 11, Its gradual contraction at the point, into a short and slender Navol string.

Which in the further growth of the Seed, breaks and disappears.

TAB. LXXXII. a a, the Pulp, or open Parenchyma.

b b, the close Parenchyma or ground of the Stone.

c c, the Flower-branch running through the body of the Stone.

d d, the Seed-Branch striking into the hollow of the Stone, and so running round the outer Membrane cc.

f f, the middle Membrane.

g g, the Chanel.

h h, the inner Membrane, in which lies the Seed.

TAB. LXXXIII. f. 1, the manner of the generation of the Essential Salts of Plants.

f. 2, A Crystal of the Essential Salt of Rosemary, a little magnified.

f. 3, a b, two of Wormwood, upon the second Solution; b upon the first.

f. 4, one of Garden Scurvy-grass; a, one side; b the other.

f. 5, A Crystal of the Marine Salts of Rosemary.

f. 6, of Garden Scurvy-grass; a, the upper side; b, the other.

f. 7, of Wormwood.

f. 8, of Black Thorne.

f. 9, another of the same.

f. 10, of Firme.

f. 11, another of Wormwood.

FINIS.
FINIS
Tab. iv. Piece of Beech Wood

Stalks of y° Leaves of

Cabbage

Colt-foot

Endive

Ivy

Dock

Mint

Borage

Mullein

Lily

Peruvian Starwort

Pear

Apercock

Lupine

f. 1. f. 2. f. 3. f. 4. f. 5. f. 6. f. 7. f. 8. f. 9. f. 10. f. 11. f. 12. f. 13. f. 14. f. 15. f. 16. f. 17.
Tab. vi.

The Root of Scorzonera.

Jerusalem Artichoke.

Burnet.

Borage.

Carrot.

Dandelion.

Parsley.
Tab VII. Roots w'ch Bleed little or nothing.

1. Marsh Mallow.
2. Patience.
3. Iris.
4. Poppy.
5. Bistort.

Roots which Bleed Lympha.

7. Bryony.
8. Borage.
11. Deadly Nightshade.
Tab. viii. Roots which Bleed a Lymph.

f. 2. Carrot
f. 3. Beet
f. 5. Nettle
f. 4. Jerusalem Artichoke
f. 7. Dropwort
f. 8. Lychnis
f. 6. Valerian

Roots which Bleed a Milk or Oily Sap
f. 10. Butyr Bur
f. 9. Lovage

A
b
f. n. Dandelyon

f. 12. Great Celadine
B
f. 13. Cychory

f. 15. Bishopsweed
f. 14. Goatbeard
Tab. 9.

Roots with Milky or Balsamick Vessels, and Lymphæducts, both apparent.


Roots with two sorts of Lymphaticks; in some, Aqueducts and Mucicducts.


F. 15. Burnet.
The same Magnified Fig. 2.

Slice of a small M. Mallow Root Fig. 1.
Tab xiii  The same magnified Fig. 2.

Slice of Dandelion Root f. 1.
The small end of a Burley Root

Fig. 1.
Fig. 1
The small end of Hors-Radish Root
The same magnifyed
Tab 18. Stalks & Branches cut transversely

Indian Wheat

f.1 Dandelion

f.2

Borage f.3

f.4 Holyoak

f.5 Coelwort

f.6

Wild Cucumer

Burdock f.7

Scorzozera f.8

Endiue f.9

Vine f.10 A

B

f.11 Sumach
Tab. 21.

AB Piece Cut out of (ab) and
Magnified to show its Lymphaducts & Aer.-vesicles.

a.b. Part of a Vine Branch
Cut transversely.
Holly Branch cut transversely
Barberry Branch cut transversely
Tab. 25

Apple Branch cut transversely

f. 2. The same
Tab. 26
Pear Branch
cut transversely

f. 2
The Same

f. 1
Plum Branch cut transversely

The same
Tab. 28

Elm Branch
cut transversely

f. 2.
The same

f. 1.
Wallnut Branch cut transversely
Wormwood Stalk cut transversely.
Part of a Vine Branch cut transversely and split half way down & middle.
Tab. 38

Thistle stalk
cut transversely

f. 2.
The Same

f. 1.
The small particle of Fir-wood (a) magnified.

One of the Lymphatic Fibers or Lymphaticules in a Thread (b,c).

A Linter Thread (d,e,f).
Part of Tab. XI represented somewhat longer &

with several breaks, to show its'Connor, both of

Pendicular & Horizontal Filer
Leaf of Dock.

Wild-Clary.

Branch of Sumach.
FIG. 1. Magnify.

Leaf of Gossypus.

Of Bear's Ear.

Fig. 2.

Hairs on leaf of Tree Sage.

Of Jerusalem Coslips.

Hairs on leaf of Mullen. Fig. 3.
Tab. XLV.

Leopards

Bane

Great Laserwort

Mountaine Calamint

Black Poplar

Shrubby Marsh-Mallow
TAB. XLVII.

Leaf of Strynga.

Hemlock.

Holyoak.

Strawberry.
Stalks of

Mallow.

Dock.

Dandelion.

Wild Clary.

Borage.

Mullen.
Tab. 50.

A young Borage Leaf
The Air Vessels unroaved in a Vine Leaf.
The Aer-Vessels unwoved in a Scabious Leaf.
f. 1. Flower of St. John’s wort.

f. 2. The same a little magnified.

f. 3.
Tab. 58.
Snapdragon f. 1.
The Sperme of Plantaine f. 2.
Bear's-foot f. 3.
Carnation f. 4.
Mallow f. 14.
The Spermatik Globules in f. 13.
Bindweed f. 5.

f. 13.
One of y' Theca (t) in f. 12.

f. 12.
The Attire (t) in f. 11.

f. 11.
The Flower of Mallow.

f. 7.
Bean.

f. 8.
Lily.

Deadly Night Shade.

Pancre f. 10.
Tab. 59.

A sprig of Goldenrod flowers.

The flower (a) magnified.

One flower.

One suit of (a) flower (a).

The broad sheath.
Tab. 50.

A French Marigold.

One suit of which about 2 are within each. (lab.)

One suit of Chrysanthemum. One of this about 20 are in every flower.
Tab. 63.

One of f Flowers in a Bud (a magnis).

f. 3. The same flower cut open, shewing if spermatick Thes., &c. Utens.
Plate 65

f. 2 Cut transversely

f. 3 The piece (ab) magnified

f. 4 An Apple cut by the length
Tab. 66.

f. 3 great
One of the Baggs, a.c.e.

f. 4
One of the little Baggs
c.e. cut transversly

f. 1
a Limon cut downe

cut transversly

Garden Cucumber

f. 6
Wild Cucumber
Fig. 2: Cut by the length.

Fig. 1: Tear cut transversely.

Tab. LXVII

The pellucid, ab magnifi'd.

Fig. 5: Quinie.

A piece cut out of Fig. 1.
f. 1. A plum cut transversely

f. 3. A piece taken out of f. 2.

f. 4. The piece a, Magnifyd

f. 5. A young one with new bulky Coats of f. Seed

f. 6. The same by f. Length

f. 7. One with the Kernel full grown
Tab. 69.

f. 1. a Cherry whole.
f. 2. A Grape.
f. 3. A Gooseberry cut down.
f. 4. A Gooseberry cut transverse.

f. 5. A (f. 4.) magnified.
Garden Raveh.

Seed-Cases of
Red Pepp.

Tab. 70.

of
Garden Bean.

Yellow Henbeane.
Seeds of:

Poppy.
Little Century.
Spergula.
Little Celandine.
Lycium.

Great Celandine.

Chickweed.

Ben.

Pentaphyll. frupis.

Devoc-foot.

Brocklime.

Rush.

Little Bell.

Sed. maj.

Ranwort.

Barley.

Grafe.

St. John's wort.
Melissa Mollavica

Bellis Tunceti

Stachus Arabica

Wart Wort

Chrysanth. Americ.

Blattaria

Force Glove

Fancy
Date.

Seeds of


Viola lutea.

Wood.

Great blow Lupine.

Orach

Rhizoma

Garden Radish

Holyeak

Cotton Plant
A Garden Bean in one Lobe of
of the Seminal Root is laid bare.

The Radicle cut transversely.

A piece of its true skin.
Tab. 80
Showeth ye Structure of ye Stone & ye two upper Membranes of ye Seed

j. 1.
j. 2.
j. 3.
j. 4.
j. 5.
j. 6.
j. 7.
Tab. 81.  
Sheweth ye further process in the Generation of ye Seed.
Tab 82.

The young Fruit, Three Membranes, & Seed now loose.
Tab. 23

Ellent: Salts of Plants.

f. 2.  

f. 3.  

f. 4.  

f. 1.  

Marine Salts of Plants.

f. 5.  

f. 6.  

f. 7.  

f. 8.  

f. 9.  

f. 10.  

f. 11.