

Aristotelian Metaphysics of the Vegetative Soul and Early Modern Plant Physiology: Comparison between Plant Functions in Aristotle, Pseudo-Aristotle, and Cesalpino

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1. Introduction

Andrea Cesalpino was a major scholar of botany during the Renaissance, well-known for being the first systematist and for developing accurate observations of plant morphology and anatomy.¹ As a philosopher, he endorsed Aristotelianism. In the first book of his *De plantis libri XVI* (1583),² Cesalpino presented his theses on the anatomy and physiology of plants. He mixed new considerations of the functions of plants, based on his observations, while trying to remain faithful to the Aristotelian doctrine of the vegetative soul. We aim to answer the following questions. To what extent do Cesalpino's theses on the growth, nutrition, reproduction, movement and sensation of plants agree or differ from those of Aristotle, Theophrastus and of the Pseudo-Aristotle—author of the apocryphal treatise *De plantis*—whose texts were authoritative for Aristotelianism at the time?³ How does Aristotelianism influence Cesalpino's botanical theses, and conversely, how do certain botanical theses defended by Cesalpino challenge Aristotelian ideas? To find solutions to these questions, we show how Cesalpino problematized and attempted to resolve discrepancies between the metaphysical and the scientific dimensions concerning the vegetative functions of plants.

1 Julius von Sachs, *History of Botany (1530-1560)*, trans. Henry Edward Fowler Garnesey (Oxford: Clarendon Press, 1890); Alan Gilbert Morton, *History of Botanical Science: An Account of the Development of Botany from Ancient Times to the Present Day* (London: Academic Press Inc, 1981); Edward Lee Greene, *Landmarks of Botanical History. Part II*, ed. Frank N. Egerton (Stanford: Stanford University Press, 1983); Brian W. Ogilvie, *The Science of Describing: Natural History in the Renaissance* (Chicago: University of Chicago Press, 2006).

2 Page numbers refers to the *editio princeps* of Andrea Cesalpino, *De Plantis libri XVI* (Florence: Marescottom, 1583). We first add the book and the chapter, then the number of the page. For the sake of precision, we add paragraph numbers from our forthcoming English translation of Book I: Quentin Hiernaux, Corentin Tresnie, eds., *Andrea Cesalpino's De Plantis Libri XVI (1583) and the Transformation of Medical Botany in the 16th century. Edition, Translation, and Commentary on Book I* (Boston: De Gruyter, forthcoming). All translations from Cesalpino's *De plantis libri XVI* are our own.

3 Fabrizio Baldassarri, "Early Modern Philosophy of Plants and the Unwelcome Guest: Pseudo-Aristotle's *De plantis*," in *Peri Phytōn. Greek Botanical Treatises in the West and the East*, eds. Maria Fernanda Ferrini and Guido Giglioni (Macerata: EUM, 2020), 237-264.

2. Context

Aristotle's treatise on plants is not extant.⁴ Nevertheless, Aristotle's ideas about plants can be partially reconstructed from passages in other works. Although there are some brief botanical remarks in his other treatises, it is mainly in *De anima* that Aristotle discussed plants in a theoretical perspective, although plants are not the main focus of Aristotle's *De anima*, which deals with the nature, location, properties and faculties of the soul of all living beings, especially animals and humans. Theophrastus, a disciple of Aristotle, wrote two of the most important ancient treatises on botany: *Historia plantarum* and *De causis plantarum*. These treatises were only rediscovered in the West during the Renaissance. Because of the absence of a Latin translation of Theophrastus, Pseudo-Aristotle's *De plantis* served as the primary botanical reference throughout the Middle Ages in the Latin West and in the Islamic world. This treatise is not by Aristotle, and historians today usually attribute it to Nicolaus of Damascus (circa 64 B.C. – after A.D. 14). The text was probably written with much inspiration from Aristotle's genuine treatise on plants and from Theophrastus' works. The original Greek versions of Aristotle and Nicolaus' *De plantis* are lost, however, and the text has been deeply altered by the successive translations that have brought it to us (first in Syriac, then in Arabic, then in Hebrew, finally in Latin and again in Greek), making it inconsistent and difficult to interpret.⁵ Nevertheless, medieval scholars relied on this text in the West thanks to the first Latin translation by Alfred of Shareshel (circa 1160-circa after 1220)⁶, which was used, for example, by Albert the Great and Vincent de Beauvais⁷.

Cesalpino, when writing *De plantis libri XVI*, was aware of this treatise, at the time attributed to Aristotle, although he may have doubted his authenticity.⁸ Moreover, he had access to the work of

4 For example, in his *De generatione animalium*, 1.1, 716a1-2: "Still, plants will have to be considered independently all by themselves" (transl. Arthur Leslie Peck).

5 According to Galen's testimony (*De Indolentia*, 17), Aristotle's true treatise on plants disappeared at the end of the second century, when one of its last manuscripts was burned in a fire in Rome. Alexander of Aphrodisias presents the loss of the original treatise as an established fact at about the same time (*In librum de sensu commentarium*, 87, 11-12) (Marwan Rashed, "Aristote à Rome au II^e siècle: Galien, De indolentia, §§15-18," *Elenchos* 32/1 (2011): 55-77; Michel Federspiel, Jean-Pierre Levet and Marie Cronier, eds., *Pseudo-Aristote. Du Monde. Positions et dénominations des vents. Des plantes* (Paris: Belles Lettres, 2018), 40). However, it was not until the 16th century that the authorship of the surviving treatise was questioned. It was the historian of botany Ernst Heinrich Friedrich Meyer, *Nicolai Damasceni De plantis libri duo Aristoteli vulgo adscripti* (Leipzig, 1841), who first proposed Nichoaus of Damascus as the author.

6 The current reference translation in French (Federspiel, Levet and Cronier, *Des plantes*) is therefore based mainly on this Latin version of the text, because of its completeness and influence. The English reference translations (Hendrik Joan Drossaart Lulofs and Evert Lubbertus Jacobus Poortman, eds., *Nicolaus Damascenus. De Plantis: Five translations* (Leiden: Brill, 1989)) are based on the Syriac fragments, and the Hebrew and Arabic versions.

7 On the influence of Pseudo-Aristotle on Albert the Great's botany, see Marilena Panarelli, "Albert the Great's *De vegetabilibus* and its unique position among the medieval commentaries on *De plantis*," in *Peri Phyton*, 137-162.

8 Julius Caesar Scaliger (1484-1558) rejected the authorship of Aristotle on *De Plantis*. Cf. Julius Caesar Scaliger, *In libros duos, qui inscribuntur De plantis, Aristotele autore, libri duo* (Paris: Michael Vascosani, 1556). It continued to circulate among Renaissance thinkers with less influence and remained a source for Aristotelian botanists such as Cesalpino. Luciana Repici, "Andrea Cesalpino e la botanica antica," *Rinascimento* 45 (2005): 47-87. Karen Meier

Theophrastus rediscovered in the West from 1483 thanks to the printing of the Latin translation by Theodore Gaza (circa 1400-circa 1478)⁹. It is not clear, however, exactly where the Aristotelian influences on Cesalpino's botany came from. They might be from Nicolaus as well as directly from Aristotle and Theophrastus. Indeed, the first part of Nicolaus' *De plantis* draws from all of Aristotle's naturalist treatises and mainly from *De anima*, while the second part of book 1 is inspired, as for it, especially by Theophrastus' *Historia plantarum*, of which it paraphrases entire passages. Finally, book II, less structured and less clear, borrows from Aristotle's *Meteorologica*.¹⁰ In the rest of this article, we explain first the positions of Aristotle, Theophrastus and Pseudo-Aristotle (or Nicolaus) on the functions of plants and then compare them with Cesalpino's views. Indeed, the history of botany has commented extensively on Cesalpino's morphological observations and especially on his famous classification, while the history of science and the history of philosophy have shown little interest in the Italian botanist's Aristotelian-tinged physiological ideas.

3. Plants, their functions and their soul in Aristotle and Nicolaus

In Aristotle's *De anima*, plants are repeatedly used as examples or counterexamples in discussions of the faculties of the soul. Most notably, the case of plants provides both the motivation for, and a first application of, the famous definition of the soul as the first actuality of a natural body that has organs. Aristotle wrote:

Even the parts of plants are organs, although extremely simple ones, e.g. the leaf is a covering for the pod, and the pod for the fruit; while roots are analogous to the mouth, for both take in food. If then we are to speak of something common to every soul, it will be the first actuality of a natural body which has organs.¹¹

If plants are to be considered alive in the same sense as humans are, the definition of the soul must equally fit both.¹² Plants, alongside with insects, provide an important objection to attempts to locate the soul in a specific place of the body. As plants and some insects can survive – and even grow and reproduce – after being cut into parts, Aristotle argued that each of these parts must retain

Reeds, *Botany in medieval and Renaissance universities* (London and New York: Garland Publishing, 1991), 19.

Fabrizio Baldassarri, "Early Modern Philosophy of Plants and the Unwelcome Guest."

9 Cesalpino mentions explicitly Gaza and Theophrastus.

10 Federspiel, Levet and Cronier, *Des plantes*, 49.

11 *De anima* 2.1, 412a29-b-6 (transl. D.W. Hamlyn). See also *De partibus animalium* II, 10, 655b32-656a2.

12 The question of how exactly plants are living substances is an noteworthy problem of Aristotelian exegesis, see for example Rosamond Kent Sprague, "Plants as Aristotelian Substances," *Illinois Classical Studies* 16/1 (1991): 221-229.

the whole of the plant's or the insect's soul and all of its functions, such as nutrition and reproduction.¹³

3.1. Nutrition in the Aristotelian tradition

Everything that lives must possess the ability to grow.¹⁴ Any kind of growth (and, for that matter, of maturation and of decay) implies the presence of food and hence of a nutritive power (θρεπτική δύναμις); therefore, every living being must have such a power.¹⁵ In other words, to count as an ensouled or living being, it is enough to use food to fuel growth or maturation. When this power exists in a soul without any other psychic faculty, Aristotle called this soul and its body a plant. This most elementary power of the soul, namely the nutritive power, actually fulfills two functions (ἔργα). The first is nutrition strictly speaking, i.e., obtaining and processing food. The second is “generation” (γένεσις), often translated as “reproduction”, by which a living being produces another being, similar to it¹⁶. This generative power does not complement the nutritive one but is another *function* of the very same *power*.¹⁷ It has been remarked that Aristotle told neither how it is possible for the same power of the soul to have two functions, nor why these two functions are attached to the nutritive power.¹⁸ It might be because the seed (of both plant and animal) is a residue of the food after it has been used to feed the body, rendering nutrition and seed production two steps of the same process.¹⁹ Aristotle's successors, including Cesalpino, shed light on the close relation between nutrition and generation through the study of plants. Nonetheless, what Aristotle wrote in *De anima* is that nutrition and reproduction allow for the survival of the living being: as an individual for the former, as a species for the latter.²⁰ Both explanations are compatible, the former focusing on the material side of these functions, the latter on their teleological side.²¹ Cesalpino accepted the

13 *De anima* 1.4, 410a9-10; I, 5, 411b19-21 and II, 2, 413b16-22.

14 *De anima* 2.2, 413a27-b1.

15 *De anima* 2.2, 413b6-9; II, 4, 415b25-28; III, 12, 434a22-27.

16 *De anima* 2.4, 415a22-415b1.

17 This precision has raised challenging issues about how exactly the same power may accomplish so different things. We can only sketch them in this chapter. See for example the discussion by David Lefebvre, “Looking for the Formative Power in Aristotle's Nutritive Soul,” in *Nutrition and Nutritive Soul in Aristotle and Aristotelianism*, ed. Gilioui Korobili and Roberto Lo Presti (Berlin: De Gruyter, 2021), 101-125, as well as Klaus Corcilius, “Soul, Parts of the Soul, and the Definition of the Vegetative Capacity in Aristotle's *De anima*,” in *Vegetative Powers: the Roots of Life in Ancient, Medieval and Early Modern Natural Philosophy*, ed. Fabrizio Baldassarri and Andreas Blank (Cham: Springer, 2021), 13-34.

18 See e.g. David Walter Hamlyn, *Aristotle's De anima Books II, III* (Oxford: Clarendon Press, 1968), 95.

19 See *Generation of Animals*, II, 3, 736b26-27 and II, 4, 740b29-37, as proposed by Pierre Thillet, *Aristote. De l'âme*, (Paris: Gallimard, 2005), 113, n. 202.

20 *De anima*, 2.4, 415b1-7. This is true of all living beings: *De generatione animalium* II, 1, 731b31-732a1 and *De generatione et corruptione* II, 10, 336b25-337a4.

21 Georges Rodier, *Aristote. Traité de l'Âme* (Paris: Belles Lettres, 1900), vol. 2, 227, already suggests the simple interpretation that nutrition *stricto sensu* and reproduction are the two possible results of the food's processing, which therefore remains one power.

attribution of both operations to the nutritive soul and the teleological argument.²²

Aristotle's followers slightly altered his views. Nicolaus of Damascus departed from Aristotle on several points. For example, Aristotle believed that no locomotion could be attributed to plants and their souls; Nicolaus considered nutrition to be locomotion within the plant.²³ He wrote, "but within plants motion is easy, because dryness, which is one of the powers of earth, draws moisture."²⁴ This movement is understood to be earth moving inside the plant, which attracts moisture. Nicolaus wrote that the heat contained in the plant allows the moisture to flow:

It is not in the nature of moisture to rise upwards, but the heat draws that moisture into the extremities of the plant, so that the food will get to all its parts, while that which is superfluous is secreted.²⁵

Indeed, contrary to Aristotle's assertion²⁶, plants are not made up of only elemental earth, but also of water and fire:

Plants have three properties: the first is derived from earth, the second from water, the third from fire. From earth, the plant receives a fixed position; from water, the coagulation of its parts; from fire, the cohesion of its fixed position.²⁷

Unlike Aristotle in *De anima*, Nicolaus sought to explain more precisely the practical workings of plant nutrition and growth on the basis of the theory of the elements and the principle of concoction (concoction being a process involving heat and moisture).²⁸ It seems that Nicolaus altered Aristotelian physical and metaphysical doctrines to allow for solutions to botanical problems, drawing very freely on Aristotle's explanations in the *Meteorologica* about the formation of salt water, sand, and earthquakes, which he sought to transpose analogously to the functioning of plants. However, his physiological accounts are hard to follow. For example, he wrote:

22 Cesalpino, DP 1.1, 1; Hiernaux-Tresnie §5.

23 Federspiel, Levet and Cronier, *Des plantes*, 220 associate this movement with the *Elxis* of *Physics* VII, 2, 243a17 ff. which is a movement that goes towards the motor.

24 Translation borrowed from Drossaart Lulofs and Poortman, *De plantis*, 174, §142, 822b1-2.

25 *De plantis*, 176, §147, 822b18-19.

26 *De anima* 3.13, 435a21-b4, discussed below.

27 *De plantis*, §135, 822a12-14. This quotation is a personal translation from the Latin version of the text (cf. the French translation of Federspiel, Levet and Cronier, *Des plantes*, 107) because the Arabic version and its English translation (Drossaart-Lulofs and Poortman, *De plantis*, 172-173) are significantly different: "Plants have three powers: earthy, watery and fiery. The earthy power is the subsistence of plants, the watery one makes them grow and the fiery one consolidates them." Instead of stating that the plant is fixed by virtue of its proximity to the earth, the Arabic version and the English translation simply state that the plant gets its food from the earth. This interpretation seems to us to be less consistent with the argument of §135 which we comment on below.

28 *De plantis*, §253, 829b29-32.

And so grasses and herbs are only formed by a process of composition, not from a simple element, as in the case of the salination of sea-water and the production of sand. For when the ascending vapours coagulate, grasses can be formed, while dew is falling and the place is rarefied. From it the forms of the seed will come forth in accordance with the powers of the stars. As to the matter – I mean the matter of water – it is one and the same; for even if there exist many different kinds, from water nothing else will ascend than fresh water. Accordingly, salt water is heavier; and accordingly that which arises from water is finer than water. When, therefore, the air draws it up, it will become fine and rise upwards [...].²⁹

This passage seems to take up the Aristotelian idea that the formation of plants and their growth is intimately linked to species growth, i.e., its reproduction through the formation of seeds. However, it remains unclear how this process works. Cesalpino was unsatisfied by these elemental explanations and tried to return to a stricter Aristotelian interpretation of plant physiology.

3.2. Generation in the Aristotelian tradition

In Aristotelianism, nutrition allows for the growth and the reproduction of the organism. If Aristotle did not develop precise ideas on plant reproduction in *De anima*, Nicolaus, inspired by Theophrastus and other passages from diverse Aristotle's treatises, explicitly addressed the subject. This passage from Theophrastus played an important role in Nicolaus' theory:

The ways in which trees and plants in general originate are these: spontaneous growth, growth from seed, from a root, from a piece torn off, from a branch or twig, from the trunk itself; or again from small pieces into which the wood is cut up (for some trees can be produced even in this manner).³⁰

Theophrastus enumerated seven types of generation for plants' growth, without giving special status to any of them. Although Nicolaus Damascenus' *De plantis* (§113-131) is based on this text, the author's interpretation significantly deviates, as he conceives of three or sometimes five modes of reproduction. He wrote:

²⁹ *De plantis*, 184, §171-173, 824b4-16.

³⁰ *Historia plantarum* 2.1, 1.

Some plants grow when they are planted, others when they are sown, while others grow spontaneously. Plants that are planted are cut off, either from the root to be planted, or from the trunk, from branches [or from the seed]³¹, either from all of it, or when tiny cuttings are torn from it. Some are planted in the earth and others are planted in other trees, such as those which are engrafted.³²

Nicolaus suggested three main types of plant reproduction: planting (which includes grafting and any type of vegetative reproduction), sowing of seeds, and spontaneous generation. Emphasis is placed on how plants reproduced, which means that spontaneous generation and sowing are given special status, while all other modes are gathered under the heading of planting, where they are subsequently organized. The distinction between vegetative and seed reproduction is probably based on Aristotle's comparison of the seed of the plant to the embryo of a fertilized egg that contains both the power to engender the chick and the material for its nutrition.³³ This comparison with the egg is taken up by Nicolaus.³⁴ In contrast to seed reproduction, vegetative reproduction is conceived as being closer to growth since it does not imply the mixing of a male and female principle. In this sense, plants, more than animals, allow us to understand how the growth of individuals and the reproduction of species are two sides of the same nutritive faculty, as *De anima* posits. Moreover, we should not necessarily project the idea of sexual reproduction onto reproduction by means of seeds. Indeed, the question of plant sexuality was very problematic for the ancients.

Theophrastus seemed to consider the presence of separate sexes in plants, male and female, as symbolic rather than a biological property.³⁵ Following Theophrastus, Nicolaus explained:

For in every kind of plant the male is what is coarse, hard and rigid, and the female what is tender, weak and full of fruit.³⁶

And further on, still using Theophrastus, he wrote:

31 We put [or from the seed] in square brackets because according to Federspiel, Levet and Cronier, (*Des plantes*, 207) and their French translation, this part would constitute an apocryphal addition, which is consistent with the idea that Nicolaus does distinguish three modes of reproduction and does not equate sowing with vegetative reproduction. "Pour pousser, certains arbres ont besoin d'être plantés; d'autres naissent d'une graine; d'autres enfin naissent par génération spontanée. Ceux qui sont plantés sont détachés de la racine ou du tronc, ou des branches, [ou de la graine], ou bien sont entièrement transplantés; certains sont légèrement brisés. Certains sont replantés dans la terre, d'autres dans les arbres, c'est-à-dire greffés" (*Sur les plantes*, 103-104 §113-114, 820b30-35). Drossaart-Lulofs and Poortman already marked it with a crux, noting (*De plantis*, 299) that these words are "puzzling."

32 *De plantis*, 162, §113-114, 820b30-35.

33 *De generatione animalium* 1.23, 731a5 and following.

34 *De plantis*, §39-47, 817a10-40.

35 *Historia plantarum*: 3.8, 1; 5.4, 1.

36 *De plantis*, 138, §38, 817a8-9.

Some people assert that the differences between cultivated and wild plants are known by the character of masculinity and femininity, whenever the existence of each of them is distinguished by their features. For the male is more dense than the female, has more branches, is harder and has less moisture, whereas the fruits are smaller and less liable to reach maturity. The leaves too and likewise the twigs are different.³⁷

Already in Aristotle, we find the idea that, for certain species like the fig tree, some trees bear fruit, while others do not but favor the fruiting of the first. However, in Aristotle, this usage of sex is strictly analogical, as he wrote:

The creatures which cannot move about [...] are in their essence similar to plants, and therefore, as in plants, so also in them, male and female are not found, although they are called male and female just by way of similarity and analogy.³⁸

Aristotle thus seems to be closer to Empedocles, who conceived (according to Nicolaus) there to be a mixture of male and female sex in each plant, writing:

Now in plants the female is not separate from the male; in certain of the animals, however, it is separate, and here, in addition, it has need of the male.³⁹

This thesis (at least the version of Empedocles reported in *De plantis* asserting the reunion of the male and female sexes in each plant⁴⁰) is rejected by Nicolaus, notably on the grounds that the resulting capacity for self-fertilization would make the plant superior to the animal in its autonomy. This possibility of self-fertilization does not seem coherent to Nicolaus for metaphysical reasons, because a substance cannot be both agent and patient, but also for empirical reasons. He considered the development and growth of plants to be heteronomous: they depend on external circumstances such as the earth, the sun, the temperature, and the seasons. It must therefore be the same for their generation, the earth providing the female nutritive principle and the sun the male generative principle in the fruit.⁴¹

The fact that Nicolaus explicitly distinguished reproduction by seed from vegetative

37 *De plantis*, 168, §130, 821b21-27.

38 *De generatione animalium* 1.1, 715b17-21.

39 *De generatione animalium* 2.4, 741a4-6.

40 *De plantis*, §36; §39, 817a.

41 *De plantis*, §36-49, 817a1-b6.

reproduction should not let us think he was on the track of true sexual reproduction in plants. Yet Theophrastus had already observed that the reproduction of plants from their fruits produced plants of inferior quality to those obtained by vegetative reproduction⁴². Nicolaus agreed with this analysis and noted the consequences of sexual reproduction, namely a potential adulteration of the variety. He simply stated that reproduction from seeds is not always reliable, because sometimes a seed is of inferior quality to the plant from which it is derived, and vice versa.⁴³

Nicolaus also repeated an anecdote from Theophrastus about the fertilization of female palm trees which allows their fruiting through the use of some parts of male palm trees. While Theophrastus clearly explained that the powder of the male inflorescences must be shaken onto the female inflorescences in order to obtain viable fruit⁴⁴, the Latin version of Nicolaus reads:

In the case of palms, if leaves, leaf powder or bark of a male palm are applied to the leaves of a female palm, so that they are in good contact, this will cause the fruit to ripen quickly and prevent it from falling.⁴⁵

The method of fertilization here is therefore quite different, less precise (and inefficient) than the one described by Theophrastus.⁴⁶ The text also adds:

Sometimes a heavy wind blows and bears the odour of the male to the female, so that its fruits are concocted.⁴⁷

However, this mentioning of a kind of wind might be an addition from the Arabic tradition, inspired by Pliny the Elder.⁴⁸

Among the ancients, the use of the terms male and female for plants is therefore mostly analogical. The characteristics associated with the sex of plants are more symbolic than biological. Consequently, *De plantis* leaves a great deal of room for spontaneous generation compared to the other modes of generation. Contrary to the three modes of reproduction mentioned in §113, in §205

⁴² *Historia plantarum*, 2. 2, 4.

⁴³ *De plantis*, §116, 821a3-6.

⁴⁴ *De causis plantarum* 2.9; 3.18.1 and *Historia plantarum* II.8.4.

⁴⁵ *De plantis*, §119, 821a14-16. Here we propose a personal translation from the text of the Latin edition, as the Arabic version is quite different in content, see the next footnote.

⁴⁶ The Arabic version used for the English translation (Drossaart-Lulofs and Poortmann, *De plantis*, 164-165) makes better sense and is more faithful to Theophrastus: "As regards the palm tree, when over its spathe something from the male spathe with its bloom and its dust is sprinkled, it ripens the fruit and prevents it from being shed," This version of the text clearly, and only, mentions "dust" of "the spathe" which is the pollen of the inflorescence. Cesalpino had only the Latin version.

⁴⁷ *De plantis*, 164 §120, 821a20-21.

⁴⁸ According to Federspiel, Levet and Cronier, *Sur les plantes*, 210, referring to Pliny, *Natural History*, 12.35.

(827a3-7) Nicolaus tells us that there are five principles of plant generation: seed, planting, putrefaction, water moisture, or parasitization of another plant. In reality this is not contradictory insofar as the last three cases are in fact three modalities of spontaneous generation. Thus, he specified that some organisms "proceed from earth or from trees".⁴⁹

Those ideas about plant spontaneous generation are directly borrowed from Aristotle. He wrote:

The same holds good also in plants, some coming into being from seed and others, as it were, by the spontaneous action of Nature, arising either from decomposition of the earth or of some parts in other plants, for some are not formed by themselves separately but are produced upon other trees, as the mistletoe.⁵⁰

Similar conceptions are found in Theophrastus from which Nicolaus took the example of the dodder.⁵¹ However, Theophrastus was more circumspect about the generality of spontaneous generation, and even about its existence and calls for more studies on the subject.⁵² The §187-188 of *De plantis* explain the supposed functioning of spontaneous generation:

Sometimes, however, putrefactions are set up in damp ground and in sand, due to enclosed air. When there has been much rain and wind, the sun causes these putrefactions to appear, and owing to the dryness of the earth their roots will dry up and harden, and then mushrooms and the like will be produced. Some plants are produced in places that are exceedingly hot, because the heat concocts what is inside the earth and the heat of the sun is retained, so that vapour is formed and suckers come from it. And so palm trees are suddenly produced in all hot places.⁵³

This explanation makes it possible again to account for the Aristotelian proximity of generation and growth. Nicolaus then explained that the same thing happens in cold places in opposite ways and that "the ground opens up and a plant comes out", as well as in the generation of aquatic plants on the surface of water and even in sulfurous waters or on the surface of rocks that generate plants by

49 *De plantis*, 132, §20, 816a20-21.

50 *De generatione animalium*, I, 1, 716a10. See also *Historia animalium*, 5.1, 539a22 ff. and 5.19, 551a5.

51 Compare Theophrastus, *De causis plantarum* 2.17 with Nicolaus, *De plantis*, §204.

52 Theophrastus, *De causis plantarum*, 4.15.4.

53 *De plantis*, 190, §187-188, 825b13-24.

their internal concoction.⁵⁴ More specifically, §203 discussed the appearance of specific plants on wet soil:

The plants which grow in damp places will appear like patches of verdure on the surface of the earth. In such a place there is, in my opinion, little rarity, and when the sun stands over it, it draws that dampness and the place will grow warm through the resulting motion and the heat which is retained within the earth. So the plants have no nutriment to stimulate their growth, but the moisture helps them with their expansion. Accordingly they trail along on the surface of the earth like a green mantle. They have no leaves, but grow like the kind of plants which appear on the surface of the water, but they are smaller than those on the water because they are related to earthiness and neither go upwards nor expand.⁵⁵

This passage probably describes the growth of moss. The plants that appear on the surface of the water are algae. This passage can be compared with one in the Pseudo-Aristotelian treatise *De coloribus*, that reads:⁵⁶

This happens logically, and in all growing things this [green] is the first colour that obtains. For all water that stands for a long time is green originally, being mixed with the rays of the sun, but it gradually grows black, but becomes green again when mixed with fresh water.⁵⁷

The idea is that the element "water" tends naturally toward the color green under the action of heat; since water is partly the material of plants, it tends to take the green color when it is exposed to the action of the sun. On this question of plant color left unaddressed by Aristotle, Nicolaus combined Aristotle's and Theophrastus' observations with his own reflections to build a descriptive model independent from classical metaphysical reasoning. It is not always clear how these can fit in the framework of the *De anima*.

⁵⁴ *De plantis*, §190-195, 825b29-826a27.

⁵⁵ *De plantis*, 196, §203, 826b20-32.

⁵⁶ It is however unlikely that the author of *De coloribus* be the same as the Pseudo-Aristotle of *De plantis*.

⁵⁷ *De coloribus* 5, 794b24-29. The translation is borrowed from W.S. Hett, *Aristotle Minor Works* (Cambridge, MA: Harvard University Press, 1936). We only add "[green]" as it is clearly implied in the original context.

4. Cesalpino on Plant Nutrition and Generation

Nicolaus tried to expand on Aristotle's model of plant nutrition by introducing explanations based on the Aristotelian theory of elements. Cesalpino, as a careful reader of Aristotle, was unsatisfied with such innovations. He therefore proposed his own ideas on nutrition. Thus Cesalpino did not assert in the *DP* that plant nutrition is a simple attraction of moisture due to the nature of elements. He distanced himself from theories of the properties and affinities of the four elements. Rather, he sought to better understand the physical mechanism of plant nutrition⁵⁸. As an Aristotelian, Cesalpino confronted an *aporia* that results from Aristotle's methodological zoocentrism that systematically explains plants and their organs by analogy with animals and posits that plant roots are like animal veins.

According to Cesalpino, both roots and veins serve to transport food from an organ of nutrition to a principle that extracts vital heat from it. The earth plays the same role for plants as the abdomen for an animal, because the roots are connected to the entrails like veins. However, the analogy is imperfect, since it does not account for the selection of food by plants insofar as this function is carried out by sensation (taste, touch, etc.) in animals. Since plants lack the sensitive part of the soul, Cesalpino undertook to find an explanation for such a selection within the nutritive faculty. The models of the selective attraction of nutrients that he favors belong to the inanimate and artificial realm: the force of attraction of a magnet, of the vacuum of a gourd or a sucker (*utriculus*), the absorption of a sponge, and finally the filtration by capillarity of oil lamps, which he finally retains.

Once again, the general spirit of this inquiry might be inspired from Nicolaus' treatise. Just like him, Cesalpino attempted to explain nutrition on the basis of properties of the plant's constituents. The Aristotelian method and psychology led to the description of plants from animals; their limitations lead Cesalpino to complete this description from the physical world and from craft objects. This could be seen as a first step towards a mechanistic conception of plants. However, Cesalpino still considered his explanation as falling within the scope of Aristotelian psychology: capillarity is but the means (*ratio, ingenium*) used by nature to fulfill the nutritive function. Indeed, the keystone of his physiology remains the soul and the principle of heat that allows growth, movement and sensation⁵⁹.

Concerning plant reproduction, it should be noted that the Italian naturalist recognized, like Nicolaus, three distinct modes: by seeds, by sobols (vegetative reproduction) and by spontaneous

⁵⁸ Cesalpino, *DP* 2.2, 4-5; Hiernaux-Tresnie §20-25.

⁵⁹ In Book I of the *DP*, this notion of heat is itself ambiguous, sometimes considered in its physical sense of heat production, sometimes as a metaphysical vital principle. We can therefore see a trace of the elemental theory of the ancient philosophers.

generation.⁶⁰ This last mode of reproduction is however hardly mentioned, in the course of a single sentence:

The first stage of a plant's development happens from the root, as this is what is born first – either from the seed, or from putrefaction.⁶¹

Cesalpino did not bring any real development to the hypothesis of spontaneous generation in this work, although he discussed it in depth in the *Quaestiones peripateticae*, where he contended that all animals including humans can be generated out of putrefaction.⁶² At most, one can see in chapter 7 an indirect echo of the passage of the theory of colors of Nicolaus mentioned above, without that the spontaneous generation of algae is clearly associated with it:

The color of the leaves is the same as grass, because the liquid of plants, once it is exposed to the sun, takes on this color, just as we can see in stagnant water, when it is dried up by the sun.⁶³

The fact that Cesalpino did not develop any explanation of the functioning of spontaneous generation, while his mention of putrefaction might be referring to it, is strange. Here, maybe he shared Theophrastus' carefulness about the phenomenon of plant spontaneous generation.

Cesalpino, unlike his predecessors, theorized more explicitly the difference between vegetative reproduction and reproduction by seeds:

The sobole differs from the seed as the fetus does from the egg: the seed is like an egg which contains a principle of life, but by no means life itself, whereas the sobole has life of its own; albeit near and like a shoot from its parent, before it is able to draw its liquid from the soil by itself with its own roots. Previously, the sobole, when it is big enough to be visible, is either an incomplete root, or a shoot, or both. The principle of these produces the seed within the bark. As a result, plants are not able to nourish too many offspring, whereas they have no problem in bearing many seeds, as can viviparous and

⁶⁰ Cesalpino DP 1.3-6, 5-13; Hiernaux-Tresnie §27-63.

⁶¹ Cesalpino, DP 1.4, 8; Hiernaux-Tresnie §38.

⁶² At least in his botany. However, he discusses spontaneous generation in his *Quaestiones peripateticae* 5.1, 92A - 97A.

⁶³ Cesalpino, DP 1.7, 14; Hiernaux-Tresnie §69.

oviparous animals. On the other hand, the generation of the sobole is simpler, since it consists of a release, while the formation of seed requires several stages.⁶⁴

Cesalpino took up the Aristotelian analogy of the seed and the egg and clarified that vegetative reproduction, by sobole, is more akin to growth than to the more complex generation that takes place from seeds.

The Italian botanist also compared animal and plant growth. However, he emphasized the peculiarity of the development or budding (*germinatio*) of plants capable of generating new essential organs, whereas this is only possible during embryogenesis in animals:

It is only in the uterus, in viviparous animals, that we can observe a true “budding” (*germinatio*). The fetus, in fact, which sprouts like a sort of shoot in its own way, survives thanks to the food that is provided, in the same way that a shoot does. There is a difference, however, in that in animals, the principle [of development] comes from the outside, that is by the semen of the male, although the food comes from the uterus. In plants, on the other hand, both the matter and the principle come from within. Of course, in oviparous animals, the eggs grow, but those that are deprived of the male semen are infertile. Indeed, without the contact of the male, they do not have the sensitive soul by which animals are defined. As for the plant, it has no need for this principle; as if it is up to it alone to release the shoot from itself.⁶⁵

Once again, we can recognize the Aristotelian comparison of the seed and the egg, which Cesalpino made explicit. In the seed, both the “male” principle and the “female” matter come from the mother plant. Thus the egg is an imperfect analogy for the development of the seed, since without external fertilization the embryo does not develop, likely indicating that Cesalpino did not recognize the sexuality of plants and preferred the thesis of self-reproduction. He also distanced himself from the thesis, relayed by Nicolaus⁶⁶, of an external female principle brought by the earth and an external male principle brought by the Sun. The following passage goes in the direction of a self-reproduction not involving sexuality:

On the other hand, in plants, we have not needed to consider that the task of generation is carried out by anything other than matter, in contrast to animals which are divided

64 Cesalpino, DP, 1.5, 11; Hiernaux-Tresnie §53.

65 Cesalpino, DP, 1.3, 5-6; Hiernaux-Tresnie §28.

66 Pseudo-Aristotle, *De plantis* §36-49, 817a1-b6, summarized in the section about generation above.

into males and females: the sperm of the male gives form to matter in the female by using her corporeality (*corpulentia*), as we explained in *Quaestiones peripateticae*. But as plants do not need a great differentiation of their organs and use less breath, they organize their matter thanks to the breath of life conceived as in the case of an egg. This is why the male/female distinction is not something they would need but lack, even if we do name them as male and female in accordance with some comparison.⁶⁷

Although Cesalpino claimed to rely on the Aristotelian position by referring to his own *Peripatetic questions*, his position on plant sexuality is in fact more complex and nuanced. Other observations on the sexes of certain plants are indeed more precise and closer to the truth than that of the Ancients. Thus, in chapter 7 of the DP devoted to flowers, he wrote:

Certain [plants] are completely sterile, including the Amentaceous plants, which are born without any hope of producing fruit. As for [sterile plants] which do bear fruit, they do not flower, such as cade, yew and in the herbs genus, mercury, nettle and hemp. In all these species, sterile plants are called male and those that fruit female. This is for the reason that the female's plant matter is more tepid and the male's hotter; because what should have passed into the fruit vanishes in flowering due to the excessive heat. However, it is said that in this type [of plant], females grow better and are more fertile if they are planted near males. It is noticeable in the case of the date palm, for example, that a sort of breath emitted from the male plant compensates for the lack of heat in the female for fructification.⁶⁸

In this passage, Cesalpino associated the idea of sexes in plants only with dioecious species (nettle, mercurial, hemp, oxycedra, date palm, and yew), i.e., species whose male plants bear inflorescences that do not fruit, while the female plants do. Cesalpino based his conception of life, as we have said, on the (metaphysical) principle of heat. His hypothesis is that in dioecious plants, the male's excessive heat is entirely transferred to the development of flowers, so that there is not enough left to fructify in the manner of female plants, whose flowers require less heat. In this same passage, he took up the famous example of date palms, relying on Pliny's thesis of the fertilizing wind in a version that is once again more metaphysical than empirical. These observations do not, therefore, lead to the recognition of a theory of plant sexuality in Cesalpino (as has sometimes been

67 Cesalpino, DP 1.6, 11-12; Hiernaux-Tresnie §57.

68 Cesalpino, DP 1.7, 15; Hiernaux-Tresnie §73.

asserted)⁶⁹. The theory, inherited from antiquity, which still prevailed during the Renaissance, is notably recounted by Jean Ruel.⁷⁰ Cesalpino quoted Ruel in the DP and maybe shared his ideas on the subject. According to this theory, seeds that fall into the earth are sterile before a breath manifesting itself as a wind called *Favonius* or *spiritus genitalis* fertilizes them.⁷¹ This fertilizing breath would also be at work between the male and female plants of dioecious species as Cesalpino suggests.⁷²

Despite his fidelity to Aristotle's interpretation of plant reproduction, Cesalpino contributed to the history of the discovery of plant sexuality insofar as he is a precursor of flower morphology, whose different parts he distinguishes in chapter 7: sepals, petals, stamens and anthers (and pollen), ovary (receptacle) and pistil. This step of differentiation and description is essential to recognize the organs of flowers, to describe them precisely, to contemplate about their function, and to demonstrate their respective roles in reproduction, as Camerarius did in 1694. His contribution is neither a repetition from Aristotle nor from Theophrastus or Nicolaus, as he himself freely combines their respective takes with his own empirical observations to propose a new model. He remained careful, probably much more than Nicolaus, to make this model compatible with the metaphysical organization of psychic faculties found in the *De anima*.

5. Sensation, motion and desire in plants: from Aristotle to Cesalpino

In addition to questions of nutrition and reproduction in plants, Cesalpino dealt with a long-standing problem within Aristotelian tradition, asking whether plants can be said to perceive, move or desire. Aristotle defined plants by their nutritive and reproductive power. He distinguished them from animals by their lack of any kind of cognition or local motion, which are essential features of animal souls rather than of every soul.⁷³ These distinctions regarding cognition, desire, and motion converge, since, for Aristotle, local movement presupposes a desire that sets the aim of the motion, otherwise plants would be able to move in space.⁷⁴ Souls only set their bodies in motion when they long for something, which is why animals move and plants do not.

In turn, desire requires cognition: the soul must be able to differentiate between what it wants

69 For example by Augustin-Pyramus de Candolle, *Physiologie végétale, ou expositions des forces et des fonctions vitales des végétaux* (Paris: Béchét Jeune, 1832), 48.

70 See his chapter on physiology in Jean Ruel, *De natura stirpium libri tres* (Paris: Simon de Colines, 1536).

71 Greene, *Landmarks of Botanical History. Part II*, 648-652.

72 Cesalpino, DP 1.7, 15; Hiernaux-Tresnie §73.

73 *De anima* 1.5, 410b22-27. See *De anima* 2.2 413b1-4; 2.3, 414a29-b7; *De generatione animalium* 2.5, 741a9-10; *De Sensu et Sensibilibus* 436b8-12.

74 *De anima* 3.9, 432b14-18. This does naturally not preclude other kinds of movement or change: generation, growth and alteration.

and does not want. In the most basic case, animals will choose one pleasant thing (typically: one kind of food) over another painful or less pleasant one. The ability to choose food entails a sense of pain and pleasure, which rests upon having a nutritive power, in order for the body to be able fortified, but also a sensitive power, in order to be able to feel it. Feeling pain and pleasure entails having the sense of touch, which is common to all animals. Therefore, both nutrition and sensation are needed for cognition, desire and motion. As plants only possess the former, they cannot desire or move.⁷⁵

According to Aristotle, plants are affected by the material world and its qualities such as heat and cold. However, they lack an intermediary state (or “a mean”, μεσότης) between these determinations, which could serve as a reference, or as a judging principle.⁷⁶ More specifically, the sense of touch consists in a variation of the equilibrium of the four fundamental qualities: dry, wet, hot, and cold.⁷⁷ Plants in their natural state are, according to Aristotle, constituted exclusively of earth, which is cold and dry, making them unable to gauge the variations in the qualities they do not naturally have (namely hot and wet), as neither can our bones and hair, also made of earth.⁷⁸ The mono-elemental nature of the body of plants is thus the reason why their soul is unable to have sensation as well as desire and local motion. In turn, this inability constitutes the difference between plants and animals. Cesalpino knew this doctrine very well and approvingly referred to it.⁷⁹

The fact that Nicolaus considered plants to be made up of three elements (water, fire, earth) rather than just earth could have led him to different conclusions about their sensations and movement. However, he adopted a reasoning quite similar to Aristotle's. He wrote that “plants have no motion of their own because they are attached to the earth, and the earth is motionless”.⁸⁰ This argument probably appeals to Aristotle's theory of affinities between elements.⁸¹ The idea is that entities composed of a particular element or with which they are in affinity, like plants with the earth, share characteristics of that element. As the earth is immobile, so are plants. The Latin version of §135 quoted above also went in this direction by stating that plants take their fixed position from the earth. Nicolaus then asserts, like Aristotle, that plants have no movement of their own and no voluntary movement, no sensation and that their parts have no defined limits.⁸² Plants

⁷⁵ *De anima* 2.3, 414a34-b15.

⁷⁶ *De anima* 2.12, 424a32-b2.

⁷⁷ *De anima* 2.11, 423b27-424a6. On these qualities and their link with the four elements, see *De Generatione et Corruptione* 2.3, 330a30-b12.

⁷⁸ *De anima* 3.13, 435a21-b4. Aristotle adds that all the other senses require touch, see also *De Partibus Animalium* 2.1, 647a14-19.

⁷⁹ Cesalpino, *Quaestionum peripateticarum* 5.7, 135 D, citing the second book of Aristotle's *De anima*.

⁸⁰ Pseudo-Aristotle, *De plantis*, 134, §22, 816a26-27.

⁸¹ *Meteorology* 4.4, 382a3-21; 4.5, 382b2-10; 4.6, 382b28-383a26; 4.7, 383b18-384a20 and 384a3b25. On this theory, see Tiberiu Popa, “Scientific Method in *Meteorology* IV,” *The Journal of the International Society for the History of Philosophy of Science* 4/2 (2014): 306-334.

⁸² Pseudo-Aristotle, *De plantis*, §52, 817b22-24.

are indeed endowed with a soul, because they possess a part of it (vegetative), but they do not possess sensation like animals.

Logically, Cesalpino envisaged that plants, especially for their nutrition, are conditioned by external physical causes. But at the same time, fidelity to Aristotelian psychology imposed an explanatory role for the soul, since only inanimate entities, devoid of soul, are subject to physical causality alone. This explains the further elaboration and qualification of the Aristotelian model Cesalpino developed to explain plant nutrition, as well as the greater importance he attached to plants' particular environment.

At that level, he could also have been influenced by some passages of Theophrastus. For example, at least in one place in *De causis plantarum*, Theophrastus seems to attribute a form of sensation to plants, as a mediating operator between plants and the physical causes that influence their reversible movements. He wrote:

The closing and opening of the flowers is a less difficult matter and easier to solve, since it is brought about by cold and heat, the flowers being cold and weak. Thus, they close up when their fluid condenses and (as it were) freezes (since at this time their heat leaves them too), and open when the fluid dissolves again and thaws, this being done by the sun. The plants that sink under the water and emerge above it to a greater extent are evidently colder and weaker than the flowers, and for this reason more affected by the changes. That a plant under water should be so keenly sensitive⁸³ is not unreasonable, especially in a torrid region of fiery heat.⁸⁴

Another difficulty is that Cesalpino, like Theophrastus and contrary to Aristotle and Nicolaus, observed the local movements of certain plants, in particular climbing plants, which adopt a behavior similar to the voluntary movement of animals. Indeed, he told us that thanks to their tendrils or hooks, they cling with "hands, so to speak, with which they catch the neighboring plants" to support their weight.⁸⁵ From this he deduced "a kind of sensation" of climbing plants. Unfortunately, this sentence is the only place in *De Plantis* where Cesalpino mentions sensation in plants. He did not elaborate any theoretical ideas on the subject and we are therefore reduced to hypotheses.

83 The Greek more specifically says "such a sensation" (Ἡ δὲ αἴσθησις οὕτως).

84 Theophrastus, *De causis plantarum*, 2.19.3.6 – 4.519, 3, 6 – 4, 5, transl. Benedict Einarson & George K. K. Link, 357-359.

85 Cesalpino, DP, 1.11, 23; Hiernaux-Tresnie §114.

As *De plantis* is not explicit, we can look at its influences. In this respect, Nicolaus stated that the plant “possesses a soul [and sensation]. For a thing that is nourished is not without a soul”.⁸⁶ The Arabic version and the Latin translation of Nicolaus’ *De plantis*, on which Cesalpino relied, adds the word for sensation, which is nowadays considered an interpolation.⁸⁷ Consequently, if Cesalpino attributed this ambiguous position on the sensation of plants to Aristotle, this could explain his tendency to recognize a “quasi sensation” in plants, in particular in climbing plants which would need it to perform their movements. This would allow him to account for what he observed while giving a coherent (pseudo-)Aristotelian interpretation to this ambiguous passage of *De Plantis*. Of course, Aristotle himself does *not* attribute sensation to plants, as this suggestion was only hinted to in Theophrastus, then more explicitly added by Nicolaus, or rather by whoever might be the author of the interpolation. Cesalpino knew Nicolaus’ text well enough to keep (consciously or not) the idea that, after all, sensation could serve plants’ nutrition⁸⁸. Assuming he did consider the passage genuinely Aristotelian, the consequence of this attribution of a quasi sensation is that climbing plants could express a “quasi desire”. Cesalpino, does not write this explicitly, but hints at this consequence of which he was aware as an Aristotelian. In no text did Aristotle accept any kind of desire in plants, but it is precisely because (as we have seen) desire is grounded in sensation. Therefore, if we allow for sensation, it could open the way for desire. And Cesalpino told us indeed that these climbing plants:

climb by wrapping themselves around their neighbors [...] as if they possessed a kind of sensation (*quasi sensus quiddam*) of the body next to them, since they creep until they find it, and having found it, grab onto it.⁸⁹

They crawl “until” they find, that is to say that they seek (even desire) a support “to” catch it. Their vegetal “hands” would allow them to touch, to feel, and to locate the desirable supports. What we are witnessing here is a case of Cesalpino accepting a proposition (plants have sensation) which is not in the model found in the *De anima*, perhaps under the combined pressure of Nicolaus’ treatise and Theophrastus suggestion, added to his own observation. But in doing so, he immediately injected it back in Aristotle framework, as he draws another conclusion (plants have desire) which only makes sense if we have the argument of the *De anima* in mind. His way of tackling botanical problems clearly involves the continuous attempt to keep together both Aristotelian metaphysical theses and empirical botanical observations.

86 Pseudo-Aristotle, *De plantis*, 134, §27, 816b4-5.

87 Droossaart Lulofs and Poortman, *De plantis*, 261.

88 On this link between nutrition and a vegetative sensation see Giglioni, “Plantanimal Imagination,”

89 Cesalpino, DP 1.11, 23; Hiernaux-Tresnie §114.

Finally, let us add that Aristotle and Nicolaus affirmed that plants do not breathe and are not characterized by the alternation of wakefulness and sleep, because the latter is a diminution of sensation. On these faculties, Cesalpino told us nothing.

6. Conclusion

Aristotle's characterization of plants and their faculties, albeit scanty, remained a pervasive framework for ancient and early modern botany. His theory of the soul structured the ways in which research about plants might be conducted. He kept his remarks about plants consistent with *De anima*: plants feed and reproduce through one faculty, common with animals, but they can't feel, desire or move, as they essentially lack the required internal diversity.

Theophrastus, Nicolaus and Cesalpino all took Aristotle's *De Anima* as a starting point and an undisputable authority. Yet it did not prevent either of them to somehow innovate, for the Stagirite left many a question unanswered. This is especially appreciable concerning plants' reproduction as well as their ability to desire and obtain food. Nicolaus introduced several theses that go beyond the scope of Aristotle's treatises. These were sometimes at odds with Aristotelian orthodoxy, notably in the case of plants' elemental composition. The many headed tradition of *De plantis* treatise, whether we call it Pseudo-Aristotle or Nicolaus, was in any case ready to depart from (or at least qualify) Aristotle's theoretical model in order to account for otherwise unexplained phenomena, be it at the cost of some confusion within the Aristotelian frame of research. In *De plantis*, plants seem to have reproducing and sensitive capacities that are not allowed by a faithful reading of *De anima*. The metaphysical and psychological theses are even altered in order to stay somehow consistent with the observed phenomena, be it at the cost of broader philosophical systematicity. It might be a deliberate effort of innovation as well as the mere effect of mistranslation or clumsy interpolation from Aristotle's original text, or anything in between.

Cesalpino certainly tackled important problems unsettled by Aristotle himself, like the modalities of plants' generation or the possibility for them to have a kind of sexuality or sensation. On this latter point, he might have integrated suggestions from Nicolaus or Theophrastus. But Cesalpino was more cautious and conservative than them. He kept claiming faithfulness to Aristotle's thought and indeed took care of staying consistent with its main lines, principally using concepts and arguments similar to what can be found in his treatises. Reforming the main tenets of *De anima* (or for that matter of any of Aristotle's theoretical treatises) is out of question. Plants can only have one power, although with two functions, they do not have sensitive soul as animals do. Still, there are empirical facts that hardly fit this framework. What made Cesalpino innovative was the

attentiveness of his observations, which enabled him to integrate new distinctions and data from within the (slightly augmented) Aristotelian psychological and biological framework, without sacrificing too much of its coherence. One important goal of *De plantis libri XVI* was to accommodate the Aristotelian metaphysical framework to new, finer observation about plants' ability to move and reproduce. At least concerning the faculties of the soul, Cesalpino answered questions left too little studied by Aristotle rather than enforcing his own.