

Nehemiah Grew, the early master of plant anatomy

Of what antiquity the anatomy of animals is, and how great have been its improvements in later years, is well known. That of vegetables is a subject which from all ages to this day hath not only lain by uncultivated, but for ought I know, except for some observations of some of our own country-men, hath not been so much as thought upon; whether for that the world hath been enamoured with the former, or pity to humane frailty hath more obliged to it, or other reasons I need not enquire. – Nathaniel Grew, The Anatomy of Vegetables Begun, 1671.

In 1682 was quite a year for Nehemiah Grew. He published his great work on plant anatomy, and his father, aged 75 and blind, went to prison. Grew came from a dissenting family. His father Obadiah went through Balliol, was Vicar of St Michael's Coventry in 1645, and admitted a Doctor of Divinity at Oxford in 1651. However, this fairly prominent ecclesiastical career was brought to an end with the 1662 Act of Uniformity, when Obadiah was, as they say, 'extruded' from his living. The Act, and the following Conventicle Act of 1664 re-established the Church of England, requiring all clergymen to adhere to the rites and ceremonies in the Book of Common Prayer. It also required episcopal ordination for all ministers, and resulted in some 2000 clergymen refusing and thus being expelled from the Church of England, an event wonderfully named as the Great Ejection. The Conventicle Act forbade groups of more than 5 people not from the same household meeting for worship, conventicles, thus forbidding large meetings of dissenters. To leap ahead with Obadiah, he originally supported the Parliamentarians in the Civil War, and through them had been appointed to St Michael's. After his extrusion with the new Act, he continued to preach and serve small presbyterian congregations, but in 1682 ran foul of the Five Mile Act¹ and was imprisoned for 6 months. He was blind by this time but continued to write sermons with an amanuensis. He died in 1689, preaching to the end, minister of a presbyterian congregation at St Albans in Hertfordshire.²

A short biography and long bibliography of all of Nehemiah Grew's works was published in 1990.³ Nehemiah (1641-1712) was born in Mancetter, Warwickshire, to Obadiah and his second wife Helen, who had two sons from her previous marriage. At 17, entered Pembroke College, Cambridge in 1658, and graduated BA in 1662, following his two half-brothers, Henry and William Sampson, both Pembroke Fellows. But, as with his father and Henry, was barred from service in the church. Nehemiah and Henry turned to medicine and science, both graduating in medicine from the University of Leiden in Holland⁴, Henry in 1668 and Nehemiah in 1671. Nehemiah then practiced medicine in Coventry, at the same time pursuing his interests in botany and anatomy. Over the decade of the 1670s, Grew wrote pamphlets and articles on botany, the first drawing attention of the young Royal Society, particularly its Secretary Henry Oldenburg and one of its most active members Bishop John Wilkins. On the latter's recommendation, the Society published Grew's first botanical essay in 1671, *The Anatomy*



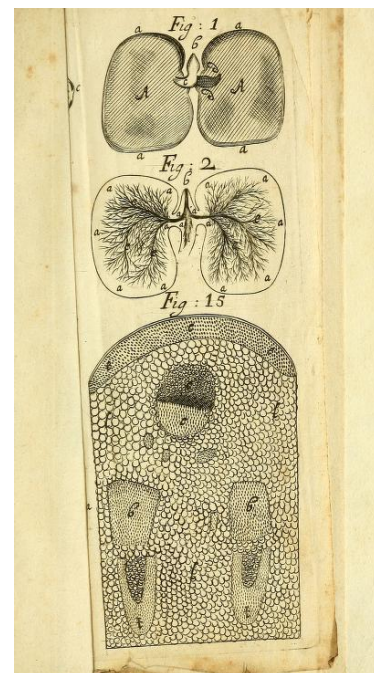
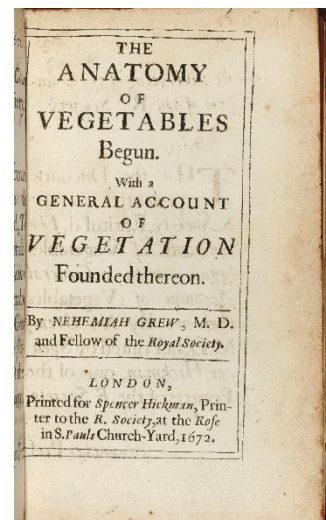
Nehemiah Grew. Late 17th C. Woodcut from R. White, Makers of British Botany, 1913.

of *Vegetables Begun* in December of that year, Grew having been elected a fellow the previous month. Things proceeded more quickly in those days. The following year, Grew was invited to London and appointed Curator for the Anatomy of Plants at a salary of £50, which the records show he asked to be secured for 5 years. The post required him to provide demonstrations, and with the help of the Society's microscope given him by Robert Hooke, he gave his first demonstration, on the 'conformation of pith in vegetables' on 22 May 1672.

Grew, Nehemiah. *The Anatomy of Vegetables Begun. With a General Account of Vegetation founded thereon by Nehemiah Grew, M.D. and Fellow of the Royal Society London. Printed for Spencer Hickman, printer to the R. Society, at the Rose in S. Pauls Church-yard. 1672. 186 pp, 3 folding plates.*⁵

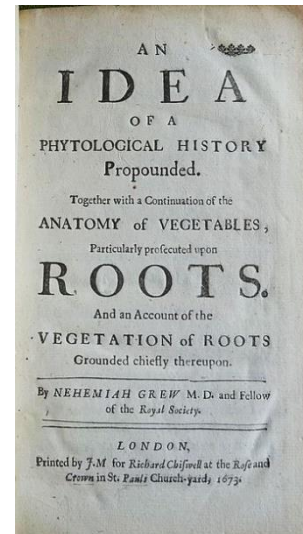
The *Anatomy of Vegetables Begun* was published at the same time as the Italian anatomist Marcello Malpighi sent in his report on botanical discoveries, the two scientists founding the science of modern plant anatomy. Malpighi's work was later fully published by the Royal Society in two volumes, *Anatome Plantarum* I and II, in 1675 and 1679⁶. Grew was at first discouraged by his contemporary's offering but was persuaded by the Society to carry on.

The book is in English though the first manuscript was in Latin, with 186 pages, with 3 folding plates. It's still available in the rare book market. The title reads odd to us, but I suppose its to indicate there is more to come; and there was. The dedication is to his patron John Wilkins, Bishop of Chester, and he says: 'I beg 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;...'. The Chapters are 'Of the Seed as Vegetating', 'Of the Root', 'Of the Trunk', 'Of the Germen, Branch, and Leaf', 'Of the Flower', 'Of the Fruit', 'Of the seed in its State of Generation'. In each, is a detailed anatomical description of the parts and structures, never before presented in such accurate detail. Here 'Germen' means the bud or cells initiating the branches and leaves. He provides three aspects of his study, accurate detail of dissections, discussion of his concept of the mechanism of development, and a teleological theory of the various used of a plant: for human life, in God's scheme of creation, and for the plant itself.⁷ He pioneers terminology; the seed radicle which turns into the root, the plumes of the seed (cotyledons) which become leaves, he identifies cells as bubbles, but in his 1682 book calls them cells. The 3 folding plates contain 18 figures, mostly microscopic cross-sections of roots, stems, buds and branches, and seed parts. He used lupins, barberry (barberry), turnip, columbine, burdock, oak amongst his specimens.



The book went into a second edition as incorporated into the 1682 *Anatomy*, and there were French and Italian translations published from 1675 onwards. A year later he published his second book, on roots, collecting existing papers, and expanding on his observations on roots in the previous work.

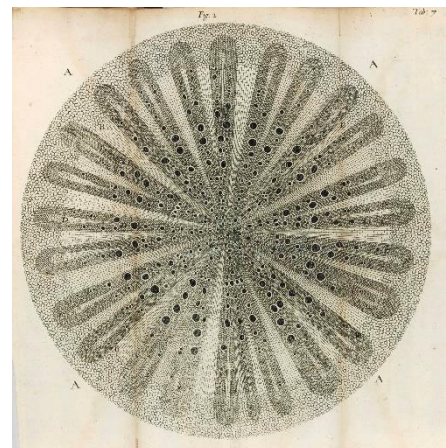
Grew, Nehemiah. *An idea of a Phytological History Propounded Together With a Continuation of the Anatomy of Vegetables, Particularly Prosecuted Upon Roots, and an Account of the vegetation of Roots, Grounded Chiefly Thereupon.* By Nehemiah Grew M.D. and fellow of the Royal Society. London, printed by J.M. for Richard Chiswell at the Rose and Crown in St. Pauls Churchyard, 1673. 144 pp, 7 folding plates.⁸



There is a dedication to Lord Brouncker, the President of the Royal Society: 'If the dedications of books were not in use, yet here I think I might have been a precedent.' In his preface, he refers generously to Malpighi 'Immediately after the publication of these [his previous observations on plant anatomy] a discourse from the learned Malpighius (to whose most ingenious and accurate industry the world is much beholden) was presented to the Royal Society upon the same subject, Decemb. 7 1671 and dated at Bononia⁹, Novemb. 1 1671.'

The book is in three parts. It contains two sets of Discourses read before the Royal Society in 1672 and 1673. These were 'An Idea of Phytological History', 'The Anatomy of Roots'; and 'The Vegetation of Roots'.¹⁰ The first part, 'The Idea' is largely an introduction on how he goes about his study, his aims and methods: 'In what manner to be prosecuted, both without and with the Microscope...What thereupon to be observed....And what from observation made probably attainable.' The second part is on structure. He describes the different sorts of roots, round or bulbous, 'as Onion. Where note, That all bulbous Roots are as it were Hermaphrodites, or Root and Trunk both together..', cylindrical or pyramidal, entire and smooth, plain and knobbed. He understands how some are perennial and others die with new annual growth. Grew uses a wide range of species for his anatomical studies, herbaceous and woody, in what must be a first for such a comparative anatomical study.

The anatomy chapters proceed through descriptions of the bark, parenchyma rays, 'bubles' and 'liquor receptacles'. He identifies sap and air spaces. Inside the bark is more parenchyma and 'lignous' vessels, our xylem. 'The Quantity of these Vessels, as to the space they take up in the Root, is to be computed two ways, by their Number or 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 Succiferous in all Roots; especially some.' Here he compares xylem and phloem. In the centre is the pith, for the most part a 'simple body'.



Slice of a small root of vine cut transversely, seen through a microscope. Fig.2, Plate 7.

The last part, the account of the vegetation of roots, is based on the foregoing anatomy, and Grew waxes philosophical, 'To philosophise is to render the

causes and ends of things. No man therefore that denieth God can do this truly; or the taking away of the 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 so 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 therefor that philosophiseth, and denieth God, playeth a childish game.’ His deist thinking tells us to observe and record, but don’t get into philosophical conjecture. However, he does allow himself to mix his anatomical findings with conjecture on function. He sets out the conditions, soil, water and sun, tells how the roots suck up water, and follows the movement of sap in vessels and fibres and parenchyma. Saline and ‘succiferous’ sap is differentiated, foretelling inorganic solute-based xylem and sugar-based phloem saps. All it needs is Hales’ later experiments (published in 1727). He finishes with descriptions of root colours and taste-based characteristics, acidic, bitter, sweet, lactiferous, oily, and that suddenly is it.

There are 42 cross-sections of roots in the plates, showing details from the bark through to the pith with different vessels and cells labelled, from a wide range of species. This is followed by 10 figures of roots split longitudinally, and a further 9 of various root sections. There is not much more to say about roots after this, and the structures prefigure his observations on stems and trunks, the subject of his third book, published in 1675.

Grew N *The Comparative Anatomy of Trunks, Together with an Account of their Vegetation grounded thereupon; in Two Parts: The former read before the Royal Society, Feb. 25. 1673; the latter, June 17, 1675. The whole explicated by Several Figures in Nineteen Copper-Plates, presented to the Royal Society in the years 1673 and 1674. By Nehemiah Grew, M.D. and Fellow of the Royal Society. London. Printed by J.M. for Walter Kettilby at the Sign of the Bishop’s Head in St Paul’s Church-yard. 1675. [24], 81, [23]pp, 19 plates comprising 27 figures.*¹¹

My copy is the 1st edition, rebound in full calf. This used to be David Bellamy’s copy and his botanical bookplate is on the end paper. Grew aims high and dedicates the work to Charles II, reminding him that the latter had received his two earlier essays favourably. He says ‘*That there are Terrae Incognitae in Philosophy as well as in Geography*’, and pursues the conceit that plants have mechanical similarities with animals. ‘*Your majesty will here see, that there are those things, which are little less admirable within a plant, than within an animal.That by all these means, the ascent of the sap; the distribution of the air; the confection of several sorts of liquors, as lymphas, milks, oils, balsoms; with other acts of vegetation, are all contrived and brought about in a mechanical way. In sum, your Majesty will find, that we are come ashore into a new world, whereof we see no end.*’

Grew also writes an address to Lord Brouncker, the President of the Royal Society ‘(together with the rest of the Fellows of the said Society)’. Here he references the concurrent publication on plant anatomy of Malpighi, also published by order of the Society’s Council. He doesn’t seem too unhappy about this, though cautiously so. ‘*Your Lordships hath thought fit, notwithstanding, lately to give the same order to the publishing of a like*

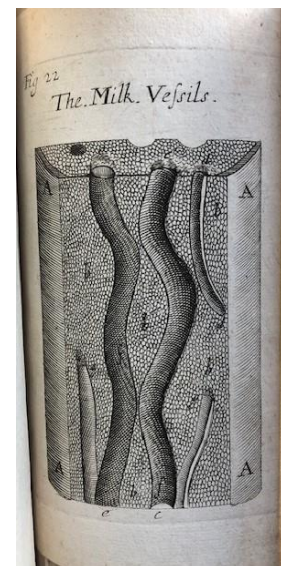


Fig 22, Representeth part of the bark of a lactiferous plant, pared by the length, and therein the milk-vessels laid bare.

undertaking, by another (indeed a most accurate) hand.' There is no disadvantage to this, two hands being better than one. *'For, although he have no mind to deceive, yet may sooner be deceived, than two may be.....yet would it still more be illustrated by the various examples of both. As also, that like as in other matters, so here the defects of both the undertakers, would mutually be supplied.'* He goes on to point out, for instance that while he observed, with the unassisted eye, air vessels in the stem, Malpighi with the microscope was able to show their spiral nature. Likewise there are observations that he has made on flowering parts, whose names, he says, Malpighi adopted, subsequent to Oldenburgh (the Royal Society Secretary) lending the latter Grew's book. Grew gives further examples of differences: *'Lastly, that I have chosen to give my examples chiefly in the transverse section; whereas those of Signior Malpighi, are principally in cutting by the length.'* In all, you feel that while he is doing his best in being generous, he is a titch annoyed.

The book is in two parts, *'The Comparative Anatomy of Trunks'* and *'An Account of the Vegetation of Trunks grounded on the foregoing Anatomy'*, with four and seven chapters respectively. He starts by describing the basic trunk by eye then microscope, using borage, dandelion, endive, and later roams across holly, apple, pear, plum, elm, fig and pine. On the outside of the borage stem is a fine, transparent skin, and this contains sap vessels with lymph then parenchyma. He notes another ring of sap vessels, with lymph, inside this the pith. Here he uses 'lymph' to denote sap in what we now know as the phloem (outer tissue) and xylem (the inner ring of vessels).¹² His observations across the species are by eye. *'Yet three things are necessary; viz. a good eye, a clear light, and a razor wherewith to cut.'* And first year Botany in 1966 at Auckland University Botany School was little different. He then takes to the microscope and looks at detailed structure, vessels are tubular and lignified, and the wood is in all made up of air vessels, parenchyma and sap vessels, and he notes the different sizes and disposition across the cross-section. There is a chapter on the pith (how is King Charles doing by now?) comprising parenchyma and sap vessels.

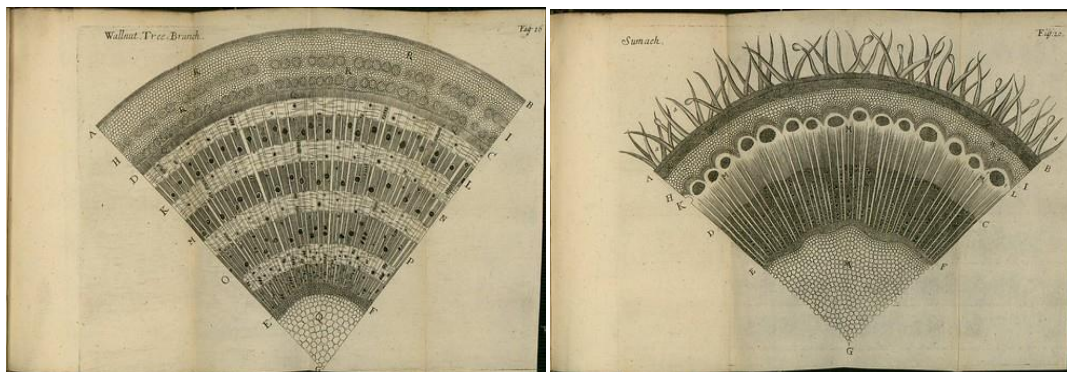


Fig. 16, Representeth a quarter of a slice of a branch of Walnut tree of four years growth, cut transversely; Fig 24, Representeth a quarter of a slice of common Sumach of the first years growth, cut transversely.

He finishes the first part with a rather elaborate comparison: *'So that the most unfeigned and proper resemblance we can make of the whole body of a plant, is, to a piece of fine bone-lace, at such time, as the women are working on it on a cushion. For all the parenchymous parts, as the pith, insertions, and parenchyma of the bark, are nothing els but lacework; the fibres of the pith running horizontally as do the threds in the lace: and bounding the several bladders of the pith and bark; as the threds do the several holes of the lace: and making up the insertions without bladders, or very small ones, as the same threds likewise do the close parts of the lace; which they*

call the cloath-work. And lastly the vessels, standing perpendicularly, run cross to the horizontal fibres; even as in the lace do to the threds. And this is the true texture of a plant:...

The second part is more about relating structure to function. He doesn't want to repeat 'many things already said: which would be nauseous and unprofitable to those, who have been pleased to peruse them.' The Chapters cover the 'Motion and course' of the sap, and air, structure, generation of 'liquors', 'Figuration' and 'Motion' of trunks, and 'Lastly the Nature of Trunks, as variously fitted for Mechanical use.' He shows that sap moves in pith, bark and wood, and there are yearly cycles in transmission in the bark, whereas transport in the wood continues over the life of the plant. He gets it pretty much right, stating that the sap ascends in the bark in the sap vessels and in the wood in what he calls the air vessels. So he seems to realise that the xylem vessels are strengthened tubes whereas the phloem seem to be more living, though he doesn't say as much. He doesn't discover that the wood carries

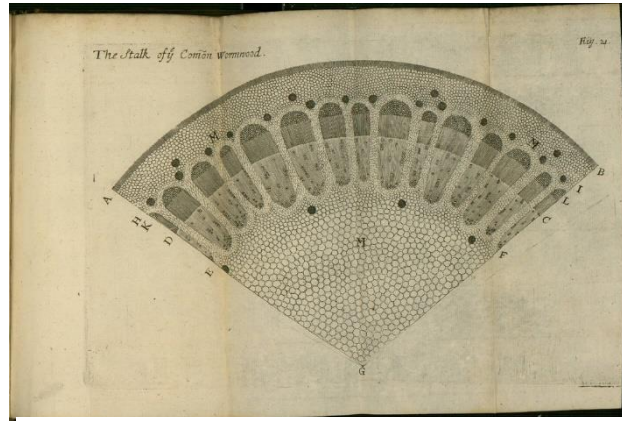


Fig. 21. Representeth a quarter of a slice of a branch of common wormwood cut transversely.

water and the bark sap is of sugars. Except that when he talks of bleeding he notes that in trees the bleeding sap from the bark is sour, sweet, bitter, hot, or of other taste, whereas that from vines has little taste. This may be more about dilution than anything else since vines can bleed copiously. And what is the cause? He says that the parenchyma cells are under pressure, they have a *conatus*¹³ to dilate themselves. He's on the money here.

He discusses the movement of air, believing it comes from the roots and infiltrates the trunk and other parts, and seems to see airspaces as some sort of air transport system, when we regard them more as just that, air spaces. We're both right. He goes into some detail on the different types of 'liquors' – sugary sap, oils, mucilage, gums, milky saps, locating them in different vessel systems and parenchyma, believing that they are generated by the plant. It all prefigures the discovery of photosynthesis and the clear distinction between xylem water transport and phloem sap.

The short Chapter 6 points towards the experiments of Stephen Hales some 60 years later. He says that 'The motions also of trunks a various. Principally four; sc. Ascending, descending, horizontal and spiral. The cause of ascent of a plant is certain magnetic correspondence betwixt the air and the air vessels of the plant...' and he does a little experiment, inverting a stem with roots and shows that the root continue to grow downwards. He finishes with a discussion on the quality of trunks or timber. Some woods are soft, with much porosity from air spaces. Others hard, like ash and beech, describing heartwood such as in oak, durable and tough. He knows about fibres and describes hemp and flax. He concludes with 'one instance more, & that is as to grafting.' The chief use is to accelerate fruit growth.

There are some 23 pages of 'The explication of the figures' followed by the lovely fold-out plates. One, that of the thistle stem, is printed in white on a black background, looking like a negative print. Fig 27 has no explanation. In all it is a small book, packed with acute observation, foundational in our understanding of both plant structure and function.

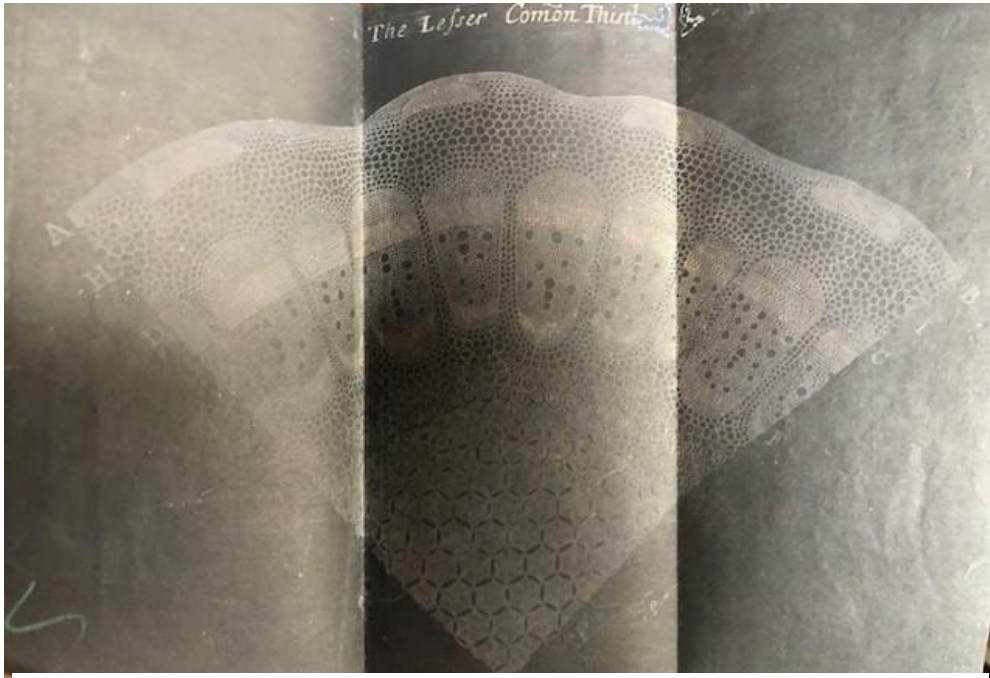


Fig 26, Representeth a quarter of a slice of the stalk of the lesser common thistle cut transversely.

In 1682, it all came together. Grew pulled together his three previous works and together with new material, published his greatest work. A prospectus was put out early in 1682, with the names of pretty much all the leading Royal Society figures listed as subscribers: Wren, Brouncker, Boyle, Evelyn, Hooke, Pepys, along with the Archbishop of Canterbury and other luminaries¹⁴. You wonder whether any of them ever read what in the end was a very technical work on the minutiae of plant anatomy.

Grew, Nehemiah. *The Anatomy of Plants with an Idea of Philosophical history of Plants. And Several Other Lectures, Read Before the Royal Society London. By Nehemiah Grew M.D. fellow of the ROYAL SOCIETY and the COLLEGE OF PHYSICIANS. Printed by W. Rawlins for the Author, 1682. pp. [2], [3 Dedication], [8 Preface], followed by successive paginations associated with each book, discourse or lecture*¹⁵. 83 engraved plates, including 3 folding and two double-page, woodcut headpieces and initials.

On a front end paper is an impressive statement from no less than Christopher Wren, President of the Royal Society, which gives a sort of license for Grew to publish this book.

'At a Meeting of the Council of the ROYAL SOCIETY, Feb. 22, 168¹/₂. Dr Grew having read several lectures of the Anatomy of Plants, some whereof have already been already printed at divers times, and some are not printed; with several other lectures of their Colours, Odours, Tasts, 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 be printed together in one Volume. Chr. Wren P.R.S.'

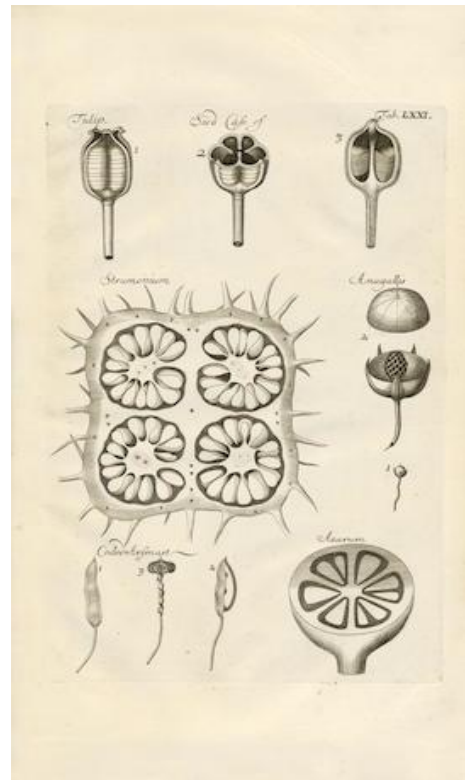
[Why did they write 168¹/₂? Was this a calendar issue? It does appear on some gravestones of the time].

There is a three page dedicatory epistle to Charles II as patron of the Society, repeating much of what he said in the earlier books comparing plants and their parts and function with those of animals. He ends with an encomium which lifts Charles above what

he deserved: '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.' There follows an eight page Preface in which Grew muses over his philosophical thinking and provides a detailed history of his interest in plant anatomy and the history of his previous publications. He describes his plates: 'In the Plates, for the clearer conception of the art described, I have represented it, generally, as entire, as its being magnified to some 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 Fabrick 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.' This is an important insight into Grew's striving for authenticity, and handling the microscopic image and its reproduction for the first time.

The book comprises five 'books' previously published or written as unpublished Discourses, and seven 'Lectures'. The books are listed as second editions of the 1672 'An Idea of a Philosophical History of Plants', the 'Anatomy of Plants Begun' of the same year, the book on *Roots* of 1673 and that on *Trunks* of 1675. There are also previously unpublished Discourses on *Leaves* (1676), *Flowers* (1676), *Fruits* (1667) and *Seeds* of the same year. The Lectures are all second editions of published tracts on salts, colours, taste and odours in plants.

The newer material extends Grew's studies, with book four on leaves, flowers, fruits and seeds. It's dedicated to Robert Boyle: '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.' Here is Boyle the experimentalist pushing Grew to explore as well as observe. In the first part he talks of the protection and folds of leaves, what is on the surfaces, the life of the leaf, duration and how it grows. He detects that thorns are modified leaves, and is concerned about how buds are protected: 'so those Buds which are tenderest, and would sooner feel the cold, if naked, have the fullest Hair; as of Thistle, Mullen, Burdock, and others.' As with his work on roots and trunks, he uses a bewildering array of species. He gives an extensive description of flower types and forms, and his most well known description is that of the 'attire' or stamens: 'But the Primary and chief Use of the Attire is such, as hath respect to the Plant it self; and



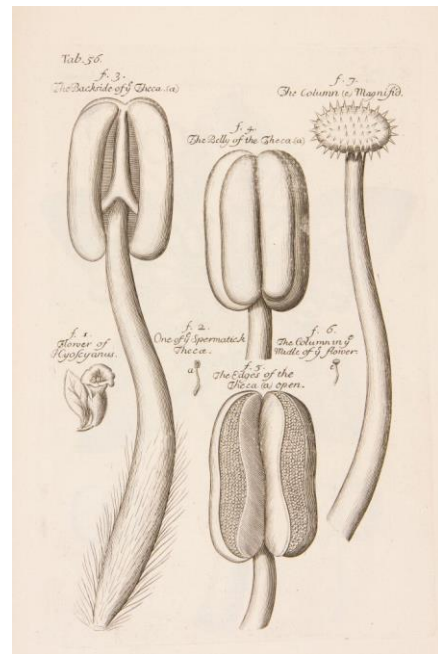
TAB . LXXI . Sheweth the Seed Case of Tulip entire, cut transversly, and Split downe Asice of Thorn - Apple , or of the Seed - Case of Stramonium, while young. That of Pimpinell naturally divided into two Hemisphers; with the Button, on which the Seeds grow, erected in the middle. The manner of the ejaculation of the Seed, in Coded Arsmart. Sures of Plum - stones. The Apertures, and Divisions, of the covers of the Seed. The Seed and Seed - Case of Harts Tongue, opened with a spring. And other contrivances both for the Motion , and Arrest of other Seeds.

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. In discourse hereof with our Learned Savilian Professor Sir Thomas Millington¹⁶, 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 Male and Female, that I was also of Opinion...'. It seems he was not the first to identify the stamens as sexual organs, the line goes back to Theophrastus¹⁷, but never has it been incorporated into such a detailed anatomical and morphological description.

The chapter on fruits comprises descriptions of pome fruit – apples, pears, quinces, plums - and of lemons and cucumbers, grapes and hazelnuts, with sections on the function of the parts of fruit and seeds. The grape is a two-seeded plum, and the: 'NUT, is a Plum inverted, or turned inside outward. For the Shell, standing naked, includes the Parenchyma: the bearded Cap, not precisely answering to that, but to the Empalement of the Flower; which likewise in many other Plants, out - lives the Foliature 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 Pith: The shell of a Nut is not Lined, but Faced with the iner Skin of the Cap.' Grew fails to grasp the ontogeny of the fruit or seed, i.e. how it is derived from flower parts, but that mustn't be a criticism. He attributes the differences between a fleshy fruit or a nut or just a dry protected seed to the development of vessels and how much sap they may provide. This is accurate in so much as it is an outcome, but not a cause. The fourth part of this fourth book is on seeds. Here he picks up on his studies of the cotyledons as leaves: 'But in the greater number of Seeds, is formed a true Bud, consisting of perfect Leavs; different from those, which grow upon the Stalk, only in Bigness; and so far in shape, as the fame 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 undiscernable, as in Maple.'

The seven lectures that conclude the text have mostly been met before, on salts and colour and the contents of saps. The 83 plates takes us into one of the most comprehensive pictorial worlds of the plant, certainly groundbreaking at the time, with only Hooke's 16 plates plant anatomy among the 60 in his *Micrographia*¹⁸ of 1665, and Malpighi's *Anatome Plantarum* of 1675 preceding it.

Grew published a wide range of pamphlets, tracts, papers on physiological, anatomical and philosophical topics over all of his life. 'Sea-water made fresh', 'Comparative anatomy of Stomachs and Guts', 'A treatise on the bitter purging salt: Sal Catharticus', a discourse on the cosmos and his deist views of God and Nature, and so it goes. He was 41 when he published his *Anatomy* in 1682, his last botanical publication. He was elected a fellow of the Royal College of Physicians in 1680, and practised in London over



TAB. LVI. [The Seminiform Attire] The same in yellow Henbane. With one of the Theca magnified; of which there are about 5 in one Flower. And the Column on the top of the Seed - Case.

the next 30 years, Grew died suddenly in 1712, 70 years old. He was married twice and had a son and daughter with his second wife Elizabeth, surviving his father by 23 years.

¹ This Act forbade non-conformist ministers from coming within 5 miles of incorporated towns, such as Coventry in Grew's case, or of their previous livings.

² Gordon A., Grew, Obadiah, Dictionary of National Biography, 1885-1900, Vol 23.

³ Lefanu, William, Nehemiah Grew, A study and bibliography of his writings. St Paul's Bibliographies, London, 1990.

⁴ The University was about 100 years old at this stage, and the largest protestant University in Europe, home to renowned classists, theologians and philosophers such as Justus Lipsius, Josef Scaliger and Hugo Grotius, and used by Baruch Spinoza, particularly to read the works of Descartes.

⁵ Spencer Hickman was a bookseller, and printer to the Royal Society. The records seem to be restricted to 1670-2. https://ia801603.us.archive.org/0/items/dictionaryofprin00plomiala/dictionaryofprin00plomiala_bw/

⁶ Marcello Malpighi, Anatomie Plantarum. Cui subjungitur appendix, Iteratas & auctas ejusdem Authoris de Ovo incubato. Observationes continens. Royal Society, London, John Martyn, 1675.

⁷ Lefanu, W., op. cit. p. 11.

⁸ Richard Chiswell (1639-1711) was a prominent London bookseller, printer and publisher. The Rose and Crown was a publishing house situated on the north side of the churchyard of St Paul's Cathedral, operating through the Civil War into the 1670s. <http://newroseandcrown.org/about/>

⁹ Bononia is Latin for Bologna in Italy.

¹⁰ Lefanu, W., op. cit. pp. 14-15.

¹¹ Walter Kettlby was a printer and publisher operating out of Duck's Lane and St Paul's Churchyard from 1669 through to 1711. He was known particularly as an episcopal bookseller.

https://ia801603.us.archive.org/0/items/dictionaryofprin00plomiala/dictionaryofprin00plomiala_bw/

¹² The terms phloem and xylem were not used until introduced by the Swiss botanist Carl Nägeli in 1858. Nägeli was also known for discouraging Mendel from his studies on genetics.

¹³ *Conatus* is a Greek word meaning to drive, notably used by the philosopher Spinoza as the drive or perseverance of a person in achieving freedom through reason.

¹⁴ Lefanu, W., op. cit. pp. 23-27.

¹⁵ See Lefanu for pagination details.

¹⁶ Sir Thomas Millington (1628-1703) was a physician who held the Sedleian Chair of Natural Philosophy at Oxford (not the Savillian Chair as given by Grew) and was at the deathbed of Charles II and dissected the dead William III.

¹⁷ *Ibid.*, pp. 25-26.

¹⁸ Robert Hooke, *Micrographia: or Some Physiological Descriptions of Minute Bodies Made by Magnifying Glasses. With Observations and Inquiries Thereupon.* London: J. Martyn and J. Allestry, 1665.