


## From Seed to Seed

### *Material Activities and Vegetable Life in Grew's Philosophy of Botany*

▼ **SPECIAL ISSUE ARTICLE** in *Nehemiah Grew and the Making of The Anatomy of Plants (1682)*, ed. by Christoffer Basse Eriksen & Pamela Mackenzie

▼ **ABSTRACT** In 1682, Nehemiah Grew included *An Idea of a Philosophical History of Plants* as the first text in his *Anatomy of Plants*. The former consists of a broad programme to study vegetation from a material standpoint. In addition to the mechanical and chymical investigation of plants, generally supported by microscopic observations—a core methodology of the Royal Society—in the text Grew engaged with some more philosophical and theoretical issues. Still, despite Grew's creditable attempt to produce a coherent and comprehensive science of plants, the absence of a definition of vegetable life has an impact on his ability to understand plants in their own right. For instance, a few questions that emerged as Grew addressed zoophytes and other bodies blurred the line between vegetables and animals. Only in the *Cosmologia sacra* (1701) did Grew propound a definition of vegetable life with a more complete schema. Is the philosophy of plants a bridge between Grew's works? In this article, I contextualize his philosophical approach, explore the features of his text, and advance the possibility of answering this question positively, although the significant distance between Grew's experimental study of plants in the *Anatomy* and the physico-theology of the *Cosmologia* makes a connection between the two texts difficult. In the end, this unbridgeable gulf broadly shaped early modern botanical studies.

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In 1682, Nehemiah Grew published his well-known *Anatomy of Plants*, a compilation of a series of lectures delivered to the Royal Society in the 1670s. Historians have generally regarded it as pioneering work and, together with Marcello Malpighi's (1628–1694) *Anatome plantarum* (1675–1679), have interpreted it as evidence of a new approach to the science of botany.<sup>1</sup> Grew appeared as a central figure in 17th-century English botany, as testified by Henry Oldenburg's (ca. 1618–1677) June 1671 letter to Martin Lister, where he claimed that “there is now a young Student yt is publishing the Anatomy of Vegetables from the Seed to ye Seed, wch is commended to be a curious and ingenious piece.”<sup>2</sup> Alongside the experimental and microscopic observation of plants, undoubtedly a central facet of his work, Grew's philosophical approach to botany also helped him foster a science of plants. Indeed, the first of the texts collected in the *Anatomy of Plants* is entitled *An Idea of a Philosophical History of Plants* (henceforth, the *Idea*), and was originally published in 1673 under the title *An Idea of a Phytological History of Plants*.<sup>3</sup> While the texts in the *Anatomy of Plants* mostly consider the anatomy of various parts of plants, the *Idea* is a more programmatic text, in which Grew raised some philosophical points—for instance, he believed it was necessary to understand “our scope” in the study of plants and direct observations of them—and proposed a theoretical framework for botany (and other areas of this discipline), providing a foundation for later natural-philosophical attention to plants.<sup>4</sup>

In this article, I aim to reveal the philosophical framework Grew employed in his microscopic study of plants, which was structured as an investigation from seed to seed, that is, a material exploration of vegetation, and how it had an impact on his anatomical writings. First, I explore this philosophical underpinning in relation to Grew's context.<sup>5</sup> Second, I discuss the contents of Grew's *Idea*, highlighting the originality of his work but also the limitations of his philosophical enterprise. Indeed, Grew only suggested that a discussion of the principles of vegetable life would be

1 See Arber (1941a, pp. 630–632); Arber (1941b; 1942); LeFanu (1990); Roos (2007a); Cunningham (2010); Mackenzie (2022).

2 Oldenburg to Lister [Letter] (1671, Jun. 10), in Hall & Boas Hall (1970, Vol. 8, p. 89).

3 It should be noted that this was Grew's second publication on plants, as the first was *The Anatomy of Vegetables Begun* (1672). The major difference between the 1673 and 1682 versions lies in the title, but there is no clear statement about this change. However, as a few texts suggest, in early modern culture “phytology” was a synonym to “philosophy of plants”; in this sense, the change does not entail any significant difference, but merely strengthens the philosophical aspect.

4 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 6, p. 3). It should also be noted that, in 1672, Malpighi sent Henry Oldenburg a short text entitled *Anatomes plantarum idea*, dated November 1671, which was later published as the Preface to Malpighi's major work. It is therefore possible that Grew was replying to this text.

5 For an overview of botany in the pre-modern period, see Ogilvie (2006) for the Renaissance; Egmond (2017) for botanical experimentation from the 16th to the 17th century; and Baldassarri (2022) for experimentation and plant philosophy.

necessary, but neither pursued nor defined these principles in his 1682 text. Yet, there is a revealing gap in the *Anatomy*; as he writes in the Preface: “the *Description* of those [plants] which are *Imperfect* [such as] *Parasitical, Marine, and Sensitive Plants* ... these things I leave to some other Hand.”<sup>6</sup> The absence of such bodies presents a challenge to Grew's overall efforts and reveals the boundaries of his *Anatomy*. However, a collection of some of these imperfect plants, such as zoophytes and plantanimals, does appear in Grew's *Musaeum regalis societatis* (1681), which I analyse in Section 3.

In the fourth part, I delve into the definition of vegetable life in Grew's late physico-theological *Cosmologia sacra*, a rather different text from his earlier anatomico-empirical botany.<sup>7</sup> Physico-theology was a genre that aimed to reconcile the sciences with religious beliefs, and for Grew it took the form of a vitalistic understanding of nature. Historians and interpreters have discussed the divergence between the mechanistic *Anatomy of Plants* and Grew's later vitalistic approach.<sup>8</sup> Brian Garrett, for instance, has pointed to a severe opposition between Grew's vitalism and mechanism, but he has also claimed that a connection between teleology and vitalism was important for Grew as he argued against the mechanistic understanding of life.<sup>9</sup> Accordingly, Grew's two texts are unbridgeable. More recently, Raphaële Andrault has challenged Garrett's interpretation, especially his notion of vital empirical phenomena.<sup>10</sup> But she has also commented on the differences and divergences between Grew's works, especially comparing Grew's texts with those of his contemporaries, such as Cudworth and Ray. In this article, I try to show that Grew's later interpretation of plant life is not entirely detached from his early anatomical and mechanical studies of plants, but that a connection exists with his philosophical aims when dealing with the principles of vegetable life, as suggested in the *Idea*. Although it is simply a programmatic text, it offers some possibilities to bridge—at least in part, as several differences persist—the gap between his works.

## 1. Philosophies of Plants in the Early Modern Period

Although no clear definition of a philosophy of plants existed in the early modern period, one text stands out as significant and helpful in explicating one: Guillaume Du Val's (1572?–1646) *Phytologia, sive philosophia plantarum* (1647). While this work is rather complex, it is possible to recognize that Du Val's main aim was to elaborate a philosophy of plants as a theoretical framework concerning vegetable life, their functions (namely, nutrition, growth, and generation) and physiology, with the

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6 Grew (1682, Preface).

7 On physico-theology in England, see Harrison (2020, pp. 39–51). See also the entire volume for more contributions on this topic: Blair & von Greyerz (2020).

8 The opposition between mechanism and vitalism is an old one. However, the boundaries are much more blurred than is sometimes conceived. See Wolfe (2022); and Bertoloni Meli (2019) also shows some interconnections between opposing fields.

9 Garrett (2003).

10 Andrault (2014b; 2021).

ultimate goal of defining the principles animating plants. In Du Val's Aristotelian interpretation, this latter was the vegetative soul. Accordingly, a phytology or philosophy of plants should investigate the foundational principles of vegetable life, namely, the vegetative soul, with the intention of observing the functioning of plants, their differentiation, virtues, and so on, and demonstrating the connections between different aspects.

The question of the principle of vegetable life gained momentum in 17th-century studies of plants and life, and a significant debate surfaced in Britain particularly, for instance in the works of Kenelm Digby (1603–1665) and Nathaniel Highmore (1613–1683), but also in Ralph Cudworth (1617–1688) and John Ray (1627–1705), who ascribed a plastic nature to plants, that is, an immaterial principle of life.<sup>11</sup> As Sarah Hutton has discussed, British natural philosophy “was particularly rich in proposing alternatives to the vegetative soul” and various interpretations were developed: from Henry More's (1614–1687) Spirit of Nature or Hylarchic principle, to Robert Boyle's (1627–1691) active principle, Matthew Hale's (1609–1676) *vis activa*, and Francis Glisson's (1599–1677) *biusia*.<sup>12</sup> According to these authors, the life of plants depends on an incorporeal principle by virtue of which plants flourish and ripen, eventually producing fruits and parts with various virtues, flavours, and tastes.

However, plants were subjected to philosophical inquiry in at least two other ways in early modern Britain. Recently, Vera Keller has shed light on philosophical gardening as a prominent part of the emergence and changing nature of experimental philosophy.<sup>13</sup> This latter appears intertwined with the experimental-philosophical approach to vegetation, which Dana Jalobeanu and Oana Matei have recently identified as developing in British culture in the second half of 17th century, from the influence of Francis Bacon's experimentation.<sup>14</sup> Two questions thus arise: what position does the *Idea* take, and where can Grew's philosophical approach to botany be situated in this context?

In the *Idea*, Grew presents a philosophical programme for the study of plants. In this sense, it appears as a programmatic framework for the anatomical study of vegetation from “a Seed to put forth a Root and Trunk ... to the Seed again,” which accords with the other sections of the *Anatomy of Plants*.<sup>15</sup> The lists of anatomical observations and experiments to be performed appears consistent with the Royal Society's empirical methodology for acquiring knowledge. In this sense, the reference to a philosophy of plants in the *Idea* appears in line with the intertwining between gardening and plant studies and experimental philosophy, recently discussed by Jalobeanu and Matei, and possibly coherent with the experimental approach to vegetation at large. As a matter of fact, as Grew remarks in the *Preface* to the 1673 publication, he mostly focused on the material organization and functioning of plants,

11 Giglioni (2008); Andrault (2014a); Clericuzio (2022).

12 Hutton (2021, p. 292); Giglioni (1996); Duchesneau (1998); Bates (2001); Reid (2019); Schmal (2021).

13 Keller (2021).

14 Jalobeanu & Matei (2020).

15 *An Idea of a Philosophical History of Plants*, in Grew (1682 § 6, p. 3).

and “while [he] speaks of Natural Causes, and particularly of those of Vegetation, [he] intends only the Material ones, which ... [one] must allow to be so qualified as to be instrumental.”<sup>16</sup> Grew then admits that he has made no comment on the vegetative soul, that is, an immaterial principle animating plants, “not for that [he had] had no thoughts hereof; but because [he did] not find they do so well answer the Scope” of his work.<sup>17</sup> In this sense, his work does not contain speculation on non-observable principles, although this was common at the time.

Additionally, Grew significantly claims that he has separated himself from the works of philosophers such as René Descartes and Pierre Gassendi, who discussed the principles of vegetable life in their own philosophies. Indeed, Grew's philosophy of plants innovatively concentrated on the material functions of vegetal bodies, leaving aside more speculative matters; one should also keep in mind that the Royal Society did not vigorously promote any particular theoretical approach.<sup>18</sup> The passage of the Preface is important and significantly resurfaces in the *Idea*. It helps reveal what a “philosophy of plants” meant for Grew: certainly not a study of immaterial principles, which he considered mere speculation, but a material understanding of plant life as a coherent unity of different bodily parts and activities, investigated through observations and experiments.<sup>19</sup> Indeed, Grew recognized that a philosophy of plants could be very effective in connecting the anatomical study of plant structures with knowledge about the principles of plant activities and life.

Still, there is something more. On the one hand, Grew does begin the *Anatomy* with a philosophical programme, indicating that he considered addressing a few philosophical issues to be necessary in providing an underlying coherence to the anatomical study of plants. And this philosophy appears consistent with experimental philosophical investigation of the principles and activities of plants. On the other hand, Grew only hints at these philosophical underpinnings in the text, rather than addressing them explicitly; for instance, he does not provide a definition of the life of plants in this text, but only claims that it is an important feature.

As a result, a philosophy of plants is only present as an implicit background to his 1682 text, not as a fully fledged field. Several decades later, he discussed plant life from a physico-theological point of view in the *Cosmologia sacra*, although this text is quite different from the *Anatomy*. In the next section, I discuss the contents of the *Idea*,

16 Grew (1673, Preface). This does not seem very different from Hooke's mechanical and experimental philosophical project: see Hooke (1665, Introduction). Additionally, for instance, on Hooke's rejection of More's Hylarchic spirit, see Bennet (1980, pp. 41–43). See also Sacco (2020).

17 Grew (1673, Preface). For a later discussion of principles organizing life, see Sheehan & Wahrman (2015, esp. Ch. 4). I thank one of the reviewers for suggesting this text.

18 See Sprat (1667, pp. 61–76); Anker (2004, p. 196). On the philosophical exploration of vegetation and vegetality, see also Baldassarri & Blank (2021).

19 It should be noted that the editor of the 1685 French translation of Grew's *Anatomy* added a text entitled “The Soul of Plants,” by Nicolas Dedu in 1682; as well as a third text, a selection of curious observations performed by Grew and Boyle regarding various controversies. Although he did not explain his decision to include Dedu's text in this edition, it seems likely that the question of the vegetative soul played a major role in it. In any case, this edition should be object of further investigation. See *Anatomie des plantes, qui contient une Description exacte de leurs partie & leurs usages ... Par Mr. Nehemias Grew, et Lame des plantes, par Mr. Dedu* (1685, pp. 247–310). The original text is Dedu (1682).

while I leave the discussion on the differences between the 1682 text and the 1701 text to the last section of this article.

## 2. The *Idea of a Philosophical History of Plants: A(n Incomplete) Philosophical Programme*

Grew begins the *Idea of a Philosophical History of Plants* with the commonplace claim that the arrival of new species from the Indies has spurred advancements in “the knowledge of vegetables.”<sup>20</sup> Since the Renaissance, naturalists and botanists had gained access to newly arrived specimens from the East and West Indies (namely, South-East Asia and South America), resources unavailable to ancient scholars.<sup>21</sup> Grew examined this aspect from a historical perspective, as he explored the ways scholars had successfully analysed these new specimens. He thus divided the study of plants into four branches: (a) the study of “their Descriptions (of all parts above ground) their Places, and Seasons,” performed by scholars such as “Clusius, Columna, Bauhinus, Boccone, and others”; (b) the study of “their Order and Kindred,” performed by scholars such as Ray and Morrison; (c) the study of “their Alimental and Mechanick uses,” performed by scholars such as Evelyn and Beale; and (d) “we are also informed of the Nature and infallible Faculties of many of them.”<sup>22</sup> This list describes the main aspects that characterized the science of plants at that time, which concern plant morphology, classification, physiology, and virtues, but also helps to contextualize Grew's work in relation to his predecessors and contemporaries.<sup>23</sup>

However, while making this list, Grew acknowledged “what is left *Imperfect*, and what *Undone*.”<sup>24</sup> In several cases, he explains, the study of plants had been held back by uncertainty and imprecision, as scholars had indiscriminately attributed plants with the same powers, without providing any clear definitions: the work on descriptions needed to be perfected, the study of affinities and their figures was long-awaited, and there were considerable delays and confusion in identifying plants. Moreover, and of greater interest to Grew, “the Reason of Vegetation, and the Causes of all those infinite Varieties therein observable ... almost all Men have seemed to be unconcerned.”<sup>25</sup> According to Grew, this aspect has attracted little attention from scholars. In the *Idea*, Grew thus proposed a methodology to fill these lacunae and produce a more exhaustive science of plants. He developed a wide scientific programme, based primarily on the claim that the naturalist ought to be guided by nature herself and act as an equal partner with the economy of nature, that is, to use

20 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 1, p. 1). This has been a traditional point of departure for texts on plants since the Renaissance; one of the most famous cases is Cesalpino's *De plantis libri XVI* (1583).

21 See Olmi (1992).

22 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 1, p. 1).

23 This was the project of a philosophical study of plants by Cesalpino, for instance.

24 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 2, p. 2).

25 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 2, p. 2).

“the Method of Nature her self.”<sup>26</sup> Accordingly, Grew's investigation follows the cycle of life of plants, “from the *Seed sown*, to the formation of the *Root, Trunk, Branch, Leaf, Flower, Fruit*, and last of all, of the *Seed* also to be *sown again*.”<sup>27</sup>

Grew highlights three main goals for the science of plants. The first is to explain the growth of plants by means of nutrition and augmentation, and, for example, how the aliment is prepared and assimilated. The second is to investigate the diverse motions perceivable in the parts of plants, for example, as their nutrition changes according to the seasons. The third is connected to the generation and preservation of species. These are three main aspects of vegetation: nutrition (and the formation of plants from the seed), the movement of fluids within plants, and generation (the production of flowers and seeds). The core of his inquiry concerns the movement of fluids within plants, a subject in line with his studies at Leiden University, where he graduated with a doctoral dissertation on the fluid in nerves.<sup>28</sup> Grew likely combined the anatomical and chymical investigation he performed in the Dutch universities with his work on plants.<sup>29</sup>

This list importantly uncovers a first element of Grew's philosophy of plants, which at this stage corresponded to an epistemology for empirical practice, aimed at understanding vegetation. First, it reveals a vast programme, dealing with the anatomy, morphology, and physiology of plants. Second, it demonstrates a precise methodology. As Peder Anker has shown, “this arrangement . . . mirrors nature's own organic order and also forms the chapter in *Anatomy of Plants*,” confirming Grew's intention to follow nature.<sup>30</sup> Through observation, one can understand the varieties, differences, and qualities of plants.

Grew contented himself with investigating the variety and movements of the fluids that create plant diversification and with answering the question of where plant diversity comes from.<sup>31</sup> This is a central issue in and the main goal of any wide-ranging study of plants, and in § 7 of the *Idea* Grew lists a number of aspects of botany one should investigate, such as the faculties, the qualities, the materials, the essences, and the powers of plants. In order to do so, one should observe nature and perform anatomical dissections on vegetal bodies. Grew discusses methods of acquiring knowledge in § 8, where he claims that “an accurate and multifarious Observation of *Plants*” is important.<sup>32</sup> Observation has two goals: the first is to arrange plants according to their degrees of affinity, such that “all *Exoticks, Plants* or *Parts of Plants*, may probably be reduced to some such *Domesticks*, unto which they may bear some

26 Grew (1672, Ch. 1, p. 1).

27 Grew (1672, Ch. 1.1, p. 1).

28 Grew (1671). On this topic, see Roos (2023, pp. 323–347).

29 Grew likely worked on the fluids of plants during the 1660s, and it is likely he connected them to his studies on the nerves in Leiden. See Grew (1672, 1.2, § 23, p. 15): “as in an *Animal Body* . . . the *Nervous Spirit* is also thereunto assistant; so is it here: the *Sap* prepared in the *Cortical Body*, is as the *Bloud*, and that part thereof prepared by the *Lignous*, is as the *Nervous Spirit*.”

30 Anker (2004, p. 202).

31 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 7, p. 4): “what those *Materials* are, which are necessary to the *Being* of these *Qualities*.”

32 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 8, p. 4).

resemblances.” In this sense, the first aim of observation is to compare specimens, not only by comparing “what is already known of both [that is, plants or parts of plants]; but also, by what may be observed in the *one*, to suggest and facilitate the finding out of what may yet be unobserved in the *other*.”<sup>33</sup> This is an important facet of Grew’s thought, as he aimed to extend the knowledge of the observable into the unobservable, acknowledging the predictive capacity of his methodology. The second goal is to know the qualities and functioning of plants. Through observation, one may learn methods of cultivation, the mechanical uses of plants such as the means of propagation, the nutritive and medicinal uses of plants, and so on. This demonstrates the connection between cultivation and a more theoretical approach to plants.

Grew then distinguishes five fields of investigation, indicating a second element of his philosophy. In § 10, Grew claims that geometry—the first field—plays a role in the study of the diversity of plants, suggesting that one should reduce plants’ external features to geometrical figuration: forms, positions, lines, and proportions. This point concurs with Grew’s broader claim that nature has essentially a geometrical order—with either a Cartesian or neo-Epicurean inclination—and, of course, with the ideas of Hooke, who in his *Micrographia* suggests that nature constructs vegetables following geometrical figures.<sup>34</sup> Accordingly, he postulated an identity in the essential constituents of plant surfaces, which could be reduced to a mathematical pattern and provide the key to the regular structure of plants. If it revealed the existence of underlying natural principles, this mathematical systematization would allow for theoretical understanding. In § 16, Grew advocates that one should “joyn [the Materials] all together,” as a science of botany should not merely be “the Knowledge of *many things*, but a multifarious Copulation of them in the Mind, that becomes prolifick of further knowledge.”<sup>35</sup> Here, Grew claims that the mind should encompass all the diverse features of plants and the results of numerous observations in order to make the complexity of plants knowable. The reference to the mind is complex, but it seems connected to the attempt to reduce plants to mathematical patterns. Although he never uses the term “induction” in the text, it seems to have been the method of logical reasoning he employed, and it was well known in the Baconian Royal Society. Grew further develops this point at a later point in the *Idea*, although intermittently.

The second field is anatomy, that is, the study of the organic and containing parts of plants. These may be investigated through dissection, microscopy, and inspection with the naked eye of their number, size, shape, and position, namely their proportions. The results of this investigation comprise the drawing section of the *Anatomy of Plants*, which were the products of observation (using instruments) and not of the imagination.<sup>36</sup> Yet, Grew adds that the microscope is not always useful, and comments that “it is certain, That some things, may be demonstrated by Reason

33 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 8, p. 4).

34 Roos (2015, pp. 562–588); compare Anker (2004, p. 196). Hooke (1665, p. 154); on Hooke, see Wragge-Morley (2020); Sacco (2020).

35 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 16, p. 8).

36 On the insistence on observation and the uses of microscope, see *An Idea of a Philosophical History of Plants*, in Grew (1682, § 17–§ 18, pp. 8–9). On imagination, see *An Idea of a Philosophical History of Plants*, in Grew



and the Eye conjunct, without a Glass, which cannot be discovered by it; or else the discovery is so dark, as which, alone, may not be safely depended on.”<sup>37</sup>

This highlights a deep philosophical issue with respect to knowledge.<sup>38</sup> While microscopic observation is important, Grew set limits on its usefulness because “it ratifies what [one] has already discovered by ocular means,” in the words of Al Coppola.<sup>39</sup> Thus, according to Grew, the acquisition of knowledge should not only consist of microscopic observation, but of observation in close combination with reasoning. As already seen, the mind plays a role in the study of botany, as reason is required for botanical hypotheses and classification. In the subsequent paragraph, Grew claims that his programme operates

as in *Metaphysical*, or other Contemplative Matters, when we have a distinct knowledge of the *Communities* and *Differences* of Things, we may then be able to give their true *Definitions*: so we may possibly, here attain, to do likewise: Not only to know that every *Plant* Inwardly differs from another, but also wherein.

Knowing the anatomical differences between plants, one may infer “a *Series* of more facile and probable *Conclusions*, of the ways of their *Causality*.”<sup>40</sup> Thus, according to Grew, a science of botany would gain from a more speculative approach to plants as it would provide an explanation of the causes behind certain effects. There is a special cognitive value to the combination of observations and experiments in scientific reasoning, which allows for an exploration of material causes.

The third and fourth fields concern the physiology of plants and centre on the question of how plants live and acquire diverse qualities (colours, odours, tastes, and virtues). Grew proposes a series of 15 chemical experiments to investigate the material causes of plant life. His argument that the life of plants changes according to the season and to the external condition of the soil, weather, and environment, led to the inclusion of husbandry within his theoretical construction of botany as a discipline.<sup>41</sup>

The fourth field concentrates more on the causes of plant life: the “*Principles*; or the *Bodies*, immediately concurrent and essential to their Being.”<sup>42</sup> Aiming to discover these causes through experimentation, Grew isolated several principles. In § 48, he claims, first, that there is a principle that keeps the parts of plants together: “the predominant *Principle* of the *Parenchymous Parts* of a *Plant*, that it is an *Acid*, seems evident.”<sup>43</sup> Second, that “the *Salts* of most *Kinds* of *Plants*,” which one could extract by means of chymical experimentation, and which possess “either their *Figure*, or

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(1682, § 63, p. 23): “where ever Men will go beyond Phansie and Imagination ... they must Labour, Hope and Persevere.”

37 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 18, p. 9).

38 Anker (2004, p. 199) suggests an apt comparison with Descartes on this point.

39 Coppola (2013, p. 268). On the role of microscopy, see Eriksen (2022). On the paradoxes of empirical knowledge, see Wragge-Morley (2020, esp. Introduction).

40 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 20, p. 10).

41 On husbandry in 17th-century England, see Matei (2015).

42 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 48, p. 18).

43 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 48, p. 18).

other *Qualities*, proper to themselves [that is, to plants], whereby they are all distinguished one from another.”<sup>44</sup> It seems that he distinguished between the principle of the organic parts of plants, although it is not clear what this means, and the salt resulting from several experiments, whose shape and structure help clarify the nature of that part and differentiate it from another.<sup>45</sup>

More generally, Grew divides the “*Organical Parts of Plants* [into] *two* .... The *Pithy Part*, and the *Lignous Part*,” and then describes the experiments one may perform on each in order to analyse their essential parts.<sup>46</sup> At this stage, Grew suggests that only by investigating these parts through chymical tests would it be possible to see “what *Principles and Proportion of Principles*, concur to *specifie* their *Substantial Forms*.”<sup>47</sup> Yet, more than just agreeing to the scholastic interpretation of living nature, as the terminology's substantial form would suggest—although it was later rejected as unintelligible in the *Anatomy*—in the *Idea* Grew discusses the physiology of plants, describing the diverse constitution of their organic parts from a chymical perspective, and concluding that the substantial nature of bodies thus consists of the composition of parts. In § 52, Grew makes two remarks concerning the principles of these organic parts, which are chymical. First,

although the chief portion, as to quantity, in both these *Bodys*, (as in most *Plants*) is an Acid Liquor; yet the latter, yields also some of an Alkaly, which the other doth not. So that they are the *Lignous Parts* of a *Plant*, generally, which yield the *Alkalick Salt*, or at least in the greatest Proportion.<sup>48</sup>

This seems to shed some light on § 48, as Grew repeats that the acid liquor is a principle in the organic parts of plants, which generally stands within the pith (what he calls the pithy part), while the ligneous part presents a more alkaline salt structure. However, he then claims that the second principle, “the *Sulphureous or Oleous principle*, is also much more predominant in the *Lignous Part*, than in the *Pithy*.”<sup>49</sup> This section therefore remains somewhat obscure, showing the difficulties in relating the activities of plants to their chymical structure.

In § 53, Grew delves deeper, extending his investigation to “a fuller and clearer view, of the *Modes of Vegetation*, of the *Sensible Natures of Vegetables*, and of their more Recluse *Faculties and Powers*.”<sup>50</sup> A crucial aspect of Grew's study of botany thus seems to investigate the material causes or principles of the organic parts producing these modes and containing the faculties or powers of plants. Even in this case, Grew's

44 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 48, p. 19).

45 See Roos (2007b).

46 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 49, p. 19).

47 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 49, p. 19). For Grew's refusal of substantial forms, see Grew (1682, p. 224)—this is the *Discourse Concerning the Nature, Causes, and Power of Mixtures*, Ch. 2, § 10: “A *Substantial Form* of a *Body*, being an unintelligible thing.” But it should be noted that this reference is important, as Grew speaks elsewhere of the substantial nature of plants or the substantial body of plants as their woody or pulpy parts, or the parenchymous part of plants. See Grew (1682, p. 47).

48 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 52, p. 20).

49 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 52, p. 20).

50 *An Idea of a Philosophical History of Plants*, in Grew (1682, § 53, p. 20).

methodology moves from an investigation of the shapes and properties of plants to inferences of knowledge about such principles, that is, from studying the anatomy and physiology of plants (the mechanical structure and chymical functioning) to defining the principles that make plants active and living.

The fifth and final field of investigation concentrates on the matters that “contribute so universally to *Vegetation*, and to whatsoever is contained in a *Vegetable*,” namely earth, water, air, and sun.<sup>51</sup> Grew proposed certain chymical experiments to examine how these elements are consituted.

Before reaching the conclusions, however, Grew hints at another line of inquiry in another short paragraph. A question, indeed, surfaces for Grew: “In what manner are these *Principles* so adapted, as to become capable of being assembled together, in such a *Number, Conjugation, Proportion, and Union*, as to make a *Vegetable Body*?”<sup>52</sup> This is a relevant point, as Grew was looking for a way to keep the knowledge of many experiments together and draw a unitary knowledge from them, as discussed in the previous sections. Combining diverse, separate observations into a single investigation of the nature of plants can likely be made possible by a positive concept of plant life, although Grew did not expand on this notion in the individual lectures or the *Anatomy of Plants*. Still, having raised this issue in the *Idea*, it is possible that a philosophical conception of plant life already underlay his work in the 1670s. In this sense, Grew indicated an ultimate issue of uniting the study of all parts and principles of plants in order to comprehend the vegetable body. Earlier, in § 55, he used the example of a clock, arguing that a description of each detached part cannot explain how it functions, but only the combination of all of them:

they [that is, the principles and powers of a plant] are such, as by being combined together, in such a peculiar way, may become *so*. So the several parts of a *Clock*, although they are and must be all *prae-existent* to it, and it is their *Form*, by which they are what they are; yet, is it the *setting together* of such *Parts*, and in such a way only, that makes them a *Clock*.<sup>53</sup>

This explanation is consistent with Grew's mechanical framework and with his attempt to study plants as a whole, dealing with the relation and unity between all parts, emphasizing the composition itself.<sup>54</sup>

In § 62, Grew seemingly aims to move beyond the mechanical analogy. Whereas he had previously claimed the importance of uniting observations into a fuller understanding of the causes of plants, here he continues: “we must also know, What are the *Principles* of these *Principles*. Which, although they lie in so great an abyss of obscurity; yet, I think, I have some reason to believe, that they are not altogether undiscoverable.”<sup>55</sup> While unveiling a programme for studying plants that consists of

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<sup>51</sup> *An Idea of a Philosophical History of Plants*, in Grew (1682, § 57, p. 21).

<sup>52</sup> *An Idea of a Philosophical History of Plants*, in Grew (1682, § 62, p. 23).

<sup>53</sup> *An Idea of a Philosophical History of Plants*, in Grew (1682, § 55, p. 22).

<sup>54</sup> A reflection of this attention to the knowledge of plants as a whole also surfaces in Grew's figuration of plants and in his contrast to Malpighi. See Bertoloni Meli (2011, p. 263).

<sup>55</sup> *An Idea of a Philosophical History of Plants*, in Grew (1682, § 62, p. 23).

several anatomies and diverse fields, Grew's philosophical approach to plants also includes the effort to unite all individual fields (morphology, anatomy, physiology), which comprise the study of plants as an organic body, with an understanding of the principle of all these principles—the principle of vegetable life, an immaterial principle that produces all effects. However, Grew did not elaborate on this point.

As a result, the *Idea* sets out a significant philosophical design, as well as an effective path to provide botany with a theoretical foundation, which could be put into practice by following nature and observing plants. Grew's philosophy would: (1) provide a methodology for experimentation; (2) recommend a speculative combination of chymical experiments and microscopic observations aimed at understanding the material causes of plant life; and (3) explicate the need to explore the immaterial or metaphysical principles of life that were required to account for plant life.

### 3. Offside: Vegetable *Passive* Life and Zoophytes

In the *Idea*, Grew propounds that organization is important to foster the knowledge of plants as a whole, that is, to proceed beyond the knowledge of the singular anatomies of plants and deal with the material principle of all the parts combined. This would lead to an understanding of the *principles of principles*, as Grew claims, or to the ability deal with the life of plants. However, his experimental studies on plants do not include any investigation of the criteria for life or the notion of vegetal life, as Raphaële Andraut clarifies.<sup>56</sup> In the *Idea*, there is only one reference to vegetal life: at § 6, when Grew states that “in this kind and harmonious *Oeconomy*, one *Part*, may be officious to another, for the preservation of the health and life of the *whole*.”<sup>57</sup> This passage connects vegetable life with Grew's struggle for understanding the principles of principles of plants, but he did not develop this point at this stage. At the same time, in the *Anatomy of Plants* he suggests that plants are like hydraulic machines, whose behaviour can be accounted for in mechanical terms, and which can be studied through chymical experiments. As a consequence, all bodies appear identical.

This identity entails an important theoretical consequence in Grew's work, revealing difficulties in differentiating between bodies. In the *Anatomy*, Grew eschewed the challenges represented by bodies that blurred the line between the realms of nature, such as corals and sponges.<sup>58</sup> As Andraut has noted, strange and rare bodies whose behaviour could not merely be reduced to the organization of parts and the mechanical explanation of plants, thus fell outside the scope of the *Anatomy of Plants*. Yet, a year before the publication of the *Anatomy*, Grew presented many such cases in a text published on behalf of the Royal Society, describing their collection of natural wonders and oddities. This text is the *Musaeum Regalis Societatis, or A Catalogue*

<sup>56</sup> Andraut (2021, p. 369).

<sup>57</sup> *An Idea of a Philosophical History of Plants*, in Grew (1682, § 6, p. 3).

<sup>58</sup> Scholars interpreted coral as an interconnection between rocks and vegetables, or petrified plants. See, for instance, Lister (1673); Ellis (1765); Brasier (2015).

and a Description of Natural and Artificial Rarities Belonging to the Royal Society, and Preserved at Gresham College (1681).<sup>59</sup>

While he does describe what was collected in the museum, Grew does not present it as collection of curiosities per se. Despite Anker's claim that this text conforms with contemporary descriptions of collections of curiosities, such as the *Miscellanea curiosa, sive Ephemeridum medico-physicarum Germanicarum academiae naturae curiosorum*, a German scientific journal in which a Latin translation of the *Anatomy* was published in 1678, Grew's *Musaeum* includes several novel features and differs from other catalogues in many respects.<sup>60</sup> In the Preface, Grew distances his work from traditional histories of nature, which imposed an order on nature or claimed to identify objects by naming them, and so on. For example, Grew raises the example of Ulisse Aldrovandi's *Quadrupedum omnium bisulcorum historia* (1621), in which the author argued that horses are close to humans in the scale of nature, but considered any scale of beings to be "a matter of high speculation."<sup>61</sup> For this reason, Grew denies his work is "an (sic) Universal History of Nature," but rather a description of particular cases:

not only Things strange and rare, but [also] the most known and common amongst us .... Not merely, for that what is common in one Countrey, is rare in another: but because, likewise, it would yield a great abundance of matter for any Man's Reason to work upon.<sup>62</sup>

Grew thus compares strange and rare bodies, such as exotic or monstrous ones, with common and local things, for both are equivalent subjects in the investigation of nature through reasoning. Within this system of reason, he thus refuses to deal with "Mystick, Mythologick, or Hieroglyphick matters," and claims that "Unicorns Horns ... would be plentiful as Elephants Teeth," because he believed it more proper "To Remarque some of the Uses and Reasons of Things." In reducing the strangeness, exoticism, and rarity of nature to the order of reason, Grew conceived this catalogue as a way to rectify mistakes and present nature within a clearer systematization. This presents, of course, an extremely valuable assessment of the role of collections and erudition in late 17th-century science.

While this appeal to reason to restrict and order the variety of nature is in line with the philosophy of the *Idea*, especially insofar as Grew convincingly claims that the descriptions would have a special cognitive value for the mind of the reader, in the *Musaeum* Grew also examined some very unusual specimens. The section on plants covers pages 179–252 of the text. On page 234, Grew discusses the sensitive plant "*s. Herbae mimosae*," whose seed

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<sup>59</sup> See Wragge-Morley (2010); Thorley (2018).

<sup>60</sup> Anker (2004, p. 199). A Latin translation of Grew's *Anatomy* is entitled "Anatomiae Vegetabilium Primordia cum generali Theoria Vegetationis, illi superstructa," in *Miscellanea curiosa* (1678, pp. 287–379).

<sup>61</sup> Grew (1681, Preface).

<sup>62</sup> Grew (1681, Preface).

is of a dark brown, not much bigger than that of a Purple Stock, angular, and frequently of a *Rhomboidal* Figure.<sup>63</sup> It takes its Name (as is commonly known) from its Imitation of sense or Animal motion. For so soon as you touch the Leaves, they presently fall, till they lie upon the gourd. After a while, they rise again; but being touched, fall as before.<sup>64</sup>

Like other scholars before him, such as René Descartes, Grew includes the sensitive herb in the category of plants, describing the shape and structure of its seed and defining the phenomenon of sensation as a mere movement of leaves, rather than claiming that it reveals animal sensation or perception in the plant. This is an important point, as he does not compare this vegetal phenomenon to animal sensation, nor does he derive his interpretation of this phenomenon from animal physiology, as Hooke did, but conceives of it in itself.<sup>65</sup> Apparently, in considering plants as entities in themselves Grew seems to eschew the analogies between animals and plants that influenced much of early modern plant studies, and which are present in the *Anatomy* too.<sup>66</sup>

In other cases, Grew claims that bodies that resemble animals were actually animal bodies, such as kernel berries, whose “Pulp or Powder ... is a Cluster of small Animals: so the Husk it self is an Animal Body, as if were grafted on the Stock or Leaf, whereon it grows.”<sup>67</sup> Further evidence that “the said Husk is really an Animal Body [emerges] upon its being burnt. A property, which I find belonging to no Plant whatsoever, except to some *Sea-Plants*.” Grew placed the latter in the section on plants “in compliance with the Vulgar Opinion ..., yet ought it to be treated of amongst Animals.”<sup>68</sup> As Grew expounds in the *Idea*, smell is a way to understand the essential principles of plants and bodies in general, while burning (*ustion*) is a chymical procedure to grapple with the nature of plants and bodies, and thereby to differentiate between them.

Similarly, the “COCHINELE. *Coccus Radicum*,” known today as the Polish cochineal, which grows on the roots of plants, is

neither a Vegetable Excrescence, as some surmise; nor an *Insect*, as others: yet an Animal Body, as the *Kermes Berry*, by some *Insect* affixed to a Plant .... For being held, as the *Kermes Berry*, in the flame of a *Candle*; it usually huffs and swells, but always stinks, like Hair or Horn when they are burnt.<sup>69</sup>

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63 I want to highlight the geometrical reference, but the italics are already in the original.

64 Grew (1681, p. 234). On the sensitive plant, see Webster (1966); Giglioli (2018); Baldassarri (2020). However, Cartesian Dutch physician Henricus Regius conceived the sensitive plant as a zoophyte, and included it in a section at the end of his chapter on brutes in his *Philosophia naturalis* (1661).

65 Hooke (1665, pp. 119–120.)

66 This also might reduce Grew's rhetorical presentation of his project and the claim that a plant is an animal “in Quires, as an Animalia s a Plant, or rather several Plants bound up into one Volume” in Grew (1682, Preface). On this analogy, see Justin Begley (2023). See also Baldassarri (2023).

67 Grew (1681, p. 240).

68 Grew (1681, p. 240).

69 Grew (1681, p. 241).

While folkloric beliefs conceived these bodies to be plants, earlier in the 1670s, Lister had identified them as insects growing attached to plants, and Grew shared a similar view.<sup>70</sup>

In describing sponges, Grew claims that they “stink, more or less, upon burning, as the *Horny Sea-Shrubs*,” a property he suggested belonged to most sea plants.<sup>71</sup> Yet, Grew denied that sponges are zoophytes, and refused to endow them with sensation:

for a *Sponge* being a springy Body, and so extensible, and yielding a little to one that plucks at it; so soon as he lets his hold go, it will, from its elasticity, shrink up again. Which motion of restitution, some probably, have mistaken for the effect of a Cap-Sense.<sup>72</sup>

Indeed, a mechanical analysis of sponges, that is, an observation of their textures and structures, sheds light on the nature of their elasticity, the property Grew attributes to them to avoid including them among zoophytes or animals. It should be noted that, in *Sylva Sylvarum* (1626), Bacon proposes an experiment concerning “the growth of sponges” and describes them as “plant-like,” suggesting that they are similar to plants and not to animals, as sometimes it was claimed at the time.<sup>73</sup> Robert Hooke in *Micrographia* claims sponges were “*Zoephyts*, or Plant Animals [because] the texture of it, which the *Microscope* discovers, seems to confirm it; for it is of a form whereof I never observed any other Vegetable.”<sup>74</sup> Diverging from Hooke, Grew affirms that, although

no *Sponge* hath any Ligneous Fibers, but is wholly compressed of those which make the Pith and all the pithy parts of a Plant. Yet, vastly thicker, and their Texture much more rare or open, so as to be visible to a good eye, especially assisted with an ordinary Glass. So that a *Sponge*, instead of being a *Zoophyton*, is but the one half of a Plant.<sup>75</sup>

What results is clear: according to Grew, sponges are not zoophytes, because their morphology (structure and texture) resembles that of plants, as observed both with the naked eye and through a microscope. The structure of sponges accounts for their attributes, such as elasticity.

Despite challenging the divisions between the realms of nature and the limits of plant life, Grew reduces the peculiarity of these cases to a mechanical systematization, a chymical experiment, and a microscopic observation of bodies. At this stage, the

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70 See “An Account of Four Books” (1671, esp. pp. 2165–2166); Lister (1671a, esp. pp. 2170–2171); Lister (1671b; 1672). See also Blout (1693, pp. 78–79), for a verbatim quotation of Grew.

71 Grew (1681, pp. 251–252).

72 Grew (1681, p. 252). The intended meaning of cap-sense is unclear. It is likely that Grew meant some sort of sensation or response to sensation where there are no nerves. Today, cap-sense refers to a certain smartphone technology.

73 *Sylva Sylvarum* (1626, § 702), in Bacon (1857–1874, Vol. 2, p. 563).

74 Hooke (1665, p. 135; also Scheme IX, fig. 3 at pp. 92–93). One should also note that Hooke refers to the sponges collected in museums of physicians in London.

75 Grew (1681, p. 252). The idea of sponges as zoophytes persisted into the 18th century—see Ellis (1765)—until they were ruled out as animals.

methodology of the *Idea* helps in approaching these particular bodies. Additionally, he rejects the category of zoophytes: rather than bodies that resemble both animals and plants, Grew views them simply as animals attached to plants, or as plants displaying phenomena understandable through mechanical properties, but which do not reveal any animalism in plants. The result is important, although some questions remain.

So far, Grew's analysis mostly frames plant life as a passive thing, as Andrault points out: it is determined by the absence of features that animals possess. This understanding was already present in the British context in the work of scholars such as Digby and Glisson. If I have situated Grew at a distance from their philosophical explorations, it should nonetheless be noted that, in the Preface to the *Anatomy of Plants*, he importantly acknowledges the role of Glisson's *Anatomia hepatis* (1654) in the development of his own research on plants.<sup>76</sup>

Still, even while investigating particular plants, Grew does not propose a definition of life, although he clearly chose not to explain them in terms of animal life. This point is significant: he seems to have endowed plants with an autonomous condition, yet he did not investigate this point further, and restricted his investigation to their mechanical or chymical properties. In sum, he merely dealt with bodies by means of mechanical or chymical analysis, although explaining these cases demonstrates the necessity of a broad underlying framework that can be applied each individual case. However, there is a definite change in his later *Cosmologia sacra*.

#### 4. Grew's Vital Principle: The *Cosmologia sacra* and Vegetable Life

As Andrault explains, *Cosmologia sacra*, or *A Discourse of the Universe as It Is the Creature and Kingdom of God* (1701), Grew's apologetic book, "is partly in accordance with his earlier views regarding the boundaries and the functioning of the plant kingdom."<sup>77</sup> One manifestation of this appears in § 7 of Chapter 4 of Book 1, where Grew claims that in the *Anatomy of Plants* he had studied the "natural Structure or Organism of Bodies [which] are distinguished one from another, only by the different Position, Proportion, and other Relations and Properties, of those two sorts of Fibers," using "both the Geometry of Nature in the Structure of their Parts; and her Chymistry, in the Preparation of their Liquors."<sup>78</sup> As I have shown above, the notions of plants as an organic unity and of a geometry of nature are crucial aspects of Grew's *Idea*. Then, in *Cosmologia*, Grew adds a more significant section on life, which was absent from his previous work. Let us now analyse this section.

Chapter 1 of Book 2 concerns life. Grew begins by differentiating between the "Vital Substance in Nature [and the] Body."<sup>79</sup> Having discussed the corporeal part

<sup>76</sup> On the passivity of plants, see Digby (1660); Glisson (1672). See also Grew (1682, Preface). One should note that plants' passive life had been discussed since antiquity.

<sup>77</sup> Andrault (2021, p. 371). Garrett (2003) has a very different view.

<sup>78</sup> Grew (1701, 1.4.7, p. 18).

<sup>79</sup> Grew (1701, 2.1.1, p. 31).



in the *Anatomy of Plants*, in this section he concentrates on the vital substance—an incorporeal substance that provides bodies with life. Later, in § 3, he states that “this Incorporeal Substance may have some sort of Existence, analogous to Corporeal Extension,” therefore substantiating the idea of unity. In this sense, Grew follows the mechanistic argument that “every Motion, is in some sort coextended with the Body moved.”<sup>80</sup> However, in § 8 he states that a “Body cannot be Vital ... is it either as Subtilized, or as Organized, or as moved, or as Endowed with Life, a proper and immediate Adjunct hereof, as well as Motion. But Body, can in none of these ways be Vital.”<sup>81</sup> Grew is clearly arguing that the vital substance is added to the body as an incorporeal power that fuels several activities in the body, and which is neither a “Subtile, Aerial, Etherial, or Ingenuous Fluid, contained in the Blood, Brain, or Nerves,” nor is it an organization of parts.<sup>82</sup> Grew rejects these as “Subtile Nonsense,” ultimately taking the position of a form of dualism.<sup>83</sup> In the *Cosmologia*, Grew also eschews the theoretical framework of Cartesian mechanical philosophy, but this does not imply that he rejects a mechanical explanation of plants physiology altogether. In contrast, his explanation of plant life seems grounded in the mechanical investigation of plants.

Nonetheless, only when studying motion and matter and the organization of the body did Grew develop a concept of life. For him, it “is necessary, that every Body should have its Organism, agreeable to the Species of Life, in the vital Principle .... So as hereby to be fitted to receive from, and transfer unto Life, all manner of proper Motions and Impressions.”<sup>84</sup> The organization of the body is therefore required for the presence of life, as it mediates between the vital substance and the corporeal substance.<sup>85</sup> The anatomical, mechanical, and chymical study of the body therefore appears to be a necessary point of departure, as it helps understand the organization of the body.

At this point, Grew considers a “Union of Soul and Body [which] is nothing else, but the Congruity between the Life and the Motion, which they either have, or are capable of.”<sup>86</sup> He then articulates his notion of dualism using a threefold partition of life: “Vegetable Life, Sense, and Thought.”<sup>87</sup> What results is an interesting division between bodies according to their capacity for life, which mirrors the traditional division between types of souls. Accordingly, the principle of life is a vital principle, a power “capable of Direction,” that regulates the generation of bodies. This power is “one and the same Vegetable Life, infused into all the parts of Corporeal nature; but

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80 Grew (1701, 2.1.3, p. 31).

81 Grew (1701, 2.1.8, p. 32).

82 Grew (1701, 2.1.9, p. 32). See also Garrett (2003, pp. 67–68).

83 Grew (1701, 2.1.11, p. 33).

84 Grew (1701, 2.1.22, p. 34). On Grew's vital materialism, see Begley (2017).

85 See Cheung (2006, p. 324).

86 Grew (1701, 2.1.23, p. 34).

87 Grew (1701, 2.1.23, p. 34).

more remarkably into Plants and Animals.”<sup>88</sup> Accordingly, the vegetable life is a vital power that exists in animals and plants, although it is infused into all nature.

While Grew claims to have described plant generation

step by step, as far as the Regularity of Principles will go . . . , a Vital or Directive Principle, seemeth of necessity to be assistant to the Corporeal. For as no Generation can be made, without Principles regularly figur'd: So, it seemeth, that no Principles, without being assisted to a determinate Motion, can be Regularly, that is, in due Order and Proportion, brought and united together.<sup>89</sup>

Undoubtedly, the vegetative soul is the principle of principles that Grew was looking for at the end of the *Idea*. The vegetative soul is the principle of those operations common to animals and plants, namely sleep and wake, nutrition and growth, and generation. In *Cosmologia*, Grew repeats a similar claim from the *Idea* that knowledge of this principle is necessary, making this notion relevant in both texts, despite their different goals. While in the *Idea* he did not investigate immaterial principles, this was the aim of the latter text.

In this sense, § 35 of *Cosmologia Sacra* contains a relevant passage. Grew writes:

There are Sundry Motions, both in Plants and Animals, depending upon this Vegetable Life. The Motion of Restitution, . . . the Peristaltick Motion of the Gutts: Wherein it is of the life Use, for the distribution of the Aliment. A Motion, whereof we have no perception, as depending on the Vegetable Life in an Animal. . . . And is imitated in a fainter degree, in those Plants which are commonly, tho' unaptly, called Sensitive. As then, Hairs and Feathers, are Plants growing upon an Animal; So these, are Vegetable Motions, in an Animal. And Therefore, though Vital, yet have nothing to do with Sense.<sup>90</sup>

He continues that motion in vegetable life is “independent on the Sensible.”<sup>91</sup> This means that, although there is a motion in plants, this motion does not depend on sensation or perception. Accordingly, Grew claims that life is not sensation, at least insofar as it concerns vegetable life—indeed, this is a commonality between animals and plants. This is an important point: if in the Aristotelian tradition life had generally been connected to sensation, and vegetal life had consequently represented a more problematic feature—scholars conceived vegetable life as more obscure, causing many of the problems in dealing with plants as a whole—Grew here is developing a different interpretation.<sup>92</sup> Indeed, he argues that vegetable life is detached from sensation, and could be defined in another way. Since some motions pertain to vegetable life, Grew could define those bodies that lie between plant and animal

<sup>88</sup> Grew (1701, 2.1.31, p. 35).

<sup>89</sup> Grew (1701, 2.1.31, pp. 35–36). Here Grew clearly refers to his anatomical study of plants.

<sup>90</sup> Grew (1701, 2.1.35, p. 36).

<sup>91</sup> Grew (1701, 2.1.36, p. 36).

<sup>92</sup> In pseudo-Aristotle's *De plantis*, the author claims that the life of plants is an obscure subject. Western tradition has debated this definition, with major consequences for the study of vegetal life. See, for instance, Giglioli (2020).

life, namely, “Plant-Animals, as the *Urtica Marina*.”<sup>93</sup> This allows him to differentiate between vegetable life and animal—or sensible—life. Accordingly, the “difference between Vegetable and Sensible Life, seemeth to be this; that in the former, the Impression arising from the Motion is entirely reflected, and lost in an Instant. In the latter, it is Immersed and retain'd.”<sup>94</sup> The motions of vegetable life are those the body is unconscious of, while animal motions are those activated by sensation and responding to it. However, earlier in the text, Grew states that life is not a principle of motion, entailing that living bodies do not create new motions, for

the Universal Stock of Motion, as that of Matter, being neither encreased, nor diminished, but only transfer'd. But [for life] I mean, a certain Power to determine the manner of its being transfer'd; or of returning an Impression upon Bodies, suitable unto that which it receives.<sup>95</sup>

In this sense, what differentiates between vegetable life and sensible motions is not just the source of motions, but the way they are transferred. According to Grew, vegetable life transfers motion immediately and loses it in the instant it develops, while animal life can produce motion and replicate it in a second moment. As a result, Grew accounted for vegetable life not in terms of an absence of motion as understood from animal life, but as an immediate transfer of these motions. In this sense, he did not produce a passive definition of plant life, but defined the latter as an activity, somehow consistently with his point in the *Musaeum*.

Aside from the important specification of vegetable life as a set of internal motions, this appears significantly in line with Grew's early studies of the movement of liquids in plants (and animal nerves), as well as with his investigation of the structure of plants. If, on the one hand, Grew's specification of vegetable life filled the gaps in his early work, on the other hand, his later definition of vegetable life seems coherent with his philosophical programme to define the principles of principles in the *Idea*.

## 5. Conclusion

In this article, I have dealt with Grew's *Idea of a Philosophical History of Plants*, in which a philosophical programme to study vegetation can be found. It consists of at least three features: first, an epistemology for the empirical study of plants, which is consistent with the claim that plant observations should mirror nature; second, a speculative investigation of plants, combining the separate fields into a theoretical framework, that is, in the mind, to discover the causes of plants—it should be noted that this issue concurs with Grew's geometrical investigation of plants; and third, the metaphysical study of the principle of all principles, that is, the principle of plant life. While the first two concern the empirical philosophical study of plants, a clear

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<sup>93</sup> Grew (1701, 2.2.1, p. 36).

<sup>94</sup> Grew (1701, 2.2.3, p. 37).

<sup>95</sup> Grew (1701, 2.1.26, p. 35).

framework of his anatomical and material study from seed to seed, the third refers to the investigation of the immaterial principle of vegetable life. Still, Grew suggested the importance of discussing plants not just as a combination of diverse functions but as an organic whole, following his clock analogy, whereas the investigation of the immaterial principle remains untreated in this text.

The tension that arises in Grew's work between his mechanical and anatomical investigation of the functions of plants, on the one hand, and the difficulties in defining a principle of life infused in plants, on the other, seems to be consistent with botanical studies of the time, which struggled to reconcile these two features of vegetal knowledge. As a result, Grew's philosophy mostly concentrates on the material activities of plants, leaving aside the question of life—something that perhaps was also due to the fact that the Royal Society's methods were not very interested in theoretical or philosophical investigations.

Grew's focus on mechanical and chemical vegetal activities resulted in an effective investigation of certain plants, such as the curiosities collected in the museum of the Royal Society, which Grew described in his 1681 text. Here, he outlines the mechanical phenomena of these plants. At this stage, these phenomena are mere reaction to external stimuli. This text is thus consistent with Grew's *Idea* (and with the *Anatomy of Plants* in general), but no definition of plant life helps to differentiate between plants and animals, or to define plant-animals in their own right.

Another approach can be found in the *Cosmologia sacra* (1701), a text with a very different aim from his 1682 *Anatomy of Plants*. In the *Cosmologia*, Grew followed a more philosophical path, and defined life as endowing bodies with an immaterial principle. He then defined vegetable life as a transfer of motion, in which motion is not retained but transferred immediately. As a result, plant life is not a passive entity, but an activity.

Despite the fact that his later definition of vegetal life seems to bear on the study of the movement of fluids in plants that comprised a significant part of Grew's *Anatomy*, the differences between the material investigation in the *Anatomy* and the theological description of plant life in the *Cosmologia* are what set these two texts apart. This ultimately makes clear a separation between the anatomical study of plants, and their concurrence in understanding the material causes of plant life, and a metaphysical definition of life. Nevertheless, the philosophical study of plants contained in the *Idea* suggests a key to an underlying consistency in Grew's work that connects these two aspects, namely, the material observation of vegetal bodies with the definition of the immaterial principle of vegetable life. Indeed, the definition of vegetable life is suggested as important in the *Idea* (though absent from the rest of the *Anatomy*) can also be found in the *Cosmologia Sacra*. Nonetheless, several differences persist between these two texts—paralleling the different approaches to plant studies in the early modern period.

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