



BRILL

NUNCIUS (2022) 1–11



The Seed, the Tree, the Fruit, the Juice

Plants in Early Modern Knowledge—An Introduction

Fabrizio Baldassarri

Ca' Foscari University of Venice, Venice, Italy;

Indiana University Bloomington, Bloomington, IN, USA

fabrizio.baldassarri@unive.it

Traditionally conceived of as subordinate bodies in the study of nature, plants gained momentum in the early modern period, when vegetation became a crucial subject for exploring nature and life in detail. This was due both to the new attraction of the specimens collected and accommodated in botanical gardens, whose blossoming condition captivated the attention of scholars, learned people, the rich and the public in general, and to the disconcerting role plants started playing in the definition of life at the time. Indeed, the sixteenth- and seventeenth-century contexts articulated a variegated attention to vegetation, such as the renewed focus on *materia medica*, the botanical need to provide a more coherent classification of specimens, or the practices of using plants in advance of any learned experiments. At the same time, natural philosophers also showed a growing interest in the field as the study of vegetal bodies in their own right emerged as a meaningful benchmark in understanding nature. As Florike Egmond has recently shown, “more than one type of experimentation [with plants] can be found in sixteenth-century natural science,”¹ as clear-cut distinctions difficultly arise, and a more complex integration of observations and (philosophical) systems substantiated work in expanding this field of knowledge into a modern science. In this sense, the intertwining of such diverse approaches slowly resulted in the late seventeenth century physiology and anatomy of plants of Nehemiah Grew (1641–1712) and Marcello Malpighi (1628–1694), generally conceived of as the pioneers in grounding a modern science of plants.

1 Florike Egmond, “Experimenting with Living Nature: Documented Practices of Sixteenth-Century Naturalists and Naturalia Collectors,” *Journal of Early Modern Studies* 6, no. 1 (2017): 38.

Diverse situations shaped this long transition from the Renaissance to the late seventeenth century, and many significant case-studies help spotlight the several steps on this path.² In the introduction to this special issue I would like to delve into a few strands that lay bare a natural philosophical approach to botanical science, a less-explored field in the construction of the science of plants, while the natural historical side of this enterprise is much better known and well-studied. In sketching three lines of investigation, I aim to draw the perimeter of this theoretical approach that developed in the early modern time, outlining the range of botanical knowledge in the period. The first consists of the attribution of a principle to plant life, that is, a point of departure for any philosophical understanding of the nature of plants. The second is the performance of botanical experiments and observations, a crucial step in dealing with vegetal bodies in detail. The third is the development of analogies between plants and animals, a meaningful attempt to develop a physiology of plants. In this sense, these axes unearth how much natural philosophers reorganized the study of plants, making botanical studies “emancipate[d] from practical exigencies and acquire disciplinary status through the study of similarities and differences between appearances and internal structures.”³ Let us shed light on these lines.

A first, crucial moment in this transition in the study of plants surfaced around the 1580s, when a natural philosophical focus on plants acquired an increasingly relevant role in the field. Encompassed within Aristotelian natural philosophy, a theoretical framework in botany importantly particularized the work of Giovanni Costeo (Costeus, 1528–1603), *De Universali stirpium natura libri duo* (1578), Franz Tidike (Tidicaeus, 1554–1617), *Phytologia generalis* (1582), and Adam Zaluzianski (1558–1613), *Methodi herbariae libri tres* (1592), as well as the more renowned text of Andrea Cesalpino (1523/1524–1603), *De plantis libri xvi* (1583). In aiming to define the nature of plants, these texts combine speculative leanings with botanical observations and the classifying of specimens, somehow providing a more comprehensive survey of green nature. In the preface to his work, for example, Cesalpino writes that “since science consists in gathering the similar and differentiating the dissimilar, and this distribution is into genres and species, that is, into classes based on the characters, which

2 For other cases, see the special issue *Manipulating Flora*: cf. Fabrizio Baldassarri and Oana Matei, “Manipulating Flora: Seventeenth-Century Botanical Practices and Natural Philosophy. Introduction,” *Early Science and Medicine* 23, nos. 5–6 (2018): 413–419.

3 Claudia Swan, “The Uses of Botanical Treatises in the Netherlands, c. 1600,” in *The Art of Natural History: Illustrated Treatises and Botanical Paintings, 1400–1850*, ed. Therese O’Malley and Amy R.W. Meyers (New Haven, CT, and London: Yale University Press, 2008), 64.

describe the nature of things [namely, plants], I tried to do this in my universal history of plants [...] This [is] a rational method.”⁴ This rational method develops from the definition of a principle for the activities of plants, namely, the vegetative soul. In focusing more and more on the internal structure and the internal activities of plants to understand their nature, these scholars conceived of this principle as a means to help differentiate between plants, and ultimately develop a sound classification of vegetation. Cesalpino starts *De plantis* by claiming the importance of the vegetative soul, as he writes that “the nature of plants is only drawn from the *genus* of the soul, which nurtures, fosters growth, and generates the similar.”⁵ Moreover, he defines plants as suitable bodies for investigating such activities, because their structure [*instrumentorum apparatu*] is more elementary and uncomplicated than that of animals. In grounding a natural philosophy of plants on the vegetative soul, the principle of botanical activities, Cesalpino thus investigates the diverse parts of plants, from roots to fruits, and the different functions of vegetal bodies, namely generation, nutrition, and growth, ultimately providing a classification for vegetation. As Alain Morton clearly highlights, despite lagging behind for centuries, plant physiology revived in the Renaissance thanks to this natural philosophical focus on botany.⁶

The core of this enterprise thus resides in attributing a principle to vegetal functions. Probably spurred by philosophical discussions of the soul, and especially the 1550s controversy between Scaliger and Cardano,⁷ whose focus on botany should not be underestimated, new reflections on the vegetative soul as a principle of life extensively entered the study of plant physiology and the systematization of vegetal bodies during the 1580s. Traditionally grounded on Aristotle’s natural philosophical appeal to the soul as a principle of any

4 Andrea Cesalpino, *De plantis libri xvi* (Florence: Marescottom, 1583), Preface, unpaginated: “Cum igitur scientia omnis in similibus collectione & dissimilibus distinctione consistat, haec autem distributio est in genera & species veluti classes secundum differentias rei naturam indicantes, conatus sum id prestare in universa plantarum historia: ut si quid, pro ingenij mei tenuitate in huiusmodi studio profecerim [...]. Hanc vero tractandi rationem Theophrastus ...”. [Transaltion is mine.] It is to be noted that Cesalpino here refers to Theophrastus’s rational method of proceeding. I am not exploring this point, but just want to highlight the connection of a natural history with a rational method.

5 Cesalpino, *De plantis*, I, 1, p. 1.

6 Alain G. Morton, *History of Botanical Science: An Account of the Development of Botany from Ancient Times to the Present Day* (London-New York: Academic Press, 1981), 130.

7 On this controversy, see Guido Giglioni, “Scaliger versus Cardano versus Scaliger,” in *Forms of Conflict and Rivalries in Renaissance Europe*, ed. David A. Lines, Marc Laureys, and Jill Kraye (Gottingen: Bonn University Press, 2015), 109–130.

naturalistic knowledge,⁸ this combination of plant physiology and psychology highlighted a crucial threshold in the study of plants, which continued to shape the modern investigation of vegetation. Recently Guido Giglioni has unraveled a thread from Cesalpino to William Harvey's (1578–1657) account of the vegetative power, which later developed in Francis Glisson's (1599–1677) and the Royal Society's discussions of plastic nature.⁹

A second thread concerns the role of experimentation with plants fostered by scholars such as Francis Bacon (1561–1626), whose *Sylva Sylvarum* (1626) is an outstanding repository of botanical experimentation.¹⁰ Yet, as is well-known, Bacon based his experimentation on Giambattista Della Porta's (1535–1615) texts, such as *Magiae naturalis* (1558, second enlarged edition 1589), *Phytognomonica* (1588), and *Villa* (1583–1592).¹¹ In Renaissance naturalism, experimentation with plants had already surfaced as a crucial point of departure in botanical knowledge. Observation was indeed crucial for Renaissance botanists who collected plants and made *herbaria*, differentiating species according to the external variations. Yet, from the 1580s, botanical observation acquired a new focus, moving from outward features to internal structures. As Luciana Repici has shown, in Cesalpino “the work of classifying plants required on the one hand direct observations and the manipulation of specimens [...], and on the other hand a methodology able to lead and steer experimentation [*experimentum*], establishing a fixed paradigm to define and divide [bodies].”¹²

8 See Aristotle, *De partibus animalium*, in James G. Lennox, ed. and trans., *Aristotle: On the Parts of Animals I–IV* (Oxford, Oxford University Press: 2001), 6. Cf. Dennis Des Chene, *Life's Form. Late Aristotelian Theories of the Soul* (Ithaca: Cornell University Press, 2000). Fabrizio Baldassarri, “Descartes' Bio-Medical Study of Plants: Vegetative Activities, Soul, and Power,” *Early Science and Medicine* 23, nos. 5–6 (2018): 512–515.

9 On the vegetative soul and its cognates, see Fabrizio Baldassarri and Andreas Blank, eds., *Vegetative Powers: The Roots of Life in Ancient, Medieval and Early Modern Natural Philosophy* (Springer: Cham, 2021). In particular, Guido Giglioni, “Plantanimal Imagination: Life and Perception in Early Modern Discussions of Vegetative Power,” *ibid.*, 335.

10 See Dana Jalobeanu, “Spirits Coming Alive: The Subtle Alchemy of Francis Bacon's *Sylva Sylvarum*,” *Early Science and Medicine* 23, nos. 5–6 (2018): 459–486.

11 See Doina-Cristina Rusu, “Rethinking *Sylva Sylvarum*: Bacon's Use of Della Porta's *Magia naturalis*,” *Perspectives on Science* 25, no. 1 (2017): 1–35. Doina-Cristina Rusu, “Using Instruments in the Study of Animate Beings: Della Porta's and Bacon's Experiments with Plants,” *Centaurus* 62, no. 3 (2020): 393–405.

12 Luciana Repici, “Andrea Cesalpino e la botanica antica,” *Rinascimento* (2005): 67: “per Cesalpino il lavoro classificatorio richiedeva da un lato l'osservazione diretta e anche la manipolazione degli esemplari—quell'*experimentum* che invece Dioscoride, cattivo musico, non aveva applicato in tutti i casi; dall'altro, un metodo capace di guidare e orientare l'*experimentum*, con l'individuazione di un criterio fisso per stabilire e dividere

Experimentation thus concerned the activities of plants, such as generation, formation, growth, nutrition, fructification, and so on, and not just the mere exterior shape of vegetation. This kind of experimentation with plants reveals an essential aspect of botanical knowledge around the seventeenth century, as it developed from the Renaissance naturalists to Bacon, and from Bacon to the microscopic study of botany, and to seventeenth-century natural philosophical study of plant behavior.¹³

While experimentation developed as a pivotal component of knowledge, botanical gardens arose not only as places to accommodate and cultivate varieties, but also as spaces to investigate the inner nature of plants in detail. The case of the Parisian Jardin royal des plantes, founded by alchemist botanist Guy de La Brosse (1586–1641), meaningfully discloses an environment in which cultivation paralleled the observations and experimentation of vegetal bodies as a way to explore the nature of plants at large. In the seventeenth century, both gardens and plants therefore emerged as laboratories of nature, through which scholars dealt with chymical knowledge,¹⁴ with the study of specific phenomena, such as emergentism or magnetism,¹⁵ and with the movement of sap in plants in late seventeenth-century studies of plants.¹⁶

The third axis consists in the investigation of the animal-plant continuity. While this analogy had characterized the study of medicine since Antiquity, it is only during the Renaissance that scholars revived this feature, especially reappraising a Galenic tenet that the fetus lives the life of a plant at its beginning. This line of investigation ranged from Renaissance physicians such as Jean Fernel (1497–1558), André du Laurens (1558–1609), Hieronymus Fabricius

somiglianze e differenze, cioè proprio quel che era mancato a Teofrasto.” [Translation is mine.]

- 13 I have explored the botanical experiential approach in the Dutch context, see Fabrizio Baldassarri, “Descartes and the Dutch: Botanical Experimentation in the Early Modern Period,” *Perspectives on Science* 28, no. 6 (2020): 657–683.
- 14 See Dana Jalobeanu and Oana Matei, “Treating Plants as Laboratories: A Chemical Natural History of Vegetation in 17th-Century England,” *Centaurus* 62, no. 3 (2020): 542–561. Vera Keller, “A ‘Wild Swing to Phantasy’: The Philosophical Gardener and Emergent Experimental Philosophy in the Seventeenth-Century Atlantic World,” *Isis* 112, no. 3 (2021): 507–530.
- 15 See Andreas Blank, “Sixteenth-Century Pharmacology and the Controversy between Reductionism and Emergentism,” *Perspectives on Science* 26, no. 2 (2018): 157–184. Lucie Čermáková, “Athanasius Kircher and Vegetal Magnetism: Analogy as a Method,” *Early Science and Medicine* 23, nos. 5–6 (2018): 487–508. Antonio Clericuzio, “Experiments with the Resurrections of Plants: Palingenesis in Early Modern England,” *forthcoming*.
- 16 See Anna Marie Roos, *Web of Nature: Martin Lister (1639–1712), the First Arachnologist* (Leiden-Boston: Brill, 2011), 153–160.

ab Aquapendente (1533–1619), and Cesalpino, to early modern scholars such as Jean Riolan the Younger (1577 or 1580–1657), William Harvey (1578–1657), Malpighi and Grew.¹⁷ Scholars moved from embryology to fluid circulation. As will appear, while this continuity was primarily directed at studying the physiology of the human body, using plants as a suitable model, scholars slowly moved on exploring this issue to find a rational homology between the life processes of living bodies, ultimately acknowledging a crucial role to vegetation in describing life. In this sense, scholars focused more and more on plants in their own right. For example, while early in the seventeenth century Fabricius studied the structure of verbena knots as he described the valves of veins, with the work of Grew and Malpighi, the anatomy and physiology of plants acquired a more autonomous status, as they developed a more precise comparative anatomy between plants and animals, and aimed to deal with plants. From this analogical exploration, a physiological investigation of plants emerged as an autonomous field of knowledge.¹⁸

These three axes help in uncovering the new focus on plants in the early modern natural philosophical approach to the field, ultimately revealing a framework that operates in shaping the science of plants.¹⁹ Through (a) the definition of a principle of vegetal functions and life, (b) the observation of their structure and functioning in detail, and (c) a comparative anatomy between plants and animals, scholars expanded the field of investigation, combining the efforts of collecting, classifying, and authenticating specimens with the attempts to provide a theoretical system to understand vegetation in itself. From the late sixteenth century, these features shaped the study of plants, definitively resulting in an independent branch of knowledge.

17 See Miles Barker, "Putting Thoughts in Accordance with Things: The Demise of Animal-Based Analogies for Plant Functions," *Science & Education* 11 (2002): 293–304. Fabrizio Baldassarri, "In the Beginning was the Plant: The Plant-Animal Continuity in the Early Modern Medical Reception of Galen," in *Galen and the Early Moderns*, ed. Matteo Favaretti Composampiero and Emanuela Scribano (Cham: Springer, forthcoming). Fabrizio Baldassarri, "From the Analogy with Animals to the Anatomy of Plants in Medicine: The Physiology of Living Processes from Harvey to Malpighi," in *Medical Botany in Pre-Modern Times: Tradition and Innovation*, ed. Fabrizio Baldassarri (Berlin: De Gruyter, forthcoming).

18 Cf. François Delaporte, *Nature's Second Kingdom*, trans. A. Goldhammer (Cambridge MA: MIT Press, 1982).

19 Cf. Iolanda Ventura, "Changing Representations of Botany in Encyclopedias from the Middle Ages to the Renaissance," in *Collectors' Knowledge: What is Kept, What is Discarded*, ed. Anja-Silvia Goeing, Anthony T. Grafton, and Paul Michel (Leiden-Boston: Brill, 2013), 97–144.

This special issue outlines these axes at work in specific case studies, uncovering the diverse elements in the investigation of plants in seventeenth-century knowledge. Indeed, plants gradually arose as a subject that played both an epistemic role, providing knowledge about the internal structure, functioning, and organization, i.e., the nature of plants itself, and an instrumental purpose, illustrating the fundamental processes of nature at large. In integrating diverse approaches to vegetation, and developing from a strong focus on vegetal processes, a science of plants ultimately shaped early modern studies of nature.

Within this new focus on vegetation, in this special issue, the authors deal with early modern scholars' investigations of specific parts of plants, such as seeds, roots, bark, branches, juices, leaves, and fruits. Indeed, in concentrating on specific parts and their activities, early modern scholars built a broader theoretical systematization of vegetation, ultimately studying vegetal processes, activities, and the internal structure of plants. As a result, each of the following five contributions outlines the transition to a science of plants in the early modern period, decisively uncovering the intersections between diverse fields of knowledge, and the important role of speculation, natural philosophy, and theoretical frameworks in botanical knowledge. The first article, "A Clockwork Orange: Citrus Fruits in Early Modern Philosophy, Science, and Medicine, 1564–1668," is Fabrizio Baldassarri's account of the investigations of citrus fruits in the early modern period. On the one hand, these fruits drew enormous attention from naturalists, philosophers, and physicians, resulting in the monumental work of Giovanni Battista Ferrari, *Hesperides* (1646), an unparalleled text at the time in which the author collected all singular citrus fruits. On the other hand, the difficulties in dealing with an indefinite number of diverse kinds of citrus fruits unearth the attempts to construct a modern botanical knowledge that incorporates the study of common traits with the observations of peculiar cases and monstrosities, and the focus on outward diversities with the natural philosophical investigation of the physiology of plants. In this way, citrus fruits are a paradigm of the construction of an early modern science of plants.

In his article, "'To Multiply Corn Two-Hundred-Fold': The Alchemical Augmentation of Wheat Seeds in Seventeenth-Century English Husbandry," Justin Niermeier-Dohoney shows the intersections between agricultural activities, alchemical practices and techniques, and natural philosophical questions. Hinging on germination and plant growth, seed fertilization (or seed steeping) surfaced as a central activity in the British agricultural revolution's enhancement of plant fertility. Besides the economic benefits of such enterprises, Niermeier-Dohoney focuses on agricultural reformers' indebtedness to alchemical recipes and natural philosophical observations, especially highlighting

the role of Hugh Plat's and Francis Bacon's work. In their gardens-laboratories, both experimenters performed botanical observations of steeping seeds with different matter, and then registering the final results. While alchemical concepts and processes migrated from the mineralogical to the botanical world at the time, in such cases alchemical elements acquired a central role in the life of plants: Plat acknowledged a seminal virtue, which he called "a vegetable salt," whose nature crucially contributed to plant fertility, while Bacon claimed that niter was "the Life of *Vegetables*." These practices were then reproduced and discussed among the natural philosophers of the Hartlib circle, who continued applying alchemical theory to agricultural problems as a way to perform vegetal manipulation, improve botanical knowledge, and systematize a science of vegetation dealing with plant life.

Within the same context, Dana Jalobeanu and Oana Matei examine how much British natural philosophers were actively involved in cider-making in the second half of the seventeenth century, in their article entitled "Spiritual Technologies: Cider-Making and Natural Philosophy in Early Modern England." Accordingly, cider-making reveals both a practical and a theoretical side. Inspired by the Baconian program of collaborative data-sharing, and framed within Bacon's theoretical and methodological assumptions, members of the Royal Society dealt with cider-making as a way to manipulate the living spirits of the vegetal world. Besides the amelioration of agriculture, the economical import, the political dimension, and the religious impact of such an enterprise, cider-making played a relevant role in early modern science. By focusing on vegetation, concoction, and fermentation in cider-making, scholars used this enterprise to specify the chemical processes of vegetal bodies in detail. Furthermore, cider-making appealed to technological knowledge such as cultivation, storing fruits, and grafting as well, therefore revealing this enterprise as a large arena in which scholars could test their assumptions and knowledge of the vegetal world and develop a more comprehensive science of plants.

In the second half of the seventeenth century, microscopic observations of seeds arose as a new way to observe vegetation and further botanical knowledge. In his article, "Picturing Seeds of Poppies: Microscopes, Specimens and Representation in Seventeenth-Century English Botany," Christoffer Basse Eriksen sheds more light on scholars of the Royal Society such as Henry Power, Robert Hooke, and Nehemiah Grew, whose diverse ambitions in observing and picturing poppy seeds unearth different scientific strategies. While the intersection of kitchen culture, agricultural, economical, and medicinal fields had shaped the focus on seeds since the Renaissance, the seventeenth-century natural philosophical attempts to understand germination in mechanical or chymical ways drew new attention to seeds, especially benefitting from micro-

scopic observations in the 1660s.²⁰ In dealing with this context, Basse Eriksen reveals how much the accounts of poppy seed produced a set of different epistemic images, either validating the atomic composition of nature, uncovering the beauty of the sub-visible world, or disclosing the geometrical structure of plants. While dealing with the core of plant germination (and life), diverse nuances of a modern science of plants emerged in picturing poppy seeds.

The last article of this special issue concerns Nehemiah Grew's representation more in detail. In her "Contested Vision: Comparison and Collaboration in Nehemiah Grew's Plant Anatomy Illustrations," Pamela MacKenzie explores the illustrations of microscopic plant life in detail, especially highlighting the innovative approach of Grew. In many regards, this article represents the point of arrival of botanical investigations in the early modern period, as with Grew (and Marcello Malpighi) comparative anatomy, vegetal physiology, and a representation of microscopic plant life grounded a modern science of plants. Through the case of plant representation, Mackenzie shows how much plant observations relied on an interpretative framework, uncovering a meaningful feature in botanical knowledge. In the end, while different approaches to plants surfaced in such a context, a broader map of plant studies resulted in late seventeenth-century science.

The importance of a more direct observation of plants and the intersection of diverse approaches surfaces in Jacob Breyne's (1637–1697) title page to *Exoticarum aliarumque minus cognitarum Plantarum centuria prima* (1678), in which Solomon, Cyrus, Theophrastus, Dioscorides, and Breyne himself are depicted while directly investigating the nature of a sunflower. Although herbals and other botanical texts generally represented ancient scholars in their frontispieces (mainly as statues), this one significantly shows them at work with a specimen (Fig. 1).²¹ This figure thus reveals the importance of direct observation of vegetal bodies, as different people sit around the sunflower, studying it from diverse perspectives. While relying on ancient (and biblical) botanical wisdom, Breyne's collecting enterprise unearths the attention to botanical observations and the integration of different approaches to vegetation as a non-secondary feature in early modern botanical knowledge. By

20 For a different overview of observations of minute bodies and plants in the seventeenth century, see Mary Learner, "Embroidering the New Science: Seventeenth-Century Florilegia and Botanical Study," *Nuncius* 35, no. 3 (2020): 685–717.

21 On a study of herbal frontispieces, see Kaleigh Hunter, "Engraving *The Herball*: Frontispieces and the Visual Understanding of Botany in 16th–17th Century England" (PhD, Leiden University, 2018).



FIGURE 1 Section of title page of Jacob Breyne, *Exoticarum aliarumque minus cognitarum Plantarum centuria prima* (Danzig, 1678)
 COURTESY OF WOLFENBÜTTLER DIGITALE BIBLIOTHEK DER HERZOG
 AUGUST BIBLIOTHEK [HTTP://DIGLIB.HAB.DE/DRUCKE/6-7-1-PHYS-2F/START
 .HTM?IMAGE=0009](http://diglib.hab.de/drucke/6-7-1-phys-2f/start.htm?image=0009)

addressing the study of seeds, soil, trunks, leaves, fruits, flowers, and plant processes from diverse perspectives, this fascicle ultimately offers new elements of reflection on the transition to a modern science of plants in seventeenth-century knowledge.

Acknowledgments

I would like to thank the authors, who readily contributed and patiently discussed their topics, the referees, who carefully provided important assessments of all articles, as well as the editorial team of *Nuncius*, who welcomed the proposal and valuably assisted us in the preparation of this fascicle. Some of the articles here included have been originally discussed at “Scientiae2019” in

Belfast, where I have set up a well-attended panel “Seeds, Plants, and Fruits.” I would like to thank the organizer of “Scientiae2019” and the attendees for their suitable comments and questions, and for the discussions, and I thank Alette Fleisher for her suggestion on Breyné’s work. Financial support for this work has been provided by the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Grant Agreement n.890770, “VegSciLif.”