



# The Architecture of the Science of Living Beings

*Aristotle and Theophrastus  
on Animals and Plants*

Andrea Falcon



## THE ARCHITECTURE OF THE SCIENCE OF LIVING BEINGS

Scholars have paid ample attention to Aristotle's works on animals. By contrast, they have paid little or no attention to Theophrastus's writings on plants. That is unfortunate because there was a shared research project in the early Peripatos that amounted to a systematic, and theoretically motivated, study of perishable living beings (animals and plants). This is the first sustained attempt to explore how Aristotle and Theophrastus envisioned this study, with attention focused primarily on its deep structure. That entails giving full consideration to a few transitional passages where Aristotle and Theophrastus offer their own description of what they are trying to do. What emerges is a novel, sophisticated, and largely idiosyncratic approach to the topic of life.

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ANDREA FALCON

*Concordia University and University of Milan*



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*To the memory of Carol Lee Price,  
a bright mind with a beautiful smile.*





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## *Acknowledgments*

My interest in the structure of the Peripatetic science of living beings dates back to my research on the scope and organization of Aristotle's science of nature. The main results of that research are published in *FALCON* 2005. My first introduction to Aristotle's study of animals was a memorable seminar jointly offered by David Charles, James G. Lennox, and Allan Gotthelf at the University of Oxford in Trinity Term 1994. The seminar, which was entitled "Philosophical Issues in Aristotle's Biology," left a lasting impression on me and a desire to know more about "Aristotle's biology." A visiting appointment in the Department of Classics at the University of Pittsburgh in the fall of 2008 marked a decisive turning point in the genesis of this book. That appointment gave me the opportunity to return to Aristotle's works on animals and reflect on their philosophical and historical significance. The fall of 2008 was also the beginning of a rewarding collaboration with Allan Gotthelf, who at the time was a multi-year visiting professor in the Department of History and Philosophy of Science at the University of Pittsburgh. My intellectual debts to him are most obvious in [Chapters 3](#) and [4](#). [Chapter 3](#) reuses results presented in *GOTTHELF-FALCON* 2017 and *FALCON* 2021a. The thesis I defend in this book is presented in a nutshell in *FALCON* 2015 and *FALCON* 2020. The first of these essays was extensively discussed with Allan Gotthelf. At a time when his health was deteriorating rapidly, Allan gave his expert feedback on the question that is at the very heart of this book, namely whether there is a unified study of living beings in addition to separate studies of animals and plants in the explanatory project that we call Aristotle's natural philosophy. I remember our exchange of ideas with great fondness and with the sadness that comes from the realization that there can be no more.

The final version of the book was written in the summer semester of 2023 when I was visiting the University of Tübingen as a full-time member of the TIDA ("Text and Idea of Aristotle's Science of Living Beings") research

team. In his capacity as principal investigator of TIDA, Klaus Corcilus organized a research workshop on the book manuscript on April 17–18, 2023. I would like to register here my heartfelt gratitude to him and to the commentators who kindly agreed to give me their expert feedback on the penultimate version of the book: Robert Roreitner ([Chapter 1](#)), Philip van der Eijk ([Chapter 2](#)), Lucas Angioni ([Chapter 3](#)), Jochen Althoff ([Chapter 4](#)), Maximilian Haars ([Chapter 5](#)), and Klaus Corcilus ([Chapter 6](#)).

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## *Conventions*

[. . .] Words in square brackets are added to improve the translation of the original Greek text.

## *Transliterations*

Here I transliterate a few terms and expressions that are important for the overall argument of this book.

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βίος (pl. βίοι)	<i>bios</i> (pl. <i>bioi</i> )	mode(s) of life
γένεσις (pl. γενέσεις)	<i>genesis</i> (pl. <i>geneseis</i> )	generation, modes of generation
δένδρον (pl. δένδρα)	<i>dendron</i> (pl. <i>dendra</i> )	tree(s), plant(s)
διαφορά (pl. διαφοραί)	<i>diaphora</i> (pl. <i>diaphorai</i> )	difference(s)
ἐν τύπῳ	<i>en tupōi</i>	in outline
ζῆν	<i>zên</i>	living, being alive
ζωή	<i>zoê</i>	life
ζῶον (pl. ζῶα)	<i>zōion</i> (pl. <i>zōia</i> )	living being(s), animal(s)
καθόλου	<i>katholou</i>	in general
κύημα	<i>kuêma</i>	first mixture (in generation)
μέγιστα γένη	<i>megista genê</i>	large kinds
σπέρμα (pl. σπέρματα)	<i>sperma</i> (pl. <i>spermata</i> )	seed(s)
τὸ διότι	<i>to dioti</i>	the reason why
τὸ ὅτι	<i>to hoti</i>	the fact that
φυτόν (pl. φυτά)	<i>phyton</i> (pl. <i>phyta</i> )	plant(s)
χωρὶς	<i>chōris</i>	separately

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## *Abbreviations*

All translations are mine (unless otherwise indicated). I tend to use English titles for all Greek and Latin works except when the corresponding Latin title enjoys greater currency (e.g., *De anima*, *Parva naturalia*). Below is a table, organized alphabetically, of the titles cited in the book. All abbreviations are based on the Latin titles.

### *Alexander of Aphrodisias*

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<i>DA</i>	<i>De anima</i>	<i>On the Soul</i>
<i>In Sens.</i>	<i>In librum De sensu commentarium</i>	<i>On Aristotle on Sense-perception and Sense- perceptibles</i>

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### *Aristotle*

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<i>APo</i>	<i>Analytica posteriora</i>	<i>Posterior Analytics</i>
<i>APr</i>	<i>Analytica priora</i>	<i>Prior Analytics</i>
<i>DA</i>	<i>De anima</i>	<i>On the Soul</i>
<i>DC</i>	<i>De caelo</i>	<i>On the Heavens</i>
<i>EE</i>	<i>Ethica eudemia</i>	<i>Eudemean Ethics</i>
<i>GA</i>	<i>De generatione animalium</i>	<i>Generation of Animals</i>
<i>GC</i>	<i>De generatione et corruptione</i>	<i>Generation and Corruption</i>
<i>HA</i>	<i>De historia animalium</i>	<i>History of Animals</i>
<i>IA</i>	<i>De incessu animalium</i>	<i>Progression of Animals</i>
<i>Juv.</i>	<i>De juventute et senectute</i>	<i>On Youth and Old Age</i>
<i>Long.</i>	<i>De longitudine et brevitate vitae</i>	<i>On Length and Shortness of Life</i>
<i>MA</i>	<i>De motu animalium</i>	<i>Motion of Animals</i>
<i>Mem.</i>	<i>De memoria</i>	<i>On Memory</i>
<i>Metaph.</i>	<i>Metaphysica</i>	<i>Metaphysics</i>
<i>Meteor.</i>	<i>Meteorologica</i>	<i>Meteorology</i>
<i>NE</i>	<i>Ethica nicomachea</i>	<i>Nicomachean Ethics</i>
<i>PA</i>	<i>De partibus animalium</i>	<i>Parts of Animals</i>

(cont.)

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<i>Phys.</i>	<i>Physica</i>	<i>Physics</i>
<i>Poet.</i>	<i>De arte poetica</i>	<i>Poetics</i>
<i>Protr.</i>	<i>Protrepticus</i>	<i>Exhortation to Philosophy</i>
<i>Resp.</i>	<i>De respiratione</i>	<i>On Respiration</i>
<i>Sens.</i>	<i>De sensu et sensato</i>	<i>On Sense-perception and Sense-perceptibles</i>
<i>Somn.</i>	<i>De somno et vigilia</i>	<i>On Sleep and Waking</i>
<i>Top.</i>	<i>Topica</i>	<i>Topics</i>

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## [Aristotle]

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<i>Col.</i>	<i>De coloribus</i>	<i>On Colors</i>
<i>Mir.</i>	<i>De mirabilibus auscultationibus</i>	<i>On Marvelous Things</i>

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## Athenaeus

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<i>Deipn.</i>	<i>Deipnosophistae</i>	<i>Sophists at Dinner</i>
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## Cicero

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<i>De fin.</i>	<i>De finibus bonorum et malorum</i>	<i>On Goals</i>
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## [Hippocrates]

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<i>De carn.</i>	<i>De carnibus</i>	<i>On Fleshes</i>
<i>De nat. puer.</i>	<i>De natura pueri</i>	<i>On the Nature of the Child</i>

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## Photius

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<i>Biblioth.</i>	<i>Bibliotheca</i>	<i>Library</i>
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## Plato

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<i>Leg.</i>	<i>Leges</i>	<i>Laws</i>
<i>Phd.</i>	<i>Phaedo</i>	<i>Phaedo</i>
<i>Phil.</i>	<i>Philebus</i>	<i>Philebus</i>
<i>Theaet.</i>	<i>Theaetetus</i>	<i>Theaetetus</i>
<i>Tim.</i>	<i>Timaeus</i>	<i>Timaeus</i>

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## [Plato]

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<i>Def.</i>	<i>Definitiones</i>	<i>Definitions</i>
<i>Epin.</i>	<i>Epinomis</i>	<i>Epinomis</i>

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*Theophrastus*


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<i>CP</i>	<i>De causis plantarum</i>	<i>Causes of Plants</i>
<i>HP</i>	<i>Historia plantarum</i>	<i>History of Plants</i>
<i>Metaph.</i>	<i>Metaphysica</i>	<i>Metaphysics</i>
<i>Odor.</i>	<i>De odoribus</i>	<i>On Odors</i>

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Other frequently cited titles are abbreviated as follows:

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CGL	<i>The Cambridge Greek Lexicon</i> , 2 vols. Edited by J. Diggle, B. Fraser, P. James, O. Simkin, A. Thompson, and S. Westripp. Cambridge: Cambridge University Press, 2021.
DK	<i>Die Fragmente der Vorsokratiker</i> , 3 vols. Zürich: Herausgegeben von H. Diels und W. Kranz, 1951 <sup>6</sup> .
<i>Dox. gr.</i>	<i>Doxographi graeci collegit recensuit prolegomenis indicibusque instruxit</i> , H. Diels. Berlin: Reimer, 1879.
FHS&G	<i>Theophrastus of Eresus: Sources for His Life, Writings, Thought, and Influence</i> , 2 vols. Edited by W. W. Fortenbaugh, P. M. Huby, R. W. Sharples, and D. Gutas. Leiden: Brill, 1993.
LSJ	<i>A Greek–English Lexicon</i> . Compiled by H. G. Liddell and R. Scott. Revised and augmented by H. S. Jones. With a revised supplement. Oxford: Clarendon Press, 1996.

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## *Introduction*

### **I Aristotle and Theophrastus on Animals and Plants**

Two separate corpora of writings have come down to us: one by Aristotle on animals and another by Theophrastus on plants. They are two parts of a single project. This project amounted to a systematic and theoretically motivated study of living beings as encountered here on earth. My ambition in this book is to reconstruct the main lines of this project.

The title *The Architecture of the Science of Living Beings* conveys the message that I am primarily concerned with the scope, organization, and deep structure of the Peripatetic study of animals and plants. Ancient authors are rarely self-reflective in their extant works. Aristotle and Theophrastus are no exception to the rule. When it comes to their intentions and plans, the best course of action is to focus on programmatic or transitional passages where they tell us what they are hoping to achieve. Most of the relevant passages are found at the beginning of their writings. There Aristotle and Theophrastus do not simply announce the subject (or subjects) they plan to treat; they also provide us with a first orientation and a rough idea of what lies ahead. I will engage in a close reading of a few of these passages and reflect on the implications they have for how we should understand what Aristotle and Theophrastus are doing (or trying to do). Here I recall the opening lines of Aristotle's *De anima*, the transitional statement at the beginning of the essay *De sensu*, where Aristotle introduces and motivates what he is doing in the essays collectively known as *Parva naturalia*, the outline of the research in natural philosophy offered at the start of his *Meteorology*, and the beginning of *History of Plants*, where Theophrastus negotiates the transition from the study of animals to the study of plants. My working assumption is that all these texts (and a few others) are not only authentic but also carefully written and contain crucial information on the deep structure of the Peripatetic science of living beings.

Since I make a great deal out of the above passages, one may legitimately wonder: what if they are not as carefully crafted as the author of this book claims they are? Is there always an intentional choice of words on the part of Aristotle and Theophrastus? And if so, how could we know? These are legitimate questions. Unfortunately, we do not have an independent way to answer them. We only have the above passages, so we have no choice but to take them as seriously as possible. The only way to vindicate my working assumption is by means of the outcomes it generates. If by taking seriously a programmatic or transitional passage I can make good sense of a large stretch of text, or I can cast new light on certain decisions taken by Aristotle and Theophrastus, then my working hypothesis is fully justified. I will assume that Aristotle and Theophrastus have full control over the way in which they create, organize, and present their arguments and, until the contrary is proven, everything in the passages discussed in this book is intentional and meaningful.<sup>1</sup> But this, I hasten to add, does not rule out other possible approaches to the same texts. Furthermore, no single text, however important, either on its own or in conjunction with others, can solve all the problems presented by works as difficult and complex as those written by Aristotle and Theophrastus. No single reading can do justice to the complexity of those works and all the interpretive challenges they pose.

The overall strategy I adopt in this book is in line with one recommended by Andrew Cunningham for a truly historical study of the intentional activity we call “science.”<sup>2</sup> Instead of uncritically applying today concepts to the study of the past, as if they were universally accepted and fully understood, we should try to find out what our predecessors were doing by taking seriously their own description (or descriptions) of their activity. This is the only way to reconstruct what that activity meant to them. Cunningham’s immediate critical targets were two: the very idea of science as a universal and transcultural knowledge-producing activity and what he perceived as our uncritical application of contemporary scientific concepts to the study of the past. To be as clear as possible: I am not advocating a purely historical approach to ancient science and ancient philosophy. I believe that ancient thinkers have something interesting to say to us today even if they do not necessarily share our philosophical agenda. But I also believe that we need to learn their lingo if we want to engage in a constructive dialogue with them. I do not mean to suggest that

<sup>1</sup> Helpful thoughts on this version of the principle of charity can be found in VAN DER EIJK 2017: 182–186.

<sup>2</sup> CUNNINGHAM 1988: 365–389.

we should all learn ancient Greek or Latin. Reading ancient texts in their original languages is surely important, but it does not guarantee by itself that we are not going to fall into the trap of historical anachronism. To avoid this trap, we need to take the conceptual tools developed by our predecessors seriously. Not only the presence but also the absence of a certain concept (or set of concepts) may have philosophical consequences. In due course I will return to the topic of historical anachronism, with a focus on our less than ideal (and mostly unreflective) use of the term “biology” in connection with the Peripatetic study of perishable living beings. There is no equivalent to this term in Aristotle and Theophrastus. I will argue that this absence tells us something important about their approach to the topic of life.

For the time being, however, I would like to concentrate on the most obvious feature of the Peripatetic study of living beings: *Aristotle and Theophrastus were engaged in the study of life via separate studies of animals and plants*. But this does not mean that they implemented a rigid division of labor – namely, that Aristotle wrote on animals and Theophrastus on plants.<sup>3</sup> Both philosophers appear to have been engaged in the study of both animals and plants. We are better informed about Theophrastus and his contribution to the study of animals (I refer the reader to [Appendix II](#)). The extant evidence that Aristotle wrote on plants is not as good. Leaving aside a few references to a study of plants in the Aristotelian corpus that are impersonal and mostly looking ahead to a study to come (I review them in [Appendix I](#)), we have a reference to a work on plants in two books listed in the three ancient catalogues of Aristotle’s writings. The catalogues attached to the life of Aristotle by Diogenes Laertius and to the so-called *Vita Hesychii* go back to a lost Hellenistic catalogue,<sup>4</sup> whereas the

<sup>3</sup> The tradition that reads into the two corpora of writings a division of labor between Aristotle (animals) and Theophrastus (plants) is old. It goes back at least to the first century BC. It is already found in Cicero:

Aristotle discussed the birth, mode of life, and form of all animals, and Theophrastus the nature of plants and the causes and principle of almost all things born from earth. From this knowledge the investigation of the most obscure is made clear. (*De fin.* V 10 = FHS&G 385)

The source of Cicero is Antiochus of Ascalon, who was a major player in the revival of interest in Aristotle and Theophrastus in the first century BC. On Antiochus and his interest in the Peripatetic philosophy of nature, see [TSOUNI 2019](#): 183–201. There is no compelling reason to think that this idea originated with Antiochus. Probably, Antiochus relied on an earlier (late Hellenistic) tradition. Unfortunately, we are in complete darkness as to his possible source (or sources) of information.

<sup>4</sup> The ultimate source of this catalogue is disputed. For Paul Moraux ([MORAUX 1951](#): 237–247), the catalogue goes back to the early Peripatos (Ariston of Ceos). Compare [DÜRING 1956](#): 11–27, who attributes the catalogue to Hermippus of Smyrna, active in Alexandria in the second half of the third century BC.

information preserved in the Arabic tradition derives from a post-Hellenistic source.<sup>5</sup> This work on plants by Aristotle may have circulated until at least the end of the second century AD.<sup>6</sup> The relationship between this now lost work and the extant work known as [Aristotle]’s *On Plants* (*De plantis*) remains, to say the least, elusive. The reader will find an introduction to the historical significance of the latter text in [Appendix III](#). In addition to the title of a lost work by Aristotle on plants, we have a few indirect testimonies transmitted by later authors. None of them amount to conclusive evidence.<sup>7</sup> Given how frustratingly scanty the extant information is, it is quite tempting to suggest that Aristotle did not write on plants but delegated this task to Theophrastus.<sup>8</sup> I refrain from endorsing this suggestion. Even though the extant evidence that Aristotle wrote on plants is not very good, there is no compelling reason to think that Aristotle programmatically limited himself to the study of animals to the exclusion of plants.

We can enlarge the scope of our investigation by considering the extant evidence for other members of the early Peripatos beyond Aristotle and Theophrastus. While Clearchus of Soli and Eudemus of Rhodes concerned

<sup>5</sup> This source is a lost catalogue by Ptolemy al-Gharib (“the unknown” or “the stranger”). The identity and date of this Ptolemy are disputed. The Greek original of this second catalogue is also lost. Its contents are transmitted by two indirect witnesses (Ibn al Qiftī and Ibn abī Usaibī’a) and two Arabic manuscripts. A critical edition of this important catalogue is now available in [RASHED 2021](#). From the newly translated prologue we learn that Ptolemy’s catalogue was written upon the request of an otherwise unknown Gallus, who had an interest in Aristotle but was not able (or willing) to engage in the study of the *pinakes* produced by Andronicus. As a result, Ptolemy produced his own catalogue, which he addressed to Gallus. While shorter, this catalogue need not be an abridgement of the work produced by Andronicus. Marwan Rashed has argued, convincingly, that Ptolemy did not follow Andronicus and his *pinakes*. Rather, Andronicus relied on a previous (Hellenistic) tradition, which may be identical with the *pinakes* produced by Hermippus of Smyrna (third century BC) ([RASHED 2021](#): xx–xxviii combined with ccxcviii–cccii). This conclusion has an important (although largely negative) consequence for us: we cannot (and, indeed, should not) use Ptolemy’s catalogue to try to shed light on what Andronicus may have accomplished in his *pinakes*.

<sup>6</sup> Alexander of Aphrodisias does not appear to have access to it: “There exists an inquiry on plants written by Theophrastus. *Aristotle’s does not survive*” (*In Sens.* 87.10–11). But Marwan Rashed finds a reference to this work in Galen’s Περὶ ἄλειτουργίας (*De indolentia*). See [RASHED 2011](#): 55–77.

<sup>7</sup> For instance, Athenaeus of Naucratis (active in the late second and early third century AD) refers to a work by Aristotle on plants (*apud* Athenaeus, *Deipn.* XIV 652 A). But Athenaeus does not appear to have access to this work; in all probability, he found this information in a Hellenistic source that remains unknown to us.

<sup>8</sup> [SENN 1930](#): 113–140 comes to this conclusion after reviewing the cross-references to a study of plants in Aristotle’s extant writings. Compare [REGENBOGEN 1937](#): 469–475, who shows that at least a couple of the passages examined by Senn (*GA* I 1, 715a16–716a1 and *HA* I 5, 539a15–24) cannot contain a reference to the extant works on plants by Theophrastus. More on this scholarly dispute in [Appendix I](#).

themselves with animals,<sup>9</sup> Phantias of Eresus wrote on plants.<sup>10</sup> A study of the testimonies for Clearchus and Eudemus on animals and Phantias on plants goes beyond the scope of this book. What matters here is that this supplementary evidence, regardless of how meager it is, confirms that the study of living beings in the early Peripatos was approached via separate studies of animals and plants.

What we know about the ancient Greek study of living beings before Aristotle and Theophrastus suggests that *the Peripatetic approach to the phenomenon of life was far from obvious, let alone uncontroversial*. In fact, it was an important innovation. This innovation has been so successful that it may look to us like an entirely unproblematic starting point for a study of life. But it isn't (and it wasn't). As a result, it is simply impossible for me to start this book *in medias res* by stating that the Peripatetic study of living beings is divided into a study of animals and plants. Instead, I must recall the discourse on and around life before Aristotle and Theophrastus.<sup>11</sup> I do this in the first part of [Chapter 1](#), where I concentrate on the ambiguity between ζῷα/animals and ζῷα/living beings. This is not an ambiguity that is native to the Greek language. Rather, it is an ambiguity created by the superposition of the Peripatetic theory onto a prior usage that is innocent with respect to that theory. While a few of Aristotle's predecessors operated on the assumption that they were concerned with ζῷα/living beings, Aristotle and Theophrastus approached the study of perishable living beings starting from the distinction between ζῷα/animals and φυτὰ/plants.<sup>12</sup> This distinction is presupposed by Aristotle and Theophrastus when they engage in their study of living beings. When considered in its

<sup>9</sup> We have eight testimonies for Eudemus: One comes from Apuleius (second century AD) and seven from Aelian (end of the second and beginning of the third century AD). They are collected in [WEHRLI 1969](#)<sup>2</sup> (fragments 125–132). A good discussion of these fragments is offered in [WHITE 2002](#): 207–241. The extant evidence (mostly from Athenaeus) that Clearchus concerned himself with aquatic animals is now edited and translated in [DORANDI-WHITE 2022](#): 227–234. For a discussion of how this evidence may fit into the Peripatetic study of animals, see [HELLMANN 2022](#): 553–579.

<sup>10</sup> We have a dozen testimonies for Phantias. They can be found in [HELLMANN-MIRHADY 2015](#) (fragments 42–55). Phantias wrote a work on plants consisting of at least seven books. In a couple of cases (fragments 43 and 50), what he contributed to the study of plants is recalled next to what Theophrastus said. Clearly, our ancient sources (or their sources of information) could still distinguish between Phantias's and Theophrastus's contributions on the topic of plants. For Phantias on plants, see [ZUCKER 2015](#): 377–405.

<sup>11</sup> A more extensive attempt to reconstruct this discourse can be found in [MEYER 2015](#): 24–245.

<sup>12</sup> A similar point can be made in connection with δένδρα, which is ambiguous between “plants” and “trees.” This word is used by Theophrastus to refer to a specific group of plants that play an important explanatory role in his theory. But δένδρα need not be understood in this narrow way, and trees need not enjoy a special status within the study of plants. In fact, the early use of the term is innocent with respect to the explanatory concerns motivating Theophrastus. More on this in [Chapters 1](#) and [5](#).

historical context, their choice to approach this study by assuming the distinction between animals and plants takes the contours of a momentous decision.

## 2 Outline of the Book and Main Argument

There are at least two questions that are prompted by the idiosyncratic approach to the phenomenon of life sketched so far. The first and more pressing is what licenses this approach. In the second part of [Chapter 1](#), I look at the foundational role that Aristotle's research into the soul plays for the Peripatetic study of animals and plants. Aristotle opens this research by saying that the soul is a principle of living beings. Here "principle" means explanatory starting point. According to Aristotle, there is no more basic feature (or set of features) from which to engage in a scientifically sound investigation of living beings than the soul. Among other things, the investigation into the soul provides Aristotle with the conceptual resources to isolate perishable from imperishable living beings and to approach the study of the former via separate studies of animals and plants. In this sense, Aristotle's research into the soul is the first, indispensable step toward a theoretically informed study of perishable living beings. When approached in this way, Aristotle's *De anima* turns out to be a treatise devoted to finding out the first principle (or principles) to be employed in the study of perishable living beings, whereas the writings on animals and plants are concerned with the application of that principle (or principles) to the explanation of the relevant phenomena.

The second question is whether separate studies of animals and plants exhaust the Peripatetic study of perishable living beings. I do not have in mind the inevitable difficulties that Aristotle and Theophrastus face when they deal with the boundaries between animals and plants and are concerned with those intermediate creatures that resist a clear-cut division into animals and plants. Important as they are, those difficulties do not undermine the approach to the study of perishable life outlined here. The question that interests me is whether this approach allows for a study of what animals and plants have in common *qua* perishable living beings. In [Chapter 2](#), I argue that this question should be answered in the affirmative. In the Peripatetic science of perishable living beings there is room, at least in principle, for such a study. This is an important result, and one that is far from obvious given how Aristotle and Theophrastus conceive of perishable life. I argue that the conceptual space for a study of animals and plants *qua* perishable living beings is to be found in the short essays that are



collectively known as *Parva naturalia*. These essays are to be read right after the research into the soul. In this sense, they presuppose the main results reached in Aristotle's *De anima*. But they are not simply a sequel to the research conducted in this work. This becomes fully apparent as soon as we reflect on what we are told in the opening statement of his *De sensu*, where a shift in focus is announced from the study of the soul to the study of "animals and everything that has life." With this choice of words Aristotle is creating the conceptual space for research that goes beyond animals and is not just concerned with plants.

A third question looms large at this point: *how far is Aristotle able to carry forward a common study of animals and plants qua perishable living beings?* I address it in the second part of [Chapter 2](#). I do so by engaging in an in-depth study of the last two instalments of the project of the *Parva naturalia*. The first is Aristotle's explanation of longevity. This explanation is offered in the essay transmitted to us with the title *On Length and Shortness of Life*. In this short but remarkable text, Aristotle shows that there are scientific questions that ought to be answered in common for both animals and plants. The second is the treatise known as *On Youth and Old Age, Life and Death, Respiration*. Here Aristotle advances his own account of why every perishable living being, whether animal or plant, goes by nature through a cycle of growth, activity in its prime, decline, and eventually death.

By the end of [Chapter 2](#) the reader should be able to appreciate that the Peripatetic study of perishable living beings consists of at least three distinct but related components: a study of what is common to animals and plants followed by separate studies of animals and plants. The ultimate motivation for such a complex architecture is to be found in the theory of scientific demonstration advanced in the *Posterior Analytics*, where Aristotle recommends that we look for explanations that are as general as possible while at the same time remaining sufficiently specific to capture salient aspects of the phenomenon under discussion. At the same time, the reader should not remain blind to the fact that what Aristotle is able to say in common for both animals and plants, important as it is, is truly limited. This conclusion is neither surprising nor controversial given that the short essays transmitted as part of Aristotle's *Parva naturalia* are concerned for the most part with sense-perception and its manifestations (e.g., in sleep and dreams). However, the theoretical implications of this largely negative result have not been fully appreciated. On the one hand, Aristotle provides himself with the conceptual resources to speak of animals and plants *qua* perishable living beings. On the other, he has very little to say on this front.

This creates an obvious tension to which I return in [Chapter 6](#). It is only at that point that I directly confront the question whether, and eventually how, Aristotle and Theophrastus bridged the gap that they created for themselves within their study of perishable living beings. Clarity on this point is especially important for the claim implied by the title I have chosen for this book. By my lights, there was a science of perishable living beings in the early Peripatos, even though this science was pursued via separate studies of animals and plants.

[Chapters 3, 4, and 5](#) jointly offer an outline of the main contents of the Peripatetic science of perishable living beings. They do so by looking at how Aristotle and Theophrastus proceed in their extant works devoted to the study of animals and plants. I have chosen my words carefully. I speak of an outline because it is simply impossible to do full justice to the richness and complexity of the Peripatetic science of perishable living beings in just three chapters. And yet, an important asymmetry must be highlighted right away: while Aristotle's works on animals have generated an enormous scholarly output, Theophrastus's writings on plants have drawn limited attention. On the one hand, even the expert reader is overwhelmed by how much has been written on and around Aristotle's study of animals. On the other, one is disappointed by how little ink has been spilled on Theophrastus and his study of plants.<sup>13</sup> While I can safely take for granted deep familiarity with Aristotle, I find myself compelled to introduce the reader to Theophrastus, since this reader may not be familiar with the contents of his two major contributions to natural philosophy: *History of Plants* and *Causes of Plants*. So, in the three subsequent chapters, I offer an overview of the main structure and organization of Aristotle's study of animals followed by a highly selective exploration of especially significant aspects of what Theophrastus says on the topic of plants.

[Chapter 3](#) discusses the most significant explanatory strategies Aristotle adopts in his study of animals. These strategies appear to be already at work at the stage of the collection and presentation of the relevant data. They are subsequently implemented at the stage of the explanation of those data. In due course, I show that these strategies are also at work in Theophrastus, so it is important to be as clear as possible about them at the outset to

<sup>13</sup> This study is, of course, not *terra incognita*. In addition to the reliable editions of the Greek text produced by Suzanne Amigues (see the References for the relevant bibliographical information), I would like to single out at least two other works: WÖHRLE 1985 is a perceptive study of the rules of scientific inquiry adopted by Theophrastus in his study of plants; SHARPLES 1995 is an incredibly rich source of information organized around the extant testimonies for Theophrastus on animals and plants collected in FHS&G.

appreciate how they are adopted, and indeed adapted to his specific subject, by Theophrastus.

Chapter 4 introduces the reader to how Theophrastus approaches the topic of plants by offering a selective discussion of the first book of his *History of Plants*. The first part of this book is a prolegomenon to the study of plants. It is also a liminal space where Theophrastus negotiates the transition from the study of animals to the study of plants. It does not take long to see that this transition is especially important for the purposes of my book since a great deal depends on the level of unity and cohesiveness Aristotle and Theophrastus are able to find in their separate studies of animals and plants. When Theophrastus refers to the study of animals, he takes it for granted that his reader is familiar with the main results achieved in the study of animals. In other words, he is building his study of plants on the study of animals. But he is doing so without ascribing the study of animals to Aristotle or claiming ownership of the study of plants. The impression is that he is contributing to a shared project that is to be approached in the following order: *first animals, then plants*. Toward the end of the chapter I address a delicate question: *is Theophrastus working within the theoretical framework provided by Aristotle's De anima?* This is emphatically not an easy question to answer. On the one hand, Theophrastus shows a great deal of independence in his investigation of the complex and wonderful world of plants, so we cannot assume that the results reached by Aristotle are binding for him. On the other hand, he takes plants and animals to be not only different kinds of perishable living beings but also separate objects of study. By so doing, he implicitly accepts one of the main results achieved by Aristotle in his research into the soul. Upon reflection, I conclude that the research into the soul conducted in *De anima* plays a foundational role not only for Aristotle but also for Theophrastus.

My focus in Chapter 5 shifts to the five books of Theophrastus's *Causes of Plants*. I concentrate my attention on the first book since it plays a pivotal role in Theophrastus's exploration of how plants propagate. Right from the start of the book, we are told that we are about to engage in a study of the various modes of plant generation. I speak of modes of generation because plants can reproduce in more than one way. It is enough to think of grafting and budding to realize that the reproductive capacity of plants is simply unmatched in the animal kingdom. By looking at how Theophrastus approaches the topic of plant propagation, we can better appreciate what Aristotle tells us at the outset of his *Generation of Animals*, where he says that plants ought to be investigated separately.<sup>14</sup>

<sup>14</sup> Aristotle, *GA* I 1, 716a1.

As I concentrate my attention on the deep structure of the *separate but coordinated studies of animals and plants left by Aristotle and Theophrastus*, I also reflect on how far their scientific practice is controlled by the theory of scientific explanation advanced in Aristotle's *Posterior Analytics*. Scholars remain deeply divided on this issue. A few have argued that Aristotle's study of animals is largely informed by the theory of scientific inquiry outlined in the *Posterior Analytics*.<sup>15</sup> Others have resisted this conclusion, insisting that the actual practice in Aristotle's writings on animals does not always conform to the theory.<sup>16</sup> Others still, while not directly challenging the relevance of what Aristotle has accomplished in his *Posterior Analytics*, are not centrally concerned with the question of how far the rules of inquiry outlined in Aristotle's *Posterior Analytics* are implemented in the Peripatetic practice of science.<sup>17</sup>

I do not expect this debate to end any time soon. I contribute to the ongoing discussion by showing that Aristotle and Theophrastus share a set of explanatory concerns, and indeed procedures, suggesting that they interpret their task, broadly speaking, in the same way. A few of those shared concerns and procedures can be traced back to Aristotle's *Posterior Analytics*. For the time being, I recall the obvious articulation of the scientific enterprise into stages, with a focus on the existence of both pre-explanatory and explanatory stages of inquiry, and the epistemic principle that requires the investigator to give explanations at the right level of generality. This principle can be restated by saying that the investigator is expected to produce explanations that apply as broadly as possible while at the same time also grasping salient articulations of the natural world. We can call this approach to explanation "the commensurate universal approach."<sup>18</sup>

<sup>15</sup> The volume jointly edited by Allan Gotthelf and James G. Lennox remains the seminal work exploring how the theory outlined in *Posterior Analytics* is applied to the study of animals (GOTTHELF-LENNOX 1987). Despite the half-hearted reception of this volume in the second, revised edition of the Clarendon translation of Aristotle's *Posterior Analytics* (BARNES 1994<sup>2</sup>: xix–xx), the essays collected in this volume have inspired a great deal of scholarly work. Here I recall two collections of essays that carry further that research program beyond the narrow boundaries of Aristotle's study of animals. While the first is a special issue of *Apeiron* edited by James H. Lesher (LESHER 2010), the second is a collection of essays put together by David Ebrey (EBREY 2015).

<sup>16</sup> LLOYD 1990: 371–401 remains the best introduction to the tensions between the Aristotelian theory and practice of science. This article (reprinted in LLOYD 1996a) is an eloquent defense of the view that in his actual investigation of the natural world Aristotle is not bound by the theoretical pronouncements made in his *Posterior Analytics* or *De anima*. But see also GRENE 2000: 444–459, who expresses skepticism as to the applicability of the theory of *Posterior Analytics* to Aristotle's study of animals.

<sup>17</sup> Here I single out KING 2001 and ZATTA 2022.

<sup>18</sup> The *locus classicus* for a discussion of how this epistemic principle controls the study of animals remains LENNOX 1987: 90–119 (reprinted in LENNOX 2001a: 7–38).

Both the insight that the scientific enterprise unfolds in stages and the commensurate universal approach have architectonic implications for the Peripatetic science of living beings. The articulation of the scientific enterprise in stages hardly needs a defense since both Aristotle and Theophrastus have manifestly structured their studies of animals and plants into a pre-explanatory and an explanatory stage of inquiry. However, the implications of the search for the commensurate universal are not immediately obvious. Aristotle often invokes the following rule of inquiry: “*first what is first.*”<sup>19</sup> If what is first is fixed with reference to the rule that mandates us to look for explanations at the right level of generality, one may end up thinking that we should begin our investigation by looking for the most common or most widespread feature (or set of features) that animals and plants share *qua* perishable living beings. More to the point: one may even be tempted to argue that what can be found to be true in common for all animals and plants should serve as a foundation to the whole study of animals and plants.

A concrete example helps here. Consider the theorem that animals and plants *qua* perishable living beings possess innate heat. This theorem is a by-product of the search for the definition of the nutritive power of the soul.<sup>20</sup> It does a great deal of explanatory work for Aristotle. For example, the various modes of animal generation observed in nature crucially depend on the quantity and quality of innate heat present in the animal. According to Aristotle, the hotter and moister the nature of the animal, the more perfect the product of its generation. While live-bearing animals give birth to something that is like themselves, egg-laying animals produce either a perfect or an imperfect egg; finally, there are animals producing something that is even less perfect than an egg, namely a grub.<sup>21</sup> It is also possible to establish a *scala naturae* in which we rank not only animals but also plants based on the relative presence or absence of internal heat.

So why not make this theorem the cornerstone of our whole scientific project? This is a difficult question to answer. At the very least, we can say that this is not how Aristotle proceeds in his extant writings. Instead of starting his investigation from this first universal, and building his entire

<sup>19</sup> Here are a few passages from the zoological corpus where this rule is invoked: *Sens.* 1, 436a6; *PA* I 5, 646a4; *PA* II 10, 655b28–29; *GA* II 4, 737b25–27. But the significance of this formulation goes emphatically beyond the study of perishable living beings: *EE* I 6, 1217a18–21; *Poet.* 1, 1447a12–14.

<sup>20</sup> More on this point in [Chapter 6, Section 4](#).

<sup>21</sup> Two independent introductions to this idea can be found in [LEUNISSEN 2017](#): 58–62 and [CERAMI 2017](#): 130–138. Aristotle, *GA* II 1, 733a32–b16 is the key text for this idea.

edifice on it, Aristotle adopts an alternative strategy captured by the following catchphrase: “*animals first, and the human being first.*” Aristotle does not begin his inquiry into perishable living beings from what is common to animals and plants but rather from animals, and within animals from the human animal. A clear formulation of this alternative strategy is found in Aristotle’s explanation of why all animals (none excluded) must alternate between periods of sleep and waking. We must assume, Aristotle says, that the causes of this alternation are the same or analogous in the other animals as in blooded animals, and the same in other blooded animals as in the human being.<sup>22</sup> Evidently, when it comes to the study of animals, the human being is the starting point not only for the presentation of the relevant data but also for their explanation.<sup>23</sup>

It is important to stress that a similar strategy is also at work when Aristotle goes beyond the study of animals and is programmatically concerned with what is common to animals and plants. I have already suggested that the short essays known as *Parva naturalia* are not only about animals but also about everything that has a share in perishable life. I now add that even when Aristotle is concerned with everything that has a share in perishable life, animals rather than perishable living beings are his primary focus. Evidently, Aristotle does not take the rule “*first what is first*” to mean that he must begin his investigation by searching for what is common to animals and plants in order to build his account from there. Rather, Aristotle applies another epistemic principle with architectonic implications for how his whole scientific project is structured. According to this alternative principle, Aristotle is required to start his investigation of perishable life from the most organized and most determinate form of life. He is required to take that form of life as his starting point to generate results that can subsequently be extended to what is comparatively less organized and less articulate. At every single stage of his inquiry, he is also required to look for the commensurate universal. The thought behind this strategy is this: distinctions and differences found in the more determinate and more organized form of life (animal life) can also be found in the less determinate and less organized form of life (plant life), albeit with less clarity. In due course I will show that

<sup>22</sup> Aristotle, *Somn.* 2, 455b31–34. The qualification “the same *or analogous*” is important because when one moves beyond the case of blooded animals, one is forced to employ analogy. I will have a great deal more to say on analogy in due course.

<sup>23</sup> For a discussion of the special role that the human being plays in Aristotle’s study of animals, see LLOYD 1983: 26–43.

Theophrastus applies the same epistemic principle in the context of his study of plants.

At least at first sight, then, there appears to be a tension, if not even an outright conflict, between the epistemic principle that requires us to begin our investigation from the most organized and most determinate and the one that mandates starting our inquiry within a given field from the most widespread phenomenon. The most organized and most determinate form of life need not coincide with the most widespread phenomenon. In fact, it only rarely does. Think of the human being in relation to the other animals, and of animals in relation to plants. Aristotle is often blamed for adopting an *anthropocentric* approach to the study of animals and a *zoocentric* approach to the study of perishable living beings. To make a long story short: these two epistemic principles seem to pull the investigator in different directions. They also generate alternative strategies to deal with the phenomenon of perishable life. And yet both appear to have architectonic relevance for Aristotle and Theophrastus. I am concerned with how Aristotle and Theophrastus negotiate the application of both epistemic principles as they investigate animals and plants, with a focus on the role that both principles play in shaping up the Peripatetic study of perishable living beings.

There is another epistemic principle that has architectonic implications for both Aristotle and Theophrastus. This is the principle that requires the investigator to begin the study of perishable living beings from the most familiar form of life. In the case of animals, the most familiar form of life turns out to coincide with the most organized and most determinate one: the human being. When considered from this angle, the principle “*animals first, and the human being first*” can also be regarded as an application of the principle that we should start our investigation from that which is more knowable to us. This puts some additional pressure on us to decide whether the most organized and most determinate form of life is invoked because it is more knowable to us or because it is more knowable by nature (*alias* more knowable per se). In [Chapter 3](#), I argue that the most organized and most determinate form of life, namely the human being, is invoked primarily because it is more knowable by nature. The human being can serve to find out differences and determinations that are present also in the less determinate form of animal life, although they are more difficult to discern in the latter case.

I would like to end this [Introduction](#) with a brief note on Theophrastus and his works on plants. The relative lack of scholarly engagement with these works is due not only to their nature (they are perceived as written in

a dry and technical style with little or no regard for philosophy) but also to a certain idea of Theophrastus. While Aristotle is considered an audacious and ground-breaking philosopher, Theophrastus is often regarded as a thinker of limited or even no depth.<sup>24</sup> On this view, Theophrastus is not an original thinker; rather, he is a loyal collaborator and a continuator of Aristotle's research project. This is a project that Theophrastus would have found already delineated and to which he would have contributed his works on plants as well as a few additional essays on natural philosophy. This view is not only widespread; it is also quite old. It has prompted a distinctive approach to Theophrastus's writings that is best exemplified in the Aldine edition of Aristotle (the *editio princeps* of Aristotle). In this edition, a few works by Theophrastus, including his extant writings on plants and his short work known with the slightly misleading title *Metaphysics*, are printed as a complement to Aristotle's works.<sup>25</sup>

I cannot rule out this scenario. In other words, I cannot exclude that Theophrastus completed an explanatory project left unfinished by Aristotle, who was also the owner of that project. However, I tend to give considerably more credit to Theophrastus – not only as a thinker but also as a scientific writer. I consider his writings on plants a tremendous achievement. More to the point: I consider them an achievement second to none. In my view, they deserve the same level of attention we give to Aristotle's writings on animals. When we look at these writings as contributing to a single project to which Aristotle and Theophrastus contributed, the alternative between original thinker and loyal pupil is far from compelling. Theophrastus worked within a research program that went back to Aristotle; however, he adopted this project not as a pupil following in the footsteps of his master but rather as an intelligent and equal collaborator fully aware of the complexity, and indeed flexibility, of that project.

<sup>24</sup> The perception of Theophrastus as an unoriginal thinker is so ingrained in us that scholars have felt the need to defend the view that Theophrastus is a significant philosopher and even to explain in what sense he is a philosopher. See [SORABJI 1998: 203–222](#) and [SHARPLES 1998: 267–280](#).

<sup>25</sup> This edition was issued in five folio volumes in Venice between November 1495 and June 1498. Volume 2 contains the following *opuscula* by Theophrastus: *On Fire (De igne)*, *On Winds (De ventis)*, and *On Stones (De lapidibus)*. It also contains the work *On Weather Signs (De signis)*, which is published *adespotus (incerti auctoris)*. Theophrastus's *History of Plants (Historia plantarum)* and his *Causes of Plants (De causis plantarum)* are printed in Volume 4. This volume also contains Theophrastus's *Metaphysics*, which is printed after the fourteen books of Aristotle's *Metaphysics*.



## *Aristotle's De anima and the Study of Perishable Living Beings*

### 1 The Study of Living Beings Before Aristotle and Theophrastus

Aristotle and Theophrastus were engaged in a systematic study of living beings aimed at scientific knowledge. In this chapter I argue that the theoretical foundation for their articulation of this study into two main parts, animals and plants, is to be found in the results that Aristotle reached in his own research into the soul. This research was itself a remarkable innovation. While the ancient philosophical reflection on the soul started well before Aristotle, it never took the form of a systematic investigation concerned with the soul as the principle of living beings. The ultimate reason for this innovation is to be found in Aristotle's interest in life – not an interest in this or that form of life but an unrestricted interest in all forms and manifestations of life. This interest caused him to engage in an unrestricted study of the soul as the ultimate principle or source of life. Tellingly, Aristotle criticizes his predecessors for having approached the soul by focusing exclusively on the human soul.<sup>1</sup> Aristotle names no names, but his most immediate and obvious critical target is Plato and his account of the soul in dialogues such as the *Phaedo* (also known in antiquity as *On the Soul*), *Republic*, and *Phaedrus*.<sup>2</sup> For Aristotle, Plato's almost exclusive focus on the human soul was not only arbitrary but also a non-starter. A question that is at the heart of this chapter is how the completely unrestricted study of the soul envisioned at the outset of Aristotle's *De anima* is subsequently narrowed down to the study of the soul as a principle of *perishable living beings*. Without a clear grasp of how this transition is negotiated, it is difficult to understand how Aristotle can justify his second

<sup>1</sup> Aristotle, *DA I 1*, 402b3–5.

<sup>2</sup> In Plato's *Timaeus* the focus is no longer exclusively on the human soul. In fact, Plato has a great deal to say on the topic of the world soul, which he takes to be the ideal cognitive agent (see [CORCILIUS 2018: 51–105](#)). Aristotle's criticism of Plato's account of the world soul (advanced in *DA I 3*, 406b26–407b11) remains outside the scope of this chapter.

major innovation: the approach to perishable living beings via separate studies of *animals* and *plants*.

To better appreciate the significance of this second innovation, we need to have at least an idea of the scientific discourse on and around life before Aristotle and Theophrastus. To this end, I propose to start by looking, briefly, at the so-called botanical excursus found in the Hippocratic work *On the Nature of the Child* (*De natura pueri*).<sup>3</sup> This work is the second part of a single, continuous embryological account concerned with a human being coming to be from conception to birth. The first part is advanced in the work *On Generation* (*De genitura*).<sup>4</sup> Very little is known about the (male) author of this embryological account in two parts. Since Hermann Grensemann, it has become common to refer to him as “author C.”<sup>5</sup> In addition to our two complementary works, author C produced the nosological treatise known as *Diseases 4* (*De morbis 4*). The most recent research on the Hippocratic corpus has also ascribed to him the gynecological works *Diseases of Women 1–2* (*De morbis mulierum 1–2*) and *Infertile Women* (*De sterilibus*), as well as *On Glands* (*De glandulis*).<sup>6</sup> If we accept these results, our author C turns out to be a medical expert especially (but not exclusively) concerned with women’s bodies. He emerges not only as a productive writer but also as “an important and original thinker, who occupies a pivotal place between the Presocratic thought and the research of the Academy and the Lyceum.”<sup>7</sup> This is pretty much all we can say about this ancient expert. Still, his scientific credentials, combined with his intellectual ambition, make him an excellent case study for how the discourse on and around plants was conducted before Aristotle and Theophrastus.

Early Greek philosophers such as Empedocles and Anaxagoras had an interest in the study of plants, but the discussion embedded in the treatise *On Generation/On the Nature of the Child* is the earliest extant treatment of the topic of plants in the ancient Greek scientific literature. We want to

<sup>3</sup> [Hippocrates], *De nat. puer.* 22–27 Giorgianni.

<sup>4</sup> In the manuscript tradition, *On the Nature of the Child* follows immediately after *On Generation*. They are, however, marked as separate works. The practice of printing them one after the other with continuous numbering goes back to Émile Littré (LITTRÉ 1851: 462–485). For an in-depth discussion of the relation between these two works, see LONIE 1981: 43–51 and GIORGIANNI 2006: 1–4.

<sup>5</sup> GRENSEMANN 1982.

<sup>6</sup> For the *status quaestionis* of what is known about this remarkable ancient expert, see GIORGIANNI 2020: 49–76. The relation between *On Glands* and author C is discussed in CRAIK 2009. I am following the two most recent editors of *Diseases of Girls* (*De virginum morbis*), who stop short of ascribing this work to our author C (LAMI 2007: 15–59 and POTTER 2012: 357).

<sup>7</sup> CRAIK 2009: vii. Compare CRAIK 2015: 117, 121.

know why author C felt the need to offer a sustained treatment of plants in the context of an account of the formation and development of the human embryo. We are fortunate because our unknown author is forthcoming about his motivations for such an extended discussion. Here is how he restates his main thesis in a memorable way:

Now I shall return to the point in my account for the sake of which these things have been said on these subjects. I maintain that everything that grows in the earth lives from the moisture of the earth, and that whatever kind of moisture a particular kind of earth has in it, this same kind of moisture a plant [growing in it] will have. In the same way the little child also lives from its mother in her uterus and however much health the mother enjoys the fetus too will have. *If one wishes to reflect upon what I have said concerning these subjects, from beginning to end, one will discover that the growth of things out of the earth and human growth are exactly the same* [ἦν δέ τις βούληται ἐννοεῖν τὰ ῥηθέντα ἀμφὶ τούτων, ἐξ ἀρχῆς ἐς τέλος, εὐρήσει τὴν φύσιν πᾶσαν παραπλησίην ἔουσαν τῶν τε ἐκ τῆς γῆς φυομένων καὶ τὴν ἀνθρωπίνην]. This is what I have said in the matter. (Trans. Paul Potter, slightly modified)<sup>8</sup>

If we want to understand how an extended discussion on the topic of plants contributes to the embryological account offered in the treatise *On Generation/On the Nature of the Child*, we must take the words I highlighted in italics literally. Unless we take those words literally, our author C comes across not only as a rather undisciplined investigator but also as a hopelessly confused (and confusing) writer, with no firm grasp of the boundaries of his own project. In fact, his whole discussion of plants is controlled by the working hypothesis that human development is, from beginning to end, the same as the growth of plants. Scholars often describe this extended discussion as an “excursus.”<sup>9</sup> But the use of this word is far from ideal because it ends up suggesting that this stretch of text is an expendable aside. When we put ourselves in this less than ideal frame of mind, it becomes difficult for us to take the words highlighted in italics seriously.<sup>10</sup> At most we are willing to speak of what is going on in this passage as an attempt to develop an elaborate analogy between the growth of plants and that of the embryo in the womb.<sup>11</sup> But, again, there is no

<sup>8</sup> [Hippocrates], *De nat. puer.* 27.15–24 Giorgianni.

<sup>9</sup> See, for instance, [GIORGIANNI 2012](#): 65–68. His chosen words to describe our whole stretch of text (chapters 22–27) are *parentesi*, *digressione*, and *excursus*. [CRAIK 2015](#): 115, too, speaks of an *excursus*.

<sup>10</sup> With reference to our passage, [CRAIK 2015](#) speaks of a “somewhat exaggerated justification for [the] inclusion” of chapters 22–27 in the formation and development of the human embryo.

<sup>11</sup> [REPICI 2000](#): 56–61. Compare [LONIE 1981](#): 83, who also complains that “there is no close analogy between the growth of the embryo as the author describes it and the growth of a plant.”

evidence that our author C is engaged in analogical thinking. Where we see analogous processes, he sees one and the same process at work.<sup>12</sup> Since he thinks the embryo to be identical to a plant, he does not adopt, let alone enforce, a clear-cut division between animals and plants. In fact, it seems important to his argument that no such division is presupposed.

For a better sense of what may license this overall approach to the study of life, we need to look at the background against which this Hippocratic work was written. There is now scholarly consensus that, at least on the topic of plants, author C was not an original thinker. His discussion is reminiscent of Empedocles's ideas on the topic, or at least of theories that are a development along those lines. Furthermore, we cannot exclude that our unknown author also borrowed ideas and concepts from Anaxagoras, Diogenes of Apollonia, and Democritus.<sup>13</sup> We tend to discount authors who are not perceived as being original thinkers. In fact, they are quite helpful from a historical perspective since they can be used as a reliable entry point into the way in which a certain topic was discussed. But how was the discourse on and around life approached before Aristotle? I would like to answer this question by recalling a piece of doxography advanced at the very beginning of the work known as [Aristotle]'s *On Plants*:

Life is found in animals and plants. But in animals it is patent and obvious, whereas in plants it is hidden and not clear. To establish its existence requires considerable research. The question at issue is whether plants have or have not a soul and a capacity for desire, pain, pleasure, and discrimination.

Anaxagoras and Empedocles maintain that plants are moved by desire, and they assert emphatically that plants can feel and experience both pain and pleasure. Anaxagoras says that plants are animals and feel both pleasure and pain, concluding this from the fall of their leaves and from their growth.

Empedocles supposed that the two classes are mixed in plants.

Likewise, Plato maintained that plants must have desire because of the extreme demands of their nutritive capacity. ([Aristotle], *On Plants* I 1, 815a10–23, trans. E. S. Forster)

I will return to the historical significance of this remarkable work in [Appendix III](#). Here, suffice it to say that its transmission is quite complicated. What E. S. Forster translates here is (in the words of Lotte

<sup>12</sup> LLOYD 1966: 348 sees an “exact parallelism” between the growth of plants and the growth of the human embryo. But, again, the claim our unknown author makes is stronger: he claims that there is one and the same process rather than two parallel processes.

<sup>13</sup> Full discussion in LONIE 1981: 237–239.

Labowsky) “a medieval Greek translation of a Latin rendering of an Arabic text translated, probably via a Syriac intermediary, from a lost Greek original.”<sup>14</sup> As a result, the English translation reported above must be taken with a grain of salt. It is a bit odd to say that the classes of plants and animals are mixed in plants. This amounts to saying that  $X$  and  $Y$  are mixed in  $X$ , which is not a particularly felicitous claim. Still, the complicated transmission of our work may not be the only reason why the English translation does not sound idiomatic to us. Its author writes from within the Peripatetic tradition. It is also quite possible that this author is recycling information going all the way back to Aristotle and his lost work on plants. This may explain why he takes it for granted that animals and plants are two kinds of living beings.<sup>15</sup> And yet, it is far from obvious that he is entitled to project this distinction back to Empedocles. In fact, the impression is that Empedocles, like Anaxagoras and other Presocratic and Hippocratic authors, operated with a conception of life that was impervious to this distinction. This appears to be a rather thick conception of life, involving a share in cognition – minimally, in the form of pleasurable or painful perceptions and desires. This conception was emphatically not shared by everyone. Diogenes of Apollonia appears to have grouped humans and animals together and appears to have distinguished them from plants.<sup>16</sup> Still, this thick conception is embraced most famously in the *Timaeus*, where Plato ascribes life and soul to plants because they have pleasurable and painful perceptions as well as appetitive desires.<sup>17</sup> This is far from being an isolated claim in the Platonic corpus. In the *Theaetetus*, for instance, we are told that farmers work to replace pernicious perceptions in plants with useful and healthy ones.<sup>18</sup> Since Plato integrates this claim in his elaborate defense of Protagoras as an expert in education whose task consists in replacing bad perceptions with good ones, we cannot rule out that Protagoras himself used this example and even endorsed the view that plants have pleasurable and painful perceptions. I refrain from

<sup>14</sup> LABOWSKY 1961: 132. <sup>15</sup> The point is already made in DROSSAART LULOFS 1987: 10.

<sup>16</sup> See DK 64 B 2 combined with DK 64 B 4. In the first fragment, Diogenes appears to distinguish animals from plants by their mode of emergence (growing/φύναι vs. coming into being/γίγνεσθαι). In the second, he groups animals and humans together and credits them not only with cognition (νόησις) but also with soul (ψυχή) because they breathe. Since Diogenes appears to have denied that plants can breathe as they do not possess passages for air in their bodies (DK 64 A 19.21–23), we must conclude that, in his view, plants do not have a share in life and are completely devoid of cognition. A discussion of the extant evidence for Diogenes in the context of the Presocratic reflection on life can be found in ZATTA 2017: 59–64 and ZATTA 2023a: 274–275.

<sup>17</sup> Plato, *Tim.* 77 B 3–6.

<sup>18</sup> Plato, *Theaet.* 167 B 7–C 2. This replacement is achieved by supplying plants with whatever they need to flourish (water, rich soil, and sunlight).

engaging in a discussion of the merits of this conception of life. What is relevant for my argument is that before Aristotle and Theophrastus (1) plants were regarded by many, if not most, as living beings and (2) there was a considerable debate as to the powers to ascribe to plants. In particular, (3) life could be understood in a univocal way; as a result, (4) plants could be considered full-blown stationary animals having a share in cognitive powers.<sup>19</sup>

Independent evidence in support of what we read in the work *On Plants* that the tradition ascribes to Aristotle is found in a doxographical report going back to Aëtius. The latter organizes the ancient debate on and around plants as follows:

Plato [and] Thales [say that] plants [φυτᾶ] too are ensouled [ἔμψυχα] living beings [ζῷα]. This is evident from the fact that they move to and from and hold their branches extended, and also that they yield when they are gathered together and then powerfully loosened again, so that they even pull up weights.

Aristotle [says that] they are ensouled [ἔμψυχα], but they are not animals [ζῷα]. For [he says that] animals [ζῷα] [unlike plants] have impulses and sense-perception, and some are also endowed with reason.

But the Stoics and Epicureans [say that] they are not ensouled [ἔμψυχα]. For they say that some animals [ζῷα] share in the impulsive and desiderative soul and some also in the rational soul. But plants [φυτᾶ] move somehow spontaneously and in a way that does not involve [positing] a soul.

Empedocles says that plants [δένδρα], as first of the living beings [ζῳων], sprung out of the earth before the sunlight was spread around and before day and night had been separated. Due to the proportion present in their mixture [he says that] they contained the structure of the male and the female [within themselves]. They grow from the heat that has been separated out in the earth, so that they are parts of the earth, just like embryos in the belly too are parts of the womb. The fruits are superfluities of the water and the fire in the plants. Some have a lack of moisture, and after it has evaporated in the summer, lose their leaves, while others that have more moisture remain as they are and continue to be in bloom with leaves, as is the case for the laurel, the olive, and the palm. But the differences in flavors result from the variation of the particles of earth and of the plants, which draw varieties of flavors from the *homoiomereiai* of that which nourishes them, as in the case of vines. For it is the differences in the vines that make serviceable wine, but differences in the terrain that nourish them. (*Placita* V 26.1–4 [= *Dox. gr.* 440.4–20]. Trans. Mansfeld-Runia, slightly modified)

<sup>19</sup> The reader will find a useful discussion of the extant evidence for the pre-Platonic claim that plants are perishable living beings endowed with the capacity for sense-perception and desire in ZATTA 2017: 71–77 and ZATTA 2023b: 251–272.

We too often approach doxography as an unphilosophical attempt to organize ancient views with respect to a given topic. In fact, doxography is a perfectly respectable form of philosophical history.<sup>20</sup> Our doxographical report is no exception to the rule: it is a philosophically minded attempt to delineate the theoretical options available at the time on the topic of the powers of plants. They are three: (1) plants are ensouled and they are ζῶα (Plato, Thales);<sup>21</sup> (2) plants are ensouled but they are not ζῶα (Aristotle); and (3) plants are not ensouled and by implication they are not ζῶα (Stoics and Epicureans).<sup>22</sup> The chapter ends with a rather longish entry on Empedocles, who reportedly considered δένδρα to be the first ζῶα to spring from the earth even before the sun started its rotation around the earth.

I left untranslated not only “ζῶα” but also “δένδρα” because both words are ambiguous. Let us focus on the second first. If one looks up this word in the new CGL, one finds that “δένδρ(ε)ον” – plural “δένδρ(ε)α” – means “tree” (either wild or cultivated). The same result is obtained if one checks the LSJ. But this cannot be the meaning that this word has in our context. Here it is used to refer to all the plants there might be, including trees. This is confirmed by what we read in the extant fragments from the Empedoclean poem. Typically, δένδρεα refers to plants in general rather than a particular kind of them – tree.<sup>23</sup> The term need not have a technical meaning for Empedocles. He chose this word as a *pars pro toto* for metrical

<sup>20</sup> For a defense of doxography as an enterprise motivated by philosophical rather than historical concerns, see FREDE 2022: 19–35.

<sup>21</sup> The credentials of this doxographic report as a genuine testimony for Thales are not very good. This report is not printed by DK among the testimonies for Thales. I suspend judgment on this point since nothing hinges on accepting this doxographical report as a reliable piece of information for Thales.

<sup>22</sup> Stoics and Epicureans do not dispute that nutrition is a necessary condition for sustaining living beings (ζῶα), but they think that having a soul has nothing to do with nutrition. As a result, they separate sharply the soul from nutrition and all the life-sustaining processes involved in nutrition. They account for these processes by tracing them back to a *nature* (φύσις) rather than a *soul* (ψυχή). On the Stoic distinction between nature and soul, I refer the reader to JU 2007: 97–108. This distinction would be received and reinterpreted with a new set of arguments in late antiquity.

<sup>23</sup> For instance, Empedocles gives us the following list of living beings (ζῶα):

plants [δένδρεα], men [άνερες] and women [γυναίκες], beasts [θηρες], birds [οίωνοι], and the water-nourished kind of fish [ύδατοθρέμμονες ιχθύς], and long-lived gods [θεοί] high in honor. (*On Nature*, lines 270–272 Primavesi)

This list was important to Empedocles since it resurfaced elsewhere in the poem (DK 31B3.6–8). There is a great deal that is interesting in it, starting from the inclusion of gods. They are described as long-lived rather than immortal because they too are subject to generation and destruction as part of the cosmic cycle. The position of plants at the beginning of the list might reflect the fact that plants are the first living beings to emerge from the earth in the cosmogonic process envisioned by Empedocles.

reasons. I will return to the significance of this choice in due course.<sup>24</sup> For the time being, let me restate the main message conveyed in the doxographical entry on Empedocles as follows: life emerged from the earth with the spontaneous emergence of *plants* (δένδρα).<sup>25</sup> Empedocles considered plants, not just trees, to be the very first *living beings* (ζῷα) to appear on earth in the course of a zoogonic process that was itself inscribed in a narrative account of the origin of the world *ab initio*.<sup>26</sup>

It is time to turn to the ambiguity of the Greek noun “ζῷα,” which cannot be translated consistently in our doxographical report. The noun “ζῷα” is closely related to the verb “ζῆν,” which can be rendered in English as “being alive.” If we have reasons to think that being alive is one and the same thing for all living beings, then we are entitled to say (with Plato, Empedocles, and maybe Thales) that plants (in our doxographical report either φυτά or δένδρα) are *living beings* (ζῷα). But this entails, in turn, finding out a core notion of life that can support the claim that being alive is the same (kind of) thing for animals and plants. If we have to rely solely on what we read in our doxographical entry, plants are credited with the ability to move themselves to the extent that they can recover their original upright position after being forced to bend.

It is impossible to establish what Thales may have said on the topic of the powers of plants. But it is not difficult to find textual evidence that Plato endorsed the view that being alive and being a self-mover are intimately connected. Consider the following passage from Plato's *Laws*:

CLINIAS: “What you ask me is whether we are to speak of something as being alive [ζῆν] when it moves itself [αὐτὸ αὐτὸ κινῆ].”

ATHENIAN STRANGER: “Yes.”

CLINIAS: “How could it not be [alive if it moves itself]?”<sup>27</sup>

<sup>24</sup> Chapter 5, Section 2.

<sup>25</sup> Empedocles was far from being the only early thinker to adopt spontaneous generation as the paradigmatic model of generation. If we accept that the cosmogonic account sketched out by Diodorus Siculus at the outset of his universal history goes all the way back to Democritus, the latter may have adopted a similar style of explanation. See Diodorus, *Hist.* I 7, 3 (= DK 68 B 5.2).

<sup>26</sup> This zoogonic process is described in a few famous fragments that have captured the imagination of ancient and modern readers alike. Unfortunately, the details of this process have been the subject of considerable dispute. The most recent attempts at a reconstruction of how Empedocles envisioned this zoogonic process are WELLMANN 2020: 128–158 and FERRELLA 2021: 1–26. On the role assigned to plants in the zoogonic process, see FERRELLA 2019: 75–86.

<sup>27</sup> Plato, *Leg.* X 895 C 8–9.



The idea seems to be that all living beings (ζῷα) insofar as they are alive have the power to move themselves. On this view, plants are no exception to the rule. They too move themselves even though they do not displace their bodies in the way other living beings do by moving from one place to another. Admittedly, the evidence offered in our doxographical report for the self-motion of plants is somewhat opaque: plants move to and from (presumably when the wind is blowing) but then they return to their vertical posture, holding their branches extended. But we can easily supply additional, indeed better, putative evidence for the self-motion of plants. Think of a phenomenon such as the movement of plants in response to the variable direction of the sun (or another source of light). For someone who is working in the philosophical tradition, we are now considering such a movement (we call it “heliotropism” or “phototropism”) as a prime example of self-motion.

The claim that plants are *ensouled living beings* (ἐμψυχα ζῷα) finds confirmation in Aristotle, who tells us that his predecessors took ensouled beings to exhibit two conspicuous features: self-motion and cognition.<sup>28</sup> Aristotle goes on to say that they all (no one excluded) explained self-motion by positing the existence of a soul understood as a self-mover at the beginning of the chain of motion.<sup>29</sup> Aristotle takes this view to be philosophically unsatisfying because it does not explain self-motion; rather, it ends up making it a primitive (and so unexplained) fact. Furthermore, while Aristotle credits both human and nonhuman animals with the power to move themselves, he shows no inclination whatsoever to ascribe this power to plants.<sup>30</sup> Last but not least, he does not credit plants with cognition either (the other feature associated with being alive).<sup>31</sup> In the

<sup>28</sup> Aristotle, *DA* I 2, 403b25–27:

The starting point of the research [into the soul] is to set out what is most of all thought to belong by nature to the soul. Now, that which is ensouled is thought to differ from that which is not ensouled chiefly by two things: by self-motion [κινήσει] and by cognition [τῷ αἰσθάνεσθαι].

I take αἰσθάνεσθαι to cover all the phenomena we can trace back to cognition. At any rate, the word cannot be used here to refer, narrowly, to the exercise of the power of sense-perception because Aristotle has yet to argue for the existence of different modes of cognition (sense-perception and thinking). Likewise, it makes no sense for him to refer to motion in general as a sign of life. In this context, he must be thinking of self-motion as one of the most conspicuous activities in which living (i.e., ensouled) beings are engaged.

<sup>29</sup> Aristotle, *DA* I 3, 405b31–406a12.

<sup>30</sup> A recent discussion of the reasons why, according to Aristotle, plants are alive but are not self-movers can be found in [COREN 2019](#): 33–69.

<sup>31</sup> By contrast, we have seen that in *Tim.* 77 B 3–6 Plato is willing to ascribe plants a rudimentary form of cognition that does not entail a share in memory, opinion, reasoning, or understanding.

end, Aristotle thinks that we cannot engage in a fruitful study of living beings by adopting a univocal notion of life. An important consequence of this approach is the distinction of perishable living beings into *animals* (ζῷα) and *plants* (φυτά). While both animals and plants are alive, they are engaged in different ways of being alive.<sup>32</sup>

But how different are the ways of being alive of plants and animals? Aristotle rejects the view that life is a univocal phenomenon but he does not embrace its opposite. In other words, he does not think that life is an equivocal phenomenon. I will explore what is involved in his position with a concentration on perishable life, namely life as is encountered here on earth. In this chapter and in the [following one](#), I provide the reader with an initial answer to two questions: (1) How different are the ways of being alive of plants and animals for Aristotle? (2) Do they still allow him to engage in a study of animals and plants insofar as living beings? I plan to return to both questions in [Chapter 6](#). It is only at that point that all the elements for a full answer will be in place. So I urge the reader to be patient. In the meantime, I invite the reader to appreciate the reasons for what looks like a new approach to the topic of life by turning to Aristotle's systematic research into the soul.<sup>33</sup>

## 2 Aristotle's Research into the Soul

Traces of the debate I presented in the [previous section](#) can be found right at the outset of Aristotle's *De anima*. In motivating the study of the soul, Aristotle states that his research has a significance that goes beyond the narrow boundaries of natural philosophy. At the same time he makes it very clear that this research contributes most obviously, and most directly, to the study of nature. What is immediately relevant to our discussion is the reason Aristotle gives for this claim:

<sup>32</sup> Of course, a distinction between animals and plants can be found before Aristotle. But this distinction is typically not informed by a theory. Think of the so-called cyclical argument in Plato's *Phd.* 70 D 8–9, where ζῷα and φυτά are listed as two intuitively obvious subclasses of living beings.

<sup>33</sup> This is a new approach to the topic of perishable life because there is no precursor in ancient Greek thought for the Aristotelian view. It is misleading to think that Diogenes of Apollonia is a precursor of Aristotle. While it is true that Diogenes distinguished sharply between animals and plants, he appears to have done so on the basis of a univocal notion of life. On his view, to be alive is to be able to engage in respiration. What is at stake is not only an alternative account of the role respiration plays in perishable life but also an alternative account of what it means for an animal or a plant to be alive.

knowledge of the soul seems to contribute greatly to all truth but especially to [truth about] nature *because the soul is like a principle of living beings* [ἔστι γὰρ οἷον ἀρχὴ τῶν ζώων].<sup>34</sup>

Right after the above passage Aristotle goes on as follows:

we are seeking to study and to know the nature and essence of the soul, and then [to study and to know] as many accidents as there are of it. Some of them seem to be affections peculiar to the soul, while others [seem] to belong also to *living beings* [τοῖς ζώοις] on account of the soul.

This second passage confirms that Aristotle sees a very close connection between his research into the soul and the study of living beings. I gloss over the details of this passage, which are quite intricate.<sup>35</sup>

What matters is my translation of ζῶα as “living beings.” This translation requires a few words of elaboration, especially since I have already argued that Aristotle uses ζῶα to refer to animals to the exclusion of plants. This is generally true. For example, Aristotle says that being alive (ζῆν) belongs to all *living beings* (ζῶσι), but *animals* (ζῶα) alone have a share in sense-perception because there is more to animals than merely being alive (ζῆν).<sup>36</sup> Aristotle can make this claim because his considered view is that being alive belongs in one way to animals and in another way to plants. This result follows from a theoretical commitment Aristotle makes when he famously states that “being alive [ζῆν] is said in many ways.”<sup>37</sup> The significance of this statement for Aristotle’s study of the soul can hardly be overstated. Aristotle expands on it by offering a list of life activities introduced by the claim that any one of them suffices for being alive: thinking, perceiving, change with respect to place, and change with respect to nutrition, decay, and growth.<sup>38</sup> There is a great deal that is interesting in the strategy employed at this juncture of Aristotle’s argument. To begin with, Aristotle does not try to define life or being alive. Instead, he offers us

<sup>34</sup> Aristotle, *DA I 1*, 402a4–7.

<sup>35</sup> Briefly, Aristotle distinguishes three kinds of items: the soul, the affections that belong to the soul, and the affections that belong to the living being in virtue of possessing a soul. We will soon learn that it is far from clear that there are special affections of the soul in addition to those that belong to living being in virtue of having a soul. The only possible candidate for this role is thinking (403a3–10).

<sup>36</sup> Aristotle, *DA II 2*, 413b1–2. This claim is also found elsewhere in the Aristotelian corpus. But when Aristotle makes this distinction elsewhere, he is relying on results achieved in his *De anima*. See, for instance, *Juv. I*, 467b16–25, where Aristotle distinguishes between being alive (ζῆν) and being an animal (ζῶον). More on this front in [Chapter 2, Section 3](#).

<sup>37</sup> Aristotle, *DA II 2*, 413a22.

<sup>38</sup> Aristotle, *DA II 2*, 413a23–25. Here I take *nous* and *aisthesis* to refer to activities rather than powers or capacities. The Greek allows for this ambiguity.

what he takes to be an exhaustive list of activities. Any one of them suffices for life. Furthermore, Aristotle does not distinguish between cognitive and non-cognitive activities; rather, he treats thinking and perceiving on a par with nutrition, decay, and growth. They are all regarded by him as life activities; as such, they are all traced back to a soul as their ultimate source.<sup>39</sup> Since any one of them suffices for life, Aristotle must explain how they come together in different kinds of living beings. When Aristotle says that there is more to animals than being alive, he means to say that the kind of life exemplified by animals involves, in addition to change with respect to nutrition, decay, and growth, the presence of sense-perception, minimally in the form of sense of touch. Such a life entails the ability to feel pain and pleasure as well as the ability to desire, minimally in the form of appetitive desires. All this follow, directly and immediately, from having the power for sense-perception.

Aristotle elaborates further on the way he envisions the relation between sense-perception, the ability to feel pain and pleasure, and the ability to desire in the context of his discussion of embodied cognition in *DA* III 7. Here Aristotle discusses how the activation of sense-perception leads an animal to pursue or to avoid something. It is emphatically not the case, Aristotle says, that an animal *first* perceives something pleasant or painful and *then* pursues or avoids it; rather, perceiving something pleasant or painful is *ipso facto* pursuing or avoiding it.<sup>40</sup> The capacity for pursuit and the capacity for avoidance are not different from one another or from the perceptual capacity; it is only their *being* that is different.<sup>41</sup> In other words, there are not three distinct powers in the animal; rather, there is only one power but this power is either taken by itself as in sense-perception or is taken in relation to how the animal reacts to that which is good (pleasant) or bad (painful) for it.<sup>42</sup>

<sup>39</sup> By saying this I do not mean to suggest that the celestial unmoved movers are ensouled (for Aristotle, they are disembodied intellects engaged in thinking). Rather, I am trying to capture the Aristotelian assumption that the soul as the source or principle of living beings is to be regarded as the form of a living body. The research focus of Aristotle's *De anima* is on ensouled bodies understood as hylomorphic compounds.

<sup>40</sup> In-depth discussions of this important passage can be found in [CORCILIOUS 2011: 117–143](#) and [GASSER-WINGATE 2021: 160–176](#). I find myself in agreement with Gasser-Wingate when he says that “perception is an affectively loaded form of cognition – an awareness of something combined with attending feelings of pleasure or pain” (173).

<sup>41</sup> *DA* III 7, 431a13–14.

<sup>42</sup> In *DA* III 7, 431a10–14, Aristotle tells us that the activation of the perceptual mean with respect to the good (pleasant) or the bad (painful) as such is a necessary and sufficient condition for the explanation of why the animal pursues or avoids something. The addition of the qualification “as such” (ἢ τοιαῦτα) is important. An episode of perception has a perceptual content; however, it is not because of that perceptual content that the animal pursues or avoids something but rather because

Unlike animals, plants are merely alive in the sense that they are barred from having a share in the higher (cognitive) powers of the soul. Aristotle separates plants from animals and makes room for a type of life that does not involve cognition – namely, plant life. It may turn out to be quite difficult for Aristotle to decide whether a certain creature is an animal or a plant. But this is an epistemic difficulty that does not preclude him from holding that a perishable creature must be either an animal or a plant. *Aristotle can maintain that there is a dividing line between animals and plants even if he is not able to discern that line.* His clearest pronouncement on this front is found at the outset of *HA VII (VIII)*, where he announces that nature does not make leaps but rather proceeds by small steps to the point that we may fail to see the boundary between animate and inanimate things, as well as the boundary between plants and animals.<sup>43</sup> Gradualism need not entail the absence of boundaries in nature. It only means that these boundaries are hard to find. Aristotle discusses a few borderline cases in his study of animals. They are all sea creatures that are plant-like in the sense that they resemble plants. Some of these creatures are attached to rocks or other hard surfaces in the sea and cannot survive when detached (pinnae and razor-mussels are explicitly mentioned). Still, the presence of a rudimentary form of cognition in these borderline creatures is sufficient for considering them animals rather than plants.<sup>44</sup>

the animal perceives a content of sense-perception that also happens to be good (pleasant) or bad (painful) for the animal.

<sup>43</sup> Aristotle, *HA VII (VIII)* 1, 588b4–30. Virtually the same point is made in *PA IV* 5, 681a10–15. The Roman number in round brackets for *HA* is a reference to the book in the ordering printed in BEKKER 1831. This ordering goes back to Theodore Gaza and his enormously influential edition of Aristotle's *De animalibus* (first edition printed in 1476). David Balme reinstated the pre-Gaza ordering of the books in his *editio maior* of the whole *HA* (BALME 2002) as well as in his *editio minor* of *HA VII–IX* (BALME 1991). The reasons for returning to the pre-Gaza ordering are discussed in BEULLENS-GOTTHELF 2007: 471–477. The ordering adopted by Gaza is forcefully defended in KULLMANN 2014a: 291–294 (followed by SCHNIEDERS 2019: 97–106 and EPSTEIN 2019: 82). While this ordering is not adopted on the authority of Gaza, and it depends on a certain reading of the argument that they share with Gaza, I still find it safer to adopt the traditional ordering found in the Greek and Latin manuscript tradition.

<sup>44</sup> Goffrey E. R. Lloyd has developed an alternative reading of these borderline cases (in LLOYD 1996c: 67–82). He has argued that these cases present Aristotle with a real difficulty. This difficulty cannot be explained away by considering it an epistemic difficulty. It has to do with the very *nature* of these sea creatures (emphasis mine). These creatures meet certain criteria for being animals while they also meet other criteria for being plants. Hence, they are neither fully animals nor fully plants. According to Lloyd, this does not entail that “animals” and “plants” are not viable scientific categories for Aristotle, let alone that there are no boundaries at all in the natural world. It only means that these boundaries are not as sharp as we may think they are *if we stop at the theoretical pronouncements made in Aristotle's De anima*. But when we go beyond those pronouncements and look at how Aristotle proceeds in his actual study of animals, we see that he is a careful investigator who is willing to reflect on the applicability of his theoretical distinctions once he is presented with a problematic case.

*The division into animals and plants cannot be presupposed at the outset of Aristotle's research into the soul; rather, it is a theoretical achievement that is secured only in the context of this research.* Moreover, it is an achievement that requires elaboration and defense. My brief review of the discourse on and around living beings before Aristotle suggests that the distinction between animals and plants was not seen, let alone shared, by everyone at the time. While Aristotle's predecessors and contemporaries would have agreed that the soul is a source of life in the sense that it is that which distinguishes what is alive from that which is not, they would not have granted him the distinction between animals and plants. Alternatively, they would have drawn this distinction in a different way. For instance, they would have granted that plants are a different kind of living beings, but they would have insisted that plants do have a share in cognition nonetheless. A prime example for this strategy is Plato, who in the *Timaeus* describes plants as *another* (kind of) *living being* (ἕτερον ζῶον) different from the human being.<sup>45</sup> While he holds that plants do not have a share in judgment, belief, and intelligence, he grants them sense-perception and feelings of pleasure and pain accompanied by appetitive desires.<sup>46</sup>

We can firm up the results reached so far with the help of a passage from the *Epinomis*, a dialogue attributed to Plato:

ATHENIAN STRANGER: When a soul and a body come together to form a single structure and produce a single form, do we assent that this is most truly said to be a *living being* [ζῶον].

CLINIAS: Yes.

ATHENIAN STRANGER: So this kind of thing is most correctly called a *living being* [ζῶον].

CLINIAS: Indeed.<sup>47</sup>

This passage suggests that when Aristotle was about to embark on his research into the soul, a living being (ζῶον) was considered a complex of soul and body in which the soul is the ultimate source of life.<sup>48</sup> So Aristotle is fully justified in assuming, right at the beginning of *De anima*, that the

<sup>45</sup> Plato, *Tim.* 77 A 5.

<sup>46</sup> Plato, *Tim.* 77 A–C. For an in-depth discussion of what may be involved in Plato's claim that plants have a share in sense-perception, see CARPENTER 2010: 281–303 (reprinted, with minor changes, in BALDASSARRI-BLANK 2021: 37–53).

<sup>47</sup> [Plato], *Epin.* 981A–B. The dialogue is spurious. Our ancient sources attribute its authorship to Philip of Opus.

<sup>48</sup> A few other passages from the Platonic corpus can be offered as additional evidence for the link between having a soul and being alive. Here I quote *Phd.* 105 C9–D5:

“So answer,” [Socrates] said. “*What is it that which, whenever it comes to be present in a body, makes the body alive?* [ὦ ἄν τι ἐγγένηται σώματι ζῶν]”

“It is *soul* [ψυχή],” [Simmiias] replied.

soul is “like a principle of living beings.”<sup>49</sup> We can take this initial statement as an *indistinct whole* (καθόλου) of the sort described at the outset of *Phys.* I 1.<sup>50</sup> At this early stage of the argument, we are introduced to something that requires a great deal of elaboration and articulation. More directly, both “principle” and “living beings” are ambiguous. A main task of the subsequent research consists in clarifying this initial statement. Among other things, Aristotle is expected to tell us (1) what kind of principle the soul is, (2) how many kinds of living beings there are, and (3) which of them is (or are) immediately relevant to the project attempted in *De anima*.

The ambiguity and tentativeness of ζῳα at the outset of Aristotle's *De anima* is often overlooked or minimized. I will not engage in a full review of the numerous translations of this passage.<sup>51</sup> I am content to single out the new translation produced by Christopher Shields for the Clarendon Aristotle Series because of its visibility and importance. Shields translates our sentence as follows: “for the soul is a sort of principle of *animals*.”<sup>52</sup> On this reading, Aristotle's *De anima* may be taken to have a distinctively zoological orientation right from the start. The most outspoken defender of a zoological reading of Aristotle's *De anima* is Pierre Pellegrin, who has developed an interpretation that makes it a treatise about animal psychology.<sup>53</sup> It is far from clear that Shields is advocating such a reading. His view seems to be that animals are mentioned at the outset of Aristotle's research into the soul because they are the most obvious (and least controversial) example of living beings. Animals so understood include the human being. On this reading, the opening lines of *De*

“Is this always the case?”

“Absolutely.”

“Is it, therefore, the case that *whenever soul takes possession of a body, soul always come to it bringing life?* [ψυχὴ ἄρα ὅτι ἂν αὐτὴ κατὰσχη, αἰεὶ ἦκει ἐπ' ἐκείνο φέρουσα ζωὴν]”

“Yes, it does.”

<sup>49</sup> Aristotle, *DA* I 1, 402a6–7.

<sup>50</sup> In *Phys.* I 1 Aristotle sketches out an account of how we come to know first principles. This is an account that requires the investigator to inject clarity into something that is initially confounded (see [FALCON 2017](#): 41–59). This sketch must apply to any kind of research, so it must also apply to research into the soul as the principle of living beings.

<sup>51</sup> For a review of the English translations of this passage, see [LENNOX 2021a](#): 175–176.

<sup>52</sup> [SHIELDS 2016](#): 1 (emphasis mine). The old Clarendon translation ([HAMLYN 1993](#)<sup>2</sup>) renders the Greek as follows: “for the soul is as it were the first principle of *animal life*.” An educated guess is that this translation is motivated by the same set of concerns at work in the new Clarendon translation. But the old translation is inferior to the new one: without consulting the Greek text, no one would be able to tell that “animal life” stands for ζῳα.

<sup>53</sup> [PELLEGRIN 1996](#): 465–492. In his view, right at the outset of the work, Aristotle would be looking ahead to his study of animals: “the *De anima* must be annexed to the zoological writings, to which it is a sort of general introduction” (466).

*anima* do not exclude that there are living beings other than (human and nonhuman) animals. Part of the task that Aristotle takes upon himself, right from the start, consists in clarifying what sort of principle the soul is, and whether there are ensouled beings beyond the most obvious case of human and nonhuman animals.<sup>54</sup>

Such a reading ends up being close but not identical to the one I have developed so far. My view can be restated by saying that ζῶον/living being is a *pre-theoretical concept*. This is a concept that is not informed by the subsequent theory advanced in *De anima*. By contrast, ζῷον/animal is a concept isolated in the course of Aristotle's research into the soul.<sup>55</sup> As such, it is a *normative concept* that Aristotle is expected to adopt in his study of animals. Quite tellingly, he explicitly invokes this second concept whenever it is needed or appropriate for him to do so.<sup>56</sup> At least in this sense, it is correct to say that the research into the soul conducted in *De anima* plays a foundational role for the zoological writings. This research orients, and indeed structures, the study of animals by providing the investigator with a suitable theoretical framework. More to the point: the very possibility of focusing animals to the exclusion of plants depends on adopting the normative concept introduced in *De anima*.<sup>57</sup>

Let me elaborate further on Aristotle's task as it emerges from the opening statement of his *De anima*. At the outset of the treatise, ζῶα can only mean "living beings." But ζῶα is not simply ambiguous between (1)

<sup>54</sup> One may try to expand on the little Shields says on this front. For instance, one may try to argue that it is the ordinary use of the Greek ζῶα that makes animals a prima facie uncontroversial instance of living beings. But this would require establishing that there is such an ordinary use of ζῶα as animals and that Aristotle is taking his lead from there.

<sup>55</sup> An instructive attempt to outline what is entailed in such a concept can be found in ALTHOFF 2005: 616–620. It is immediately clear that ζῷον/animal is part of a dense network of concepts Aristotle develops in *De anima* and elsewhere. The first and most obvious is αἴσθησις/sense-perception (as understood by Aristotle).

<sup>56</sup> Here are a few examples (without any pretense of being exhaustive): *Sens.* I, 436b10–12; *Juv.* I, 467b18–25; *PA* II 1, 647a20–21; *PA* III 1, 666a34; *GA* I 23, 731a30–34, 731b4–5. In all these cases, the criterion for being an animal (ζῷον) is the presence of the power of αἴσθησις/sense-perception. Moreover, in a few of these cases, Aristotle makes explicit contact with the results reached in his research into the soul. This is additional evidence that Aristotle assigns a foundational character to this research.

<sup>57</sup> The strategic relevance of the research into the soul conducted in *De anima* for Aristotle's study of animals has never been in question. What has been (and still is) debated is whether, and eventually to what extent, the framework provided by Aristotle's research into the soul is normative for his study of animals. Goffrey E. R. Lloyd acknowledges the programmatic relevance of Aristotle's *De anima* for the science of the living beings (LLOYD 1992: 146–167 [reprinted in LLOYD 1996a: 38–66]). At the same time, he argues that Aristotle remains an open-minded investigator who is willing to revise the theoretical pronouncements made in *De anima* (and elsewhere) whenever he is presented with a difficult case (LLOYD 1996b: 67–82). For Lloyd, the difficult cases are all borderline cases where the distinction between animals and plants is difficult to enforce.



living beings, including plants, and (2) animals, to the exclusion of plants. The situation is decidedly more complicated. When, in the *Epinomis*, Clinias agrees to call an ensouled being a living being (ζῶον), he agrees to call a *heavenly body* a living being. If the reader is not persuaded that the ζῶον can be used to refer to both mortal and immortal living beings, I suggest turning to the *Timaeus*, where Plato says that “everything that partakes of life [ζῆν] may justly and with perfect truth be called a *living being* [ζῶον].”<sup>58</sup> Plato makes the etymological connection between life and living being as he introduces plants as another kind of living beings next to the human being. According to him, plants ought to be called living beings (ζῶα) because they partake in being alive. His polemical target is the position that denies that plants are living beings by denying that they are ensouled.

When we reflect on what Plato says on the topic of plants, we appreciate why the doxographical tradition has no qualms registering Plato as a defender of the view that plants are living beings (ζῶα). And yet, when we look at the actual use that Plato makes of ζῶον in the *Timaeus*, we discover that he uses it to refer to things as different as:

- (1) the *cosmos*, which is described as an intelligent, ensouled ζῶον (*Tim.* 30 B 1) and a visible ζῶον containing all the ζῶα that there might be (*Tim.* 30 D 3–31 A 1)
- (2) the *fixed stars* and the *planets*, which are described as ζῶα (*Tim.* 92 B 5)
- (3) *animals*, which are called ζῶα (*Tim.* 92 C 2)
- (4) *plants*, which are collectively referred to as another (kind of) ζῶον (*Tim.* 77 A 5 and *Tim.* 77 C 3)
- (5) the *sexual parts* of the male and the female human being, which are described as a self-willed ζῶον (*Tim.* 91 A 2 and *Tim.* 91 C 2).<sup>59</sup>

For Plato there exist both perishable and imperishable living beings (ζῶα). Moreover, not only the cosmos but also the heavenly bodies are imperishable living beings (ζῶα). Both deserve to be called “gods” (θεοί). For instance, Plato refers to the cosmos as a *blessed god* (*Tim.* 34 B 8–9) and to the heavenly as *visible gods* (*Tim.* 40 A 1–3, *Tim.* 40 D 4).<sup>60</sup> In other

<sup>58</sup> Plato, *Tim.* 77 B 1–3.

<sup>59</sup> I note, in passing, that Aristotle adopts similar language in *MA* II, 703b20–22. He speaks of each of these parts as a *separate* living being (ἑσπερ ζῶον κεχωρισμένον).

<sup>60</sup> By speaking of “visible gods,” Plato is contrasting the heavenly bodies, whose conspicuous revolutions we can see and study, with the capricious gods, who show themselves only when they want and to whom they want (*Tim.* 41 A 3–6). For an idea of what Plato may mean by capricious gods, whose epiphanies are erratic and unpredictable, think of the Muses who appeared to Hesiod when he was

words, the connection between living beings/ζῷα and gods/θεοί is explicitly made in the *Timaeus*.<sup>61</sup> With this observation in place, we can now return to Aristotle's *De anima*.

Up to this point, I have placed great emphasis on the first two occurrences of the term ζῷα at the beginning of Aristotle's *De anima*. However, this term resurfaces again a few lines later in the following passage:

As it is now, those who speak and research into the soul seek to study the human soul only. But we must be careful not to ignore the question whether its account is one, like in the case of *living being* [ζῷον], or different for each soul, like in the case of horse, dog, human being, and *god* [θεός]; *living being* [ζῷον], the universal, being either nothing or posterior.<sup>62</sup>

Here Aristotle sets himself apart from all his predecessors. While they were mostly concerned with the human soul, he is ready to engage in research that is not programmatically restricted to any kind of soul. An obvious question for anyone who wants to embark on such an unrestricted investigation is whether the soul is a sufficiently homogeneous principle of living beings. In fact, the insertion of “god” next to “horse, dog, human being” makes the case for the heterogeneity of the soul quite pressing. To begin with, it is not at all obvious that the soul has sufficient unity to be the object of a single investigation. If the soul understood as the principle of life can give rise to vastly different ways of life, such as the life of a human being, the life of a horse or a dog, and the life of a god, one may legitimately wonder whether we can engage in an unrestricted study of the soul. Furthermore, it is not at all clear how such a study is to be conducted if the goal is to give an account of the soul that applies to human beings, dogs, horses, and gods. We should resist any easy way out of these methodological concerns. We cannot dismiss the presence of “god” next to “horse, dog, human being” by positing that this word was originally added as a marginal gloss and was subsequently incorporated into the main text. The presence of “god” in our text is dictated by the logic of ancient Greek thought: anything that partakes of life can be called a living being – a ζῷον. A god, *qua* living being, is no exception to the rule.<sup>63</sup> Aristotle goes on to say that living being (ζῷον), the universal, is either nothing or something

tending his sheep at the foot of Mount Helicon. They chose to appear to Hesiod but not to other shepherds (*Theogony* 22–23).

<sup>61</sup> The earth is described as the first and most senior among the gods in *Tim.* 40 C 2–3. As a result, the earth too must be regarded as an ensouled ζῷον.

<sup>62</sup> Aristotle, *DA* I 1, 402b3–8.

<sup>63</sup> Recall the pseudo-Platonic definition of god as imperishable living being advanced in [Plato], *Def.* 411a3–4.

posterior. Either option becomes attractive only if gods are regarded as living beings alongside dogs, horses, and human beings. But if so, then we may be left with no choice but to entertain the thought that “living being” (ζῶον) is a term that can be predicated of vastly different kinds of beings. In this scenario, we should therefore take very seriously the possibility that “living being” is not predicated in the way a genus is predicated of its species but in some other attenuated way to be further explored.<sup>64</sup>

For an idea of how Aristotle would like to deal with these methodological concerns, we must jump to the beginning of the second book. There, Aristotle is no longer concerned with all the living beings that there might be. By his own admission, he is now primarily concerned with *perishable living beings*.<sup>65</sup> This restriction is already in place when Aristotle gives his most common (and non-reductive) account of the soul. For Aristotle, the soul is the first actuality of a natural, organic body that has life potentially.<sup>66</sup> We do not have to wonder what “life” may mean in this context since just a few lines before giving his most common account of the soul Aristotle tells us that being alive entails being able to engage in *self-nutrition, growth, and decline*.<sup>67</sup> What these life activities have in common is that they are necessary for the life of *perishable living beings*.<sup>68</sup> The obvious question is why the restriction to perishable

<sup>64</sup> I am in broad agreement with the conclusion reached in JOHANSEN 2012: 47–48, even though Johansen omits discussion of the significance of the insertion of “god” next to “horse, dog, and human being.”

<sup>65</sup> Aristotle, *DA II* 2, 413a31–32. I add the qualification “primarily” because the focus on perishable living beings does not rule out that some of the results can be extended to imperishable living beings. The difficult question of how this extension is to be pursued remains outside the scope of this chapter. For additional reflections on this front, I refer the reader to FALCON 2009: 167–181.

<sup>66</sup> Aristotle, *DA II* 1, 412b27–28.

<sup>67</sup> Aristotle, *DA II* 1, 412a14–15: “we call life nutrition [of the living being] through itself, growth and decline” (ζωὴν δὲ λέγομεν τὴν δι’ αὐτοῦ τροφήν τε καὶ αὔξησιν καὶ φθίσιν).

<sup>68</sup> Whether these activities are also *sufficient* for the life of perishable living beings depends on whether we can read reproduction into this short list of life activities. Reproduction is instrumental to the perpetuation of perishable life, so its absence from the list is conspicuous and puzzling. One way to deal with this absence is to try to read reproduction into the text. Recall that Aristotle traces not only nutrition and growth but also reproduction back to the nutritive power of the soul. His considered view is that self-nutrition, reproduction, growth, and decline are manifestations of one and the same power, which he describes as the power to preserve itself (*DA II* 4, 416b17–19). But this move is far from convincing. How can the readers of *DA II* 1 presuppose results that become available only in *DA II* 4? The alternative is to consider the definition Aristotle gives us at the outset of *DA II* (“we call life nutrition [of the living thing] through itself, and growth and decline,” *DA II* 1, 412a14–15), a preliminary definition. As such, this definition could not be the final word on the topic by Aristotle. It could only serve as an *interim* definition giving us a first orientation as we progress with our research into the soul. Richard King has explored a version of this strategy in a recent article. He thinks that this definition of life in terms of nutrition and growth gives us a physical grounding forhylomorphism in living things, while it does not represent the final word on the topic by Aristotle (KING 2021b: 43–61).

living beings is not an arbitrary one. Since right at the outset of his investigation Aristotle has criticized his predecessors for having arbitrarily restricted their study of the soul to the case of the human being, we want to know why his own restriction is not vulnerable to the same criticism.

An answer to this question can be given by reflecting on the analogy Aristotle establishes between powers of the soul and rectilinear plane figures:

Now it is clear that there will be one account in the same way of soul and rectilinear plane figure: for just as there is no rectilinear plane figure beyond the triangle and the rectilinear plane figures ordered in the series, so here soul is nothing beyond the [powers of the soul] mentioned.<sup>69</sup>

The centrality of the analogy between powers of the souls and rectilinear plane figures for a correct understanding of the project attempted in Aristotle's *De anima* cannot be disputed.<sup>70</sup> Among other things, this analogy reveals that Aristotle has a plan for the study of the soul, and this plan not only dictates how Aristotle deals with the powers of the soul in the rest of the work but also helps him draw the boundaries of his own research. Aristotle argues that just as rectilinear plane figures are ordered in a series beginning with triangle, so are the powers of the souls. The first in this second series is the so-called nutritive power of the soul. The relevant powers of the soul are distributed across perishable living beings in such a way as to give rise to different kinds of souls. In other words, Aristotle can speak not only of a nutritive power but also of a nutritive soul. As a result, not only the relevant powers of the soul but also the different types of souls are ordered in a series beginning with the nutritive soul. This explains why Aristotle can say that the study of each (type of) soul is also the most appropriate study of the soul.<sup>71</sup>

To be sure, the analogy with rectilinear plane figures provides Aristotle with a non-arbitrary method to study the relevant powers of the soul. But it also provides him with a non-arbitrary method to approach the related phenomenon of perishable life. What is alive and perishable is minimally subject to growth and decline, and neither growth nor decline are possible without engaging in self-nutrition. What Aristotle says on the topic of thought and thinking is surely relevant to a study of a life that does not

<sup>69</sup> Aristotle, *DA* II 3, 414b20–22.

<sup>70</sup> See WARD 1998: 113–128, who insists on the “logical interpretation” of our passage. And yet this analogy also has important ontological implications for the unity of the soul. I will return to those implications in Chapter 6, Section 2.

<sup>71</sup> Aristotle, *DA* II 3, 415a12–13.

include self-nutrition, growth, and decay – namely, the life of a god. According to Aristotle, there exist both disembodied (separate) intellects and heavenly bodies. Not only the former but also the latter are divine living beings engaged in thinking. So a few of the results reached in the course of the study of *nous* as the principle of thought and thinking can be extended to these divine living beings.<sup>72</sup> At the same time, however, both the life of separate (immaterial) substances such as the disembodied intellects and that of imperishable material substances such as the celestial bodies remain outside the scope of Aristotle's *De anima*. From the second book onward, Aristotle's research into the soul is programmatically restricted to the soul as a source of perishable life. As a result, this research concentrates, at least primarily, on the kinds of perishable living substances we encounter here on earth.

In the subsequent Peripatetic tradition, the study of the soul was from the very start programmatically restricted to the study of the soul of perishable living beings. In this tradition it was customary to take a shortcut by focusing right from the beginning on a particular group of living beings. Here is, for example, how Alexander of Aphrodisias introduces his own *De anima*:

It is our aim to speak of *the soul of the body subject to generation and perishing* [περὶ ψυχῆς τῆς ἐν γενέσει τε καὶ φθορᾷ σώματος]. We will discuss its substance and its powers: what they are, how many they are, and how they differ from one another. (Alexander of Aphrodisias, *De anima* 1.1–3; emphasis mine)

Alexander goes on to say that he finds more truth in the views passed down from Aristotle than in what other thinkers have claimed on the same topic, and that he will fulfill his stated aim by setting out Aristotle's views on the soul as clearly as possible. Alexander is promising an account that will follow the one advanced in Aristotle's *De anima* very closely. There remain a few small but philosophically significant differences. The one that matters here is how Alexander embarks on his research into the soul. He does so by restricting his investigation right from the start to the soul that is a principle of perishable life. This restriction is surely faithful to Aristotle's thought. By now, however, it should be abundantly clear that the shortcut adopted by Alexander was not available to Aristotle. Aristotle must work his way into the position that Alexander

<sup>72</sup> But how this can be done is a large and complex issue that does not concern us here. For more on the challenges facing the investigator who tries to extend results reached in Aristotle's *De anima* to the study of imperishable life, see [FALCON 2005](#): 85–112.

takes for granted. Alexander can take this shortcut only because all the conceptual groundwork was already done by Aristotle.

### 3 Aristotle and the Study of Animals and Plants

Aristotle's *De anima* provides the foundation for a theoretically informed study of life on the crucial assumption that the soul is that which distinguishes what is alive from that which is not. Aristotle's first, and arguably most important, step in the study of life is his decision to focus on perishable life. The significance of this initial move can hardly be overstated. Given that for Aristotle there is life in the superlunary world, one may legitimately wonder whether he has developed the conceptual resources to justify his concentration on perishable life to the exclusion of imperishable life. The answer to this question is to be found in the analogy between rectilinear plane figures and powers of the souls. This analogy supplies Aristotle with a non-arbitrary method for the study of the soul as a source of life for perishable living beings.

The analogy between rectilinear plane figures and powers of the souls suggests that there are three kinds of souls. Consequently, there are three kinds of perishable life: plant life, animal life, and human life. The capacity for thought and its exercise, thinking, are a distinctive mark of the third kind of life. But while the study of this capacity is an integral part of research into the soul, it is not itself an integral part of natural philosophy. Aristotle makes this point in his general introduction to the study of animals: "one should not speak of the soul in its entirety, for it is not the soul in its entirety that is a nature but [only] some part of it (either one part or more parts)."<sup>73</sup> The same point resurfaces in the *Metaphysics*:

it is the task of the natural philosopher to study the soul *to some extent*, namely [to study] all [the parts of] the soul [that are] not [conceivable] without matter.<sup>74</sup>

From what Aristotle says elsewhere, it is clear that he means to rule out the capacity for thought from the purview of natural philosophy.<sup>75</sup> For Aristotle, natural philosophy is concerned with the soul under a certain description – namely, the soul as the nature of a living body. This description does not apply to *nous* as the principle or source of human thought.<sup>76</sup>

<sup>73</sup> Aristotle, *PA* I 1, 641b9–10. <sup>74</sup> Aristotle, *Metaph.* VI 1, 1026a5–6.

<sup>75</sup> Aristotle, *Metaph.* XII 3, 1070a24–27.

<sup>76</sup> I defend this claim in [FALCON 2005](#): 19–22. On *nous* and nature, see [BROADIE 1996](#): 176–193; [HUSSON 2012](#): 207–237; [LENNOX 2009](#): 1–18 (somewhat updated in [LENNOX 2019a](#): 100–107); [LENNOX 2021a](#): 193–198. The view that there are limitations to what is studied by Aristotle's natural

While Aristotle cannot accommodate *nous* as a principle of human thought within nature, he is able and willing to make a reference to such a principle in the study of nature. This becomes clear as soon as we realize that Aristotle explains certain features of the human body teleologically with reference to the human capacity for thought. Aristotle can consistently claim that we must refer to *nous* as the principle of human thought if we want to arrive at a scientifically adequate understanding of the human body, and at the same time he can maintain that *nous* falls outside the boundaries of natural philosophy. The explanation of the human erect posture illustrates this point very well. For Aristotle, the upright posture distinctive of the human being is for the sake of facilitating human thinking.<sup>77</sup> The explanation of the human tongue is another instance of the same phenomenon. According to Aristotle, the human tongue is different from that of all other animals because it is exceptionally soft and flexible to allow for human speech, which is a necessary (but not sufficient) condition for human thought.<sup>78</sup> Clearly, (1) the human body and its various parts are a legitimate topic for natural philosophy, and (2) a full explanation of their arrangement and functioning requires a reference to the human capacity for thought; but (3) this does not entail that this capacity falls within the realm of nature. We can restate points (1) to (3) by saying that *nous* functions as an explanatory principle in rendering premises relevant to the explanation of the human animal, but it is not itself a fitting object of study for natural philosophy. In due course I will argue that the human animal is not only a fitting object of natural investigation but it also plays a somewhat special role in the context of Aristotle's study of animals.<sup>79</sup> For the time being, let me stress that once we remove the study of the capacity for thought from the realm of natural philosophy, we are left with two forms of perishable life: plant life and animal life, with

philosophy when it comes to the soul is minoritarian. Most scholars think that Aristotle can accommodate *nous* within the domain of natural philosophy. For the majoritarian view, see [SEGEV 2017: 177–209](#) and [FREY 2018: 160–174](#). These scholars tend to push the passages from *PA* I 1, *Metaph.* VI 1, and *Metaph.* XII 3 to the margins of their interpretation of Aristotle. This is part of a long tradition that goes back to Alexander of Aphrodisias. On Alexander and his highly selective reading of Aristotle when it comes to the topic of *nous*, I refer the reader to [FALCON 2021C: 246–260](#).

<sup>77</sup> See Aristotle, *PA* II 16, 660b29–661a14. For a discussion of the explanation of erect posture offered by Aristotle (and Plato), see [GREGORIC 2005: 183–195](#).

<sup>78</sup> *PA* II 16, 659b30–34 combined with *PA* II 17, 660a19–23. In addition to the ability to speak a language, the powers for memory and *phantasia*, as well as a great deal of experience (*empeiria*), are also required for thought. The capacity for thought must not be confused with its enabling conditions, even though it cannot be exercised in their absence.

<sup>79</sup> See [Chapter 3, Section 2](#).

human life as a particular kind of animal life. It is because Aristotle takes animals (human beings included) and plants to be different kinds of perishable living beings that he is justified in approaching the study of perishable life via separate studies of animals and plants.

This conclusion can be squared with the view that the human being occupies a somewhat unique place in Aristotle's cosmos. A famous passage from *DC* II 12 can help us make progress on this front.<sup>80</sup> Here Aristotle confronts a difficulty that casts doubt on the claim that there is order in the natural world. One might expect order to entail that the things that are closer to the first unmoved principle of the cosmos engage in fewer activities, while those that are further away from that principle display an increasingly complex behavior. This is in fact not the case, either in the celestial region or in the sublunary world. For the sake of our argument we can concentrate on the sublunary world, where human beings display a vastly more complex behavior than animals and plants. Furthermore, plants are stationary living beings, and they are only engaged in self-nutrition and reproduction. Should we conclude that plants are closer to the best condition enjoyed by the first unmoved mover? Of course not.

Aristotle offers his solution to this difficulty with the help of an analogy: some people may remain fit without physical exercise; others may need little exercise to stay fit; others still may need to engage in a variety of strenuous physical exercise to attain the same goal; finally, there are also a few who must settle for a lesser goal because they can never be fit regardless of how much physical exercise they undertake. This lesser goal can be one of the very things done for the sake of the higher goal – for instance, weight loss. Losing weight when one is overweight is a necessary but not sufficient condition for fitness. But how are we expected to apply this elaborate analogy at the cosmological level? Here is the answer: while animals and plants are like those people who must settle for a lesser goal because they cannot achieve fitness, human beings are in a predicament comparable to those people who are required to engage in an elaborate

<sup>80</sup> A recent, in-depth analysis of this passage and its anthropological implications can be found in [RAPP 2019: 77–96](#). The epistemological status of what Aristotle accomplishes in this passage is disputed. Jointly with Mariska Leunissen, I argued (in [FALCON-LEUNISSEN 2015: 217–240](#)) that by appealing to what is reasonable Aristotle is not merely offering a dialectical solution falling short of the strict standard of natural scientific knowledge, nor is he providing us with natural scientific knowledge in the strict sense. Rather, he is trying to reduce our puzzlement by offering convictions that are suitable for humankind. I bracket the epistemological complications generated by Aristotle's appeal to what is reasonable. For the sake of the present argument, I take the account as if it were a straightforward contribution to natural science.



scheme of action to stay fit. In this respect, human beings are different not only from higher (divine) living beings, which achieve their goal with little or no action, but also from lower living beings, which are permanently barred from achieving that goal.

Human beings enjoy a somewhat special status among perishable living beings. They alone have a share in the divine goal, which is to be understood as the exercise of the activity characteristic of imperishable (divine) living beings. This activity is theoretical thinking. When we are engaged in this sort of activity, we are active with our best part, which is also a divine part. But the exercise of this activity requires us to engage in a variety of more mundane activities. I have in mind activities such as perceiving, storing memories, and speaking a language. It does not take long to see that these more mundane activities are not on a par with theoretical thinking. They are all activities that are common to the soul and the body; as such, they cannot be adequately explained without a reference to the body. By contrast, theoretical thinking can, indeed should, be considered apart from its bodily implementation, especially if it is an activity we share with the disembodied intellects. In this sense, it exceeds the boundaries of nature. We are back to the same conclusion as before: while we cannot make sense of the complexity of human life without a reference to the human capacity for thought, *nous* understood as the principle that explains this capacity is excluded from natural philosophy. This exclusion makes it possible for Aristotle to subsume human life under animal life and makes it possible for him to consider human and nonhuman animals as a single investigative domain.

Separate studies of animals and plants are announced at the outset of Aristotle's *Meteorology*:

It has already been spoken about the first causes of nature and all natural motion; also about the stars that are ordered in the motion of the heavens, and about the bodily elements, [establishing] how many they are and what their nature is, and how they change into one another, and about generation and perishing in general. There remains for consideration a part of this investigation that all predecessors called "meteorology." These things are natural, although their order is less perfect than that of the first bodily element. They take place in the region nearest to the motion of the stars, such as the Milky Way, the comets, and the inflamed and moving portents. They are also the affections that we may posit to be common to air and water, and furthermore the kinds, parts, and affections of the earth, from which we might study the causes of winds and earthquakes and all the things that happen in accordance with their motions. Some of these things puzzle us, while we may be able to touch upon others in some way. Furthermore,

[the investigation] is concerned with the falling of thunderbolts, with whirlwinds and fire-winds, and furthermore with the recurrent affections that are produced in these same bodies by concretion. Once we have dealt with these things, we will see whether we are somehow able to give an account, in accordance with the method indicated, *of animals and plants, both in general and separately* [περὶ ζώων καὶ φυτῶν, καθόλου τε καὶ χωρὶς]. Once this is done, perhaps the whole of what was established by us at the outset will be completed.<sup>81</sup>

This passage presents us with a sketch of the study of nature as envisioned by Aristotle. Like any other sketch, this one lacks in detail. For one thing, there is no reference to the human being. For another, there is no mention of the research into the soul. It is hardly controversial that we can read a reference to the human being in our passage. Much more delicate is the absence of any explicit reference to research into the soul. This absence can be handled in more than one way. It can be explained away by saying that we are only given the main lines of natural philosophy as understood by Aristotle and saying that certain details are inevitably left out. But it cannot be ruled out that Aristotle's research into the soul, while it has foundational character for the study of living beings, is not itself a part of natural philosophy. If so, the study of the principle of perishable life (the soul) is not to be conflated with the study of perishable life (animals and plants).

Recall the passages from *PA I* and *Metaph.* VI where Aristotle states that the power of thought and the ensuing activity of thinking go beyond the scope of natural philosophy. What Aristotle says at the beginning of his *Meteorology* can be taken to be additional evidence (although only negative) that the relation of the research into the soul to natural philosophy is not as straightforward as the relation of a part to the whole.<sup>82</sup> We may not be able to decide, once and for all, between the two exegetical options outlined above. What is certain, however, is that a chronological move is not available to us. We cannot say that the absence of any reference to the research into the soul is evidence that Aristotle wrote his *Meteorology* before

<sup>81</sup> Aristotle, *Meteor.* I 1, 338a20–339.

<sup>82</sup> I argued for this view in [FALCON 2005](#): 16–22. The practice of reading Aristotle's *De anima* into the research project outlined in the *Meteorology* goes back at least to Alexander of Aphrodisias. However, Alexander cannot be especially authoritative on this very point since he is manifestly engaged in a selective reading of the relevant texts. Alexander never mentions the passage from the *Parts of Animals* where Aristotle tells us that the study of the power for thought is not a part of the study of nature. In fact, Alexander acts as if this passage does not exist. Elsewhere I argued that this silence is a deliberate choice on his part since this passage does not fit well with his overall interpretation of Aristotle's natural philosophy ([FALCON 2021C](#): 246–260).

his *De anima*. Even if there is no explicit mention of the research into the soul in the programmatic passage at the beginning of Aristotle's *Meteorology*, it is easy to see that this research is part of the relevant theoretical background. Without the results achieved in the context of Aristotle's *De anima*, we would not be able to understand why we need to study *animals* and *plants* rather than *perishable living beings*.

Aristotle does not only outline the main topics of natural philosophy at the outset of his *Meteorology*; he also lists them in a definite order. This is the order in which they are to be studied.<sup>83</sup> Consider the first topic: a study of the first causes of nature and all natural motion (*Meteor.* I 1, 338a20–21). This is a brief yet precise reference to the investigation contained in the eight books of his *Physics*. It is even possible to read into this description a division of the investigation offered in the eight books into two distinct *pragmateiai*: a study of nature and a study of motion.<sup>84</sup> Whether or not we accept this reading, it is uncontroversial that a general study of nature, combined with a general study of motion, serve as a sort of theoretical prolegomenon to the ambitious research that comes to an end only when we have also given an account of “*animals and plants*.” When we consider the commitment to the study of animals and plants within this theoretical framework, we see that there is nothing conventional about the order in which Aristotle lists the various natural investigations at the outset of his *Meteorology*. An optimal study of the natural world requires that the general study of nature offered in the eight books of Aristotle's *Physics* be in place before we embark on any one of the specialized studies that jointly constitute natural philosophy.<sup>85</sup>

For different reasons, I would like to argue that the order in which animals and plants are listed in the opening lines of Aristotle's *Meteorology* is an indication of the order in which their study should be approached. The research in natural philosophy outlined by Aristotle ends with a study of perishable living beings, which consists of separate studies of animals and plants to be carried out in the following order: *first* animals, *then* plants. This order of inquiry is far from obvious. In fact, it is mildly surprising. Let us return, briefly, to the inquiry into the soul offered in Aristotle's *De anima*. When we look at how Aristotle proceeds in the second book, we see that he ascribes nutrition, growth, and reproduction to one and the same part of the soul, the so-called nutritive (alias vegetative) soul. We also see that he engages

<sup>83</sup> See BURNYEAT 2001: 7–24; FALCON 2005: 2–7; RASHED 2005: cxliv–clii.

<sup>84</sup> BRUNDSCHWIG 1991: 11–40.

<sup>85</sup> The unity and organization of Aristotle's writing on natural philosophy is a major theme in FALCON 2005 (especially 1–30).

in a study of the various parts of the soul starting from the nutritive soul. This suggests a bottom-up approach to the study of the basic powers of the soul and their corresponding life activities. Why not transpose this overall approach to the study of perishable living beings? Why not begin the study of perishable living beings with a study of plants and then move on to a study of animals?<sup>86</sup>

My answer to the above questions is offered in the rest of this book. Here I am content to stress that *studying the principle of perishable living beings (the soul) need not be the same as studying perishable living beings (animals and plants)*. Aristotle is not compelled to follow the strategy adopted for the study of the powers of the soul when he turns to the study of animals and plants. His reasons for the explanatory strategy adopted in the study of animals and plants must be found within that study rather than outside it. At this early stage of my argument, let me only highlight a further aspect of my overall interpretation. Aristotle assigns a paradigmatic status (as opposed to a merely heuristic one) to animals in his study of perishable living beings. His working hypothesis is that the methodological results achieved in the context of the study of animals can somehow be extended to the study of plants. The qualification “somehow” is important. Part of my task in [Chapters 4](#) and [5](#) consists in clarifying how, and indeed to what extent, these results can be extended from one investigative domain (animals) to the other (plants). For the time being, let me recall one important rule of inquiry that controls Aristotle's overall strategy: all investigations ought to start from the thing that is most developed and as such is also better in nature.

An especially clear formulation of this rule of inquiry is found in a fragment from the now lost *Protrepticus*:

Prior things are always more knowable than posterior things, what is better in nature [is more knowable] than what is worse: *there is knowledge more of what is organized and determinate than of their opposites* [τῶν γὰρ ὀρισιμένων καὶ τεταγμένων ἐπιστήμη μᾶλλον ἐστὶν ἢ τῶν ἐναντίων].<sup>87</sup>

<sup>86</sup> I note, in passing, that this order of investigation is found in all the medieval Arabic and Latin classifications of the so-called natural sciences. In al-Fārābī's *On the Sciences (De scientiis)*, we find the study of plants and the study of animals listed respectively as the seventh and eighth parts of natural philosophy. The same order is found in the Avicennian corpus of natural philosophy, where the discussion of the soul (*liber sextus naturalium*) comes before the study of plants (*liber septimus naturalium*) and animals (*liber octavus naturalium*). This reversal of the order found in Aristotle's *Meteorology* resurfaces in the Latin tradition (e.g., in Gundissalinus's tract *On the Division of Philosophy*). More instances of the same phenomenon could be given. All the above authors seem to think that the order of investigation we adopt for the study of the principle of perishable living beings (i.e., the soul) should also be adopted for the study of perishable living beings.

<sup>87</sup> Aristotle, *Protr.* B 33 Düring (= Iamblichus, *Protr.* 38.7–8 and *De comm math sc.* 81.7–11).

Additional passages from the Aristotelian corpus in which the order of explanation follows the order of nature – with the order of nature having normative force over the order of exposition – can be highlighted.<sup>88</sup>

According to Aristotle, animals are more developed, and so more complete (and more perfect), living beings than plants; as a result, we must begin our investigation of perishable living beings from them rather than from plants. Theophrastus appears to share this idea. In [Chapter 4](#), I argue that he embarks on his study of plants on the implicit assumption that the study of animals is already in place.

In [Chapter 5](#), I show that Theophrastus adopts explanatory strategies that are reminiscent of those that Aristotle himself employs in his study of animals. Like Aristotle, Theophrastus approaches the study of living beings via separate studies of animals and plants. Like Aristotle, he gives explanatory priority to the study of animals. By deploying analogical reasoning, Theophrastus appears to be confident that a few results reached in the context of the study of animals can be extended to the study of plants. When we take all this into consideration, we see that the Peripatetic study of animals and plants as outlined at the outset of the *Meteorology* betrays a definite order of inquiry: *Aristotle and Theophrastus study the more complete and more perfect form of life (animals) before embarking on a study of the one that is less complete and less perfect (plants).*

The epistemic principle mandating that we start our inquiry from that which is more organized and more complex need not clash with the one that requires us to begin our investigation from that which is simpler. As will become clear in due course, animals do not only display more organization and more structure than plants; they also display a more *unified* organization and a more *unified* structure than plants. We can restate this point by saying that the complexity and structure present in animals display *organic unity* in a better and more perfect way than the complexity and structure present in plants. I will elaborate further on this front in [Chapter 3](#). For the time being, I would like to return to the other promise made at the outset of Aristotle's *Meteorology*. Aristotle promised not only to study "*animals and plants*" but also to study them "*both in general and separately.*" These words are evidence that the complete science envisioned at the outset of the *Meteorology* contains separate studies of animals and plants, and that each of the two studies has a common as well as a special component. Scholars have often found the rationale for what

<sup>88</sup> For example, Aristotle, *GA* II 4, 737b25–27. For a recent discussion of this methodological principle, see LEUNISSEN 2017: 56–74 (especially 58–66).

appears to be a complex explanatory structure in *PA I*. There, Aristotle says that the explanation of certain features of animal life are to be sought across different kinds of animals. He adds that such explanations are required to avoid tedious repetitions. His examples are sleep, respiration, growth, decline, and death.<sup>89</sup>

What Aristotle says in this passage is eminently reasonable. And yet, avoiding needless repetitions cannot be his sole (let alone main) motivation for this explanatory strategy. The theory of scientific explanation outlined in *Posterior Analytics* requires Aristotle to give explanations at the correct level of generality. This requirement is central to his explanatory project. It is only by giving explanations at the right level of generality that we can capture salient features that might otherwise be missed. What Aristotle has in mind is best illustrated by recalling a famous example introduced in Aristotle's *Posterior Analytics*: we have proper knowledge of the fact that the sum of the triangle's internal angles is equal to two right angles if, and only if, we know that this property belongs to all triangles insofar as they are triangles.<sup>90</sup> Since this geometrical property belongs to all triangles, it also belongs to equilateral, isosceles, and scalene triangles. But it does not belong to them in virtue of the fact that they are equilateral, isosceles, or scalene. Rather, it belongs to them because they are triangles, or else in virtue of the fact that they are three-sided figures. Aristotle employs this example to show that there is a common explanatory level beyond that of equilateral, isosceles, and scalene triangles. He argues that this common explanatory level is reached by ignoring those facts that are specific to equilateral, isosceles, and scalene figures.

The sketch outlined at the beginning of Aristotle's *Meteorology* is seriously underwritten, so it is an entirely open question how much we are entitled to read into it. But we cannot rule out, it seems to me, that the explanatory principle introduced in Aristotle's *Posterior Analytics* informs the study of animals and plants announced in the opening lines of his *Meteorology*. There is, however, a residual ambiguity. We can read these lines as containing the promise to engage in separate studies of animals and plants (to be approached in this very order). On this reading, both studies consist of a common component followed by more specific components. But we cannot rule out that these lines announce a general study of animals and plants *in addition to* separate studies of animals and plants. We can

<sup>89</sup> Aristotle, *PA I* 1, 639a19–21.

<sup>90</sup> Aristotle, *APo I* 4, 73b32–74a3. Aristotle illustrates this epistemological request in *APo I* 5 by discussing three ways in which we can fail to provide explanations at the right level of generality. An excellent discussion of this chapter can be found in [HASPER 2006](#): 252–284.

think of this general study of animals and plants as an analogue to the general study of triangles that is required along with narrower explanations given for the different kinds of triangles. When we are engaged in this general study, we consider animals and plants in common insofar as they are perishable living beings. As readers of Aristotle's *Meteorology*, we do not know how much there is to be explained in common for animals and plants *qua* perishable living beings. I am centrally concerned with this question in the [next chapter](#). Here I would like to highlight that the project of a general study of perishable life – that is, a study that treats certain aspects of animal life and plant life in common – is not ruled out by what Aristotle promises at the outset of the *Meteorology*. On the contrary, such a project must be taken seriously because it is mandated by the theory of scientific explanation advanced in Aristotle's *Posterior Analytics*.

In this chapter we have encountered for the first time the two epistemic principles outlined in the [Introduction](#). While the first requires us to begin our investigation into perishable life from the most complex and most determinate form of life, the second may be read as entailing that we start this investigation from the most widespread phenomenon. These principles pull us in different directions. While the first requires us to engage in an investigation into perishable life starting from animals rather than plants, the second mandates a focus on what is common to both animals and plants. At this early stage of our argument, we do not know how Aristotle resolves this tension. We only know that both principles are equally important for Aristotle. The [next chapter](#) will take our discussion to the next level by showing how Aristotle negotiates their application in the context of the so-called *Parva naturalia*.

## *Aristotle's Parva naturalia and the Study of Animals and Everything That Has Life*

### 1 Introduction

In [Chapter 1](#) I argued that it is not an interest in this or that form of life but rather an interest in life in all its forms and manifestations that prompted Aristotle to engage in his research into the soul understood as the ultimate source of life. I also argued that Aristotle's *De anima* plays a foundational role for any systematic study of perishable life. It is the serial approach adopted for the study of the powers of the souls that makes it possible for Aristotle to restrict the scope of his investigation from life in all its forms and manifestations to life as it is encountered here on earth. This restriction is too often taken for granted or even overlooked. And yet, it plays an architectonic role in Aristotle's natural philosophy.<sup>1</sup>

The close connection that exists between having a soul and being alive is lost when we approach Aristotle's *De anima* as a psychological work concerned with the mind via a study of perception and thought. This exegetical approach has its roots in post-Aristotelian philosophy. Both Hellenistic and post-Hellenistic philosophers did not share Aristotle's ambition to engage in a systematic study of the natural world. Stoics and Epicureans did not trace the powers related to self-nutrition, growth, and reproduction back to the soul.<sup>2</sup> It was, therefore, quite natural for them to focus on the cognitive powers of the soul. A similar point can be made in connection with the Platonists of late antiquity. While these philosophers were eager to adopt the conceptual resources Aristotle developed for the discourse on and around the soul, they no longer felt the need to engage in any sustained investigation of the phenomenon of perishable life. In fact, they found a complete explanation of the natural world in Plato's *Timaeus*. By their lights, this work was the culmination of the ancient study of

<sup>1</sup> The epistemological implications of this restriction for the study of imperishable life are explored in [FALCON 2005: 85–112](#).

<sup>2</sup> See the doxographical report going back to Aëtius discussed in [Chapter 1, Section 1](#).



nature. It also set the limits of their interest in the natural world, controlling the selection of what was relevant in Aristotle's writings on natural philosophy. As a result, a full immersion in the study of the natural world in all its aspects became an unnecessary and unwanted distraction.<sup>3</sup> To make a long story short, the study of animals and plants remained at the margins of the ancient philosophical reflection after Aristotle. The latter stood out in antiquity as a remarkable exception for his unwavering commitment to a systematic, and philosophically motivated, study of perishable life.<sup>4</sup>

Aristotle conceived of his study of perishable living beings as an investigation into animals and plants. This is arguably one of the most important results we can take away from Aristotle's *De anima*. But nothing Aristotle says in this work rules out that there might be room for a common study of animals and plants in addition to separate studies of animals and plants. On the contrary, Aristotle is expected to remain open to the possibility that salient features of perishable life can be explained in common for both animals and plants *qua* perishable living beings. More to the point: this is a possibility that Aristotle is required to entertain since the procedures of scientific explanation outlined in the *Posterior Analytics* require him to give explanations that are as general as possible while at the same time remaining as specific as necessary to deliver scientific knowledge.

In light of the above, the questions I will try to answer in this chapter are:

- (1) Are there explanations that apply in common to animals and plants *qua* perishable living beings in Aristotle's extant writings on natural philosophy?
- (2) If there are such explanations, where are they located in his overall project?
- (3) How does Aristotle go about studying animals and plants in common?  
Last but not least,
- (4) How far is Aristotle able to pursue a common study of animals and plants?

<sup>3</sup> In the *Timaeus* Plato makes it very clear that his goal is to account for the emergence of the cosmos down to the creation of the human beings (*Tim.* 27 A combined with *Tim.* 90 E). Accordingly, he deals with the emergence of animals in a couple of pages at the very end of the dialogue. It is difficult to resist the conclusion that the emergence of animals is an expendable coda to the project attempted in the *Timaeus*. A similar point can be made with respect to the emergence of plants whose discussion is compressed in a very short, elliptical passage (*Tim.* 77 A–C).

<sup>4</sup> I discuss the reasons for this systematic marginalization of the study of perishable life after Aristotle in [FALCON 2021c: 246–260](#).

## 2 The Project of the *Parva naturalia*

The opening lines of *Sens.* 1 mark the transition from Aristotle's research into the soul to the explanatory project conducted in the short essays collectively known as *Parva naturalia*. In a couple of carefully crafted sentences, Aristotle gives us an idea of how he envisions the relation between his research into the soul and these short works on natural philosophy. For this reason, this transitional passage has been the object of a close examination by scholars interested in the architectonic question of how the different Aristotelian investigations fit together into a coherent project.<sup>5</sup> Here is my own translation of this important passage:

Since we earlier completed a study of the soul as such and each of its powers taken part by part, it is next to be investigated about *animals and everything that has life* [περὶ τῶν ζώων καὶ τῶν ζώην ἔχόντων ἅπαντων], [with a focus on] what are their specific and common activities. So, then, let us assume what was said about the soul and let us speak about the rest – and *first about what is first* [πρῶτον περὶ τῶν πρώτων].<sup>6</sup>

I begin my discussion of this text from what is obvious before turning to what is not so obvious and potentially controversial. The study of the soul comes before the study of animals and everything that has life in the order of inquiry. This is a direct consequence of the foundational role that the research into the soul plays for the project that Aristotle announces in this passage – namely, a study of animals and everything that has life. Recall that the soul is the source or provider of life. In other words, the soul is the most general and fundamental principle of living beings. This point is clearly made at the outset of Aristotle's *De anima*, where the relevance of the research into the soul for the study of living beings is also stressed. In the second part of the above passage Aristotle tells us, explicitly and unequivocally, that he now plans to build on the main results he has reached in his research into the soul.

This research supplies him with the explanatory starting points for another investigation, which he describes as the “*study of animals and everything that has life*.” Moreover, the research into the soul and the study of animals and everything that has life are to be integrated into a single explanatory project. But it remains to be seen how Aristotle conceives of their integration. To be sure, the integration envisioned in this transitional passage need not be a case of straightforward assimilation.

<sup>5</sup> Here I single out [RASHED 2004](#): 185–202; [MOREL 2006](#): 121–139; and [JOHANSEN 2006](#): 140–164.

<sup>6</sup> Aristotle, *Sens.* 1, 436a1–6.

When Aristotle says that he has completed his research into the soul and is ready to turn his attention to another investigation, he may be saying that he has moved away from the study of the soul and is about to engage in another kind of investigation.<sup>7</sup> On this reading, Aristotle not only announces the transition from the research into the soul to a study of animals and everything that has life but also indicates a shift in research focus. While the previous investigation was concerned with the powers of the soul, the upcoming inquiry will deal with the activities of animals and everything that has life.

None of the claims made so far is especially controversial. Let us now look more closely at how Aristotle describes his shift of focus. While Aristotle's *De anima* is concerned with the *soul as such* and with its fundamental powers taken as *parts of the soul*, his new project is about *animals and everything that has life*. The way Aristotle describes the contents, and even the argument, of his *De anima* calls for a few words of elaboration. To begin with, the soul is no abstract entity over and above its powers, so we should refrain from thinking that Aristotle is referring to an investigation of the soul followed by one that is concerned with its powers. Aristotle's view is that the study of the powers of the soul amounts to a study of the soul. To his mind, the only way to engage in a fruitful study of the soul is by engaging in a serial study of its relevant powers. But Aristotle does not simply speak of powers of the soul; he pointedly speaks of *powers taken as parts of the soul*. We can infer this from the fact that Aristotle tells us that they have been studied "*part by part*." I submit that Aristotle has in mind a specific subset of powers. We can refer to them as the basic powers of the soul. These powers are parts of the soul because they are separate (or separable) in account. "Separate (separable) in account" means independent in definition: each of these powers can be defined independently from the other basic powers of the soul.<sup>8</sup> Insofar as they are basic, these powers are also constitutive of the soul.<sup>9</sup>

The beginning of *Sens. I* is a carefully worded description of how Aristotle proceeds in his research into the soul. The positive (i.e., constructive) part of this research begins in earnest at the outset of the second

<sup>7</sup> I owe this point to Klaus Corcilius (CORCILIUS 2008: 25).

<sup>8</sup> The conceptual distinction between being a part of the soul and being a power (or a capacity) of the soul, and the relation between being separable in account and being a part of the soul, is discussed in CORCILIUS-GREGORIC 2010: 81–119 and JOHANSEN 2012: 53–62. There is some important disagreement among these scholars on how the distinction between basic and non-basic parts of the soul is to be secured. This disagreement can be traced by looking at the footnotes in JOHANSEN 2012: 53–62.

<sup>9</sup> For an introduction to how Aristotle thinks about powers of the soul, see JOHANSEN 2012: 1–8.

book with what Aristotle himself calls the most common account of the soul.<sup>10</sup> According to this account, the soul is the first actuality of a natural, organic body that has life potentially.<sup>11</sup> This account is not contingent upon the subsequent study of the basic powers of the soul. Rather, it gives us a theoretical framework for the investigation to come. The theoretical framework in question is nothing less than Aristotle's general hylomorphism. But this account accomplishes at least another important result. It provides us with a much-needed picture of unity before embarking on a serial account of the basic powers of the soul. In the previous chapter I argued that the most common account of the soul establishes the scope and boundaries of the research into the soul; from here onward, Aristotle concentrates on the soul of *perishable living beings*.<sup>12</sup> It is possible to restate this point by saying that this account orients, and indeed shapes, the research into the soul offered in *DA II–III*.<sup>13</sup> Once this account is in place, Aristotle continues his research via an inquiry into the basic powers of the soul. These powers are taken one by one in a certain order. Aristotle tells us, forcefully and unequivocally, that a serial study of these powers is the only way to move forward. In other words, there is no other way to secure the definitional goal announced at the outset of Aristotle's *De anima* than a serial study of the powers of the soul.<sup>14</sup> There is, however, no textual evidence that the most common account of the soul becomes superfluous once the basic powers of the soul are serially defined. We can safely say the most common account of *the soul as such* combined with a definition of each of its *powers taken part by part* is for Aristotle the optimal way to fulfill his promise made at the outset of his research into the soul.<sup>15</sup>

Before turning to the second part of our passage taken from *Sens. 1*, I would like to firm up the results achieved so far by elaborating on the distinction between basic and non-basic powers of the soul. I will do so by looking at Aristotle's treatment of memory. Memory is a power that both human and nonhuman animals have in virtue of having a soul. At least in this respect, the power of storing perceptual information and retrieving it

<sup>10</sup> Aristotle, *DA II 1*, 412b5–6.    <sup>11</sup> Aristotle, *DA II 1*, 412b27–28.    <sup>12</sup> Chapter 1, Section 2.

<sup>13</sup> For an attempt to elaborate on the overall function of the most common account in the context of Aristotle's research into the soul, see JOHANSEN 2012: 9–33.

<sup>14</sup> Aristotle, *DA II 3*, 415a12–13: "it is therefore clear that the account of each of them [*sc.* the basic powers or parts of the soul] is also the most appropriate account of the soul."

<sup>15</sup> Aristotle, *DA I 1*, 402a7–8: "we seek to have knowledge about the nature and being of the soul." Contrary to what this passage may suggest, the soul does not have a nature or essence, but it is a nature or an essence of living beings. By promising knowledge about the nature and being of the soul, Aristotle announces an answer to the question "what is the soul?"

whenever needed is not different from the power of sense-perception. Like sense-perception, memory too is a power that both human and nonhuman animals have in virtue of having a soul. There is, however, one important difference: while sense-perception is a basic power of the soul, memory is not. This explains why Aristotle does not deal with memory in the context of his research into the soul but in the *Parva naturalia*. He launches his investigation into memory with the uncontroversial but important observation that we first perceive (or think) something and then remember having perceived (or having thought) it.<sup>16</sup> This observation shows that, at least for Aristotle, memory cannot be adequately explained without reference to sense-perception and thought. Both sense-perception and thought are regarded as basic powers of the soul, so they are defined in the context of the research into the soul.<sup>17</sup>

When we reflect on how Aristotle divides his explanatory work between *De anima* and *De memoria*, we see that his account of memory is offered within the theoretical framework provided by his research into the soul. But this theoretical continuity does not mean that the treatment of memory is a supplement to the project attempted in *De anima*. No such supplement is needed given that Aristotle takes his account of the basic powers of the soul to be complete at the end of *De anima*. In other words, his discussion of memory does not perfect the account of the soul.<sup>18</sup> It is best described as an application of the main results reached in the research into the basic powers of the soul. One methodological insight carried forward from the research into the soul and self-consciously applied to the study of memory is that the study of any power of the soul, whether basic or not, is to be conducted via a study of its manifestation (or manifestations). This means that we should study memory via a study of the activity of remembering. This is an activity that has *zoological* significance since both human and nonhuman animals are capable of storing information and retrieving it.

<sup>16</sup> Aristotle, *Mem.* I, 449b15–20.

<sup>17</sup> Aristotle's explanation of memory requires reference not only to sense-perception and thought but also to another power that human and nonhuman animals share in virtue of having a soul: *phantasia*. Aristotle seems to consider *phantasia* a non-basic capacity of the soul. In this respect *phantasia* is not on a par with perception and thought. But this does not prevent him from dealing with this capacity in the context of his own research into the soul (most notably in *DA* III 3).

<sup>18</sup> *Contra* BOLOTIN 2021: VII. Here we read that “the treatises in the *Parva naturalia* are not mere appendages to the *De anima*” but rather “they help to perfect the account of the soul and of its relation to the world as a whole.” But from the fact that the short essays collected in the *Parva naturalia* are no appendages to *De anima*, it does not follow that they perfect it. The way out of this false alternative is to see that they contribute to *another* project altogether.

From an architectonic point of view, the study of memory contributes, directly and immediately, to the study of animals. We tend to obfuscate this point when we describe the study of memory and the other treatises transmitted in the context of the *Parva naturalia* as “psychological works,” or when we say that they contribute to “Aristotle’s psychology.”<sup>19</sup> But Aristotle neither adopts these expressions nor encourages us to adopt them on his behalf. For his own description of the project attempted in the short essays on natural philosophy, we need to return to the transitional passage at the outset of *Sens.* 1, where Aristotle tells us that the works collectively known by us as *Parva naturalia* are concerned with “*animals and everything that has life.*” Based on this description we can safely say that we make the equivalent of a categorical mistake when we lump together Aristotle’s *De anima* and the short essays collectively known as *Parva naturalia*. They do not contribute to the same project: while the former is about the soul as the ultimate principle of living beings, the latter are concerned with animals and everything that has life.

In *Sens.* 1 Aristotle offers another description of the explanatory project attempted in the context of his *Parva naturalia*. He tells us that these short treatises on natural philosophy are concerned with “*what is common to the body and the soul.*”<sup>20</sup> This second description complements the first by offering a precise idea of how the investigation attempted in the *Parva naturalia* relates to the one conducted in *De anima*. Among other things, this description confirms that Aristotle is no longer concerned with the soul as such. In fact, he uses the same expression, namely “common to the body and the soul,” in his own research into the soul to point forward to *another kind of investigation.*<sup>21</sup> This is most likely a reference to the investigation conducted in *De motu animalium*, which is to be regarded as a contribution to the *Parva naturalia.*<sup>22</sup> The *Parva naturalia*, augmented by *De motu animalium*, are collectively concerned with psycho-physical phenomena whose significance is either zoological or extends beyond the narrow case of animals. In other words, the study of what is common to the body and the soul contributes either to a study of “*animals*” or to a study of “*everything that has life.*”

<sup>19</sup> This is the title chosen for the new Penguin translation of Aristotle’s *De anima* and *Parva naturalia* (MILLER 2018).

<sup>20</sup> Aristotle, *Sens.* 1, 436a7–8. This description has drawn considerable attention lately. For a discussion of what Aristotle may mean by “common to the body and the soul,” see MOREL 2000: 10–24; MOREL 2006: 121–139; JOHANSEN 2006: 140–164.

<sup>21</sup> Aristotle, *DA* III 10, 433b20.

<sup>22</sup> For a full discussion of the relation between *De motu animalium* and *Parva naturalia*, see CORCILIUS-PRIMAVESI 2018: clxx–clxxvi.

A great deal is packed into the phrase “*animals and everything that has life*.” It is now time to take a closer look at the message Aristotle wants to convey with this careful choice of words. First, since Aristotle tells us that he is going to build on the results achieved in his research into the soul, it is not open to us to assume that the distinction between animals and plants is not available to him. But this observation only makes the task of understanding the peculiar expression he adopts more pressing. To be sure, the phrase “*everything that has life*” entails an implicit reference to plants. But it would be a mistake to rush to the conclusion that in *Sens. 1* Aristotle is announcing a study of animals and plants based on the results reached in the investigation of the soul. If this were what Aristotle had in mind, he would have spoken of a study that is concerned with *animals and plants* (περὶ ζώων καὶ φυτῶν). Instead, he speaks of a study that is concerned with *animals and everything that has life* (περὶ τῶν ζώων καὶ τῶν ζωῆν ἐχόντων).<sup>23</sup>

To study everything that has life is not equivalent to studying everything that is alive without qualification. Recall that in *De anima* Aristotle has successfully isolated perishable life from imperishable life. Since he is building his entire theoretical edifice upon the results achieved there, he must be tacitly assuming this restriction to perishable life at the beginning of the *Parva naturalia*. If so, in *Sens. 1*, Aristotle is announcing a study of *everything that has a share in perishable life*. But, again, this is emphatically not equivalent to announcing a study of animals and plants. To see why, we must return to the theory of scientific explanation outlined in Aristotle’s *Posterior Analytics*. We have seen that this theory requires Aristotle to give explanations at the right level of generality. The investigator is expected to produce explanations that apply as broadly as possible while at the same time remaining sufficiently specific to capture the salient features of the phenomena under discussion. In some cases, this entails seeking explanations that are common to most, or even all, animals; in other cases, it means going beyond the case of animals to look for explanations that apply to everything that has life, including plants. This is exactly what Aristotle has in mind. In fact, he may be referring to the explanatory

<sup>23</sup> Alternative, acceptable translations are “*animals and all living things*” (MILLER 2018: 70) and “*animals and all the beings that have life*” (BOLOTIN 2021: 3). The living beings in question are *perishable* living beings, and the life in question is *perishable* life. David Ross obfuscates this point, as well as the existence of two distinct explanatory levels at the outset of the *Parva naturalia*, when he paraphrases our passage by saying: “now that we have discussed soul and its faculties, we must consider the activities peculiar to some animals and those common to all, beginning with the most important” (ROSS 1955: 183).

requirement outlined in his *Posterior Analytics* when he distinguishes between *specific* and *common activities*. By “specific activities” Aristotle need not mean species-specific activities; he may mean activities that are specific to all animals. When our text is read in this way, Aristotle is elaborating on what he has just told us. He has announced “*a study of animals and everything that has life*”; he now goes on to say that such a study ought to be conducted first by focusing on what is *specific to animals* and then by turning to what is *common to everything that has a share in perishable life*.

This reading becomes even more appealing when we realize that, in addition to introducing the investigation conducted in this work, the opening lines of *Sens.* 1 are meant to inform the reader about the explanatory project conducted in the other short essays traditionally transmitted in the context of the *Parva naturalia*. It turns out that these essays are clearly divided into two distinct groups, reflecting two different explanatory levels. While the first group deals with activities that occur along with sense-perception or through sense-perception,<sup>24</sup> and so with activities pertaining to some, most, or even all animals (*On Sense-perception and Sense-perceptibles*, *On Memory and Recollection*, *On Sleep and Waking*, *On Dreams*, *On Divination in Sleep*, *On the Motion of Animals*), the second group is concerned with aspects of perishable life that are not restricted to animals (*On Length and Shortness of Life*, *On Youth and Old Age*, *Life and Death*, and *Respiration*). Aristotle's treatment of respiration may be taken to be *prima facie* evidence against this division. But it does not take long to see that this treatment is embedded within his larger study of life and death. Aristotle himself makes this connection at the outset of *Juv.* when he says that life is contingent upon respiration for some animals.<sup>25</sup> In light of the above, it is far from surprising that the Aristotelian tradition in antiquity and beyond has considered the writings collected in the second (smaller) group, to the extent that they are concerned with activities that are common to all perishable living beings, plants included – a sort of bridge between the study of animals and that of plants.

Let us return to the programmatic passage offered at the outset of Aristotle's *Meteorology*, where Aristotle announces a study of “*animals and plants, both in common and separately*.” We have seen that, at least at the outset of this work, we cannot rule out that Aristotle promises, in

<sup>24</sup> Aristotle, *Sens.* 1, 436b2–3.

<sup>25</sup> Aristotle, *Juv.* 1, 467b12–13. The qualification “for some animals” is important since Aristotle does not consider respiration an activity shared by all animals. More on this in due course.



addition to separate studies of animals and plants, a study that captures salient features pertaining in common to both animals and plants. Recall the geometrical example Aristotle uses in his *Posterior Analytics*: we do not achieve proper knowledge of equilateral, isosceles, and scalene triangles unless we study them both in common and separately. We study these triangles separately when we study the properties that belong to them insofar as they are equilateral, isosceles, and scalene triangles. We study these triangles in common (or in general) when we study them insofar as they are triangles. Likewise, we do not reach proper scientific knowledge of animals and plants unless we study them both separately and in common. To study animals and plants in common is equivalent to studying them insofar as they are *perishable living beings*.

If Aristotle ever fulfills the promise made at the beginning of the *Meteorology*, he is likely to do so in the context of the *Parva naturalia*. This is the place where he announces not only a study of animals but also a study of everything that has a share in perishable life. On closer inspection, however, what is studied in common for animals and plants is surprisingly little. The essay *On Length and Shortness of Life* is by far the most promising case study, so I would like to turn to this short work to see what decisions or moves Aristotle makes in this essay and what they teach us about how Aristotle goes about implementing a common study of animals and plants.

### 3 Longevity As a Case Study

In the essay *On Length and Shortness of Life* Aristotle is centrally concerned with explaining the phenomenon of longevity.<sup>26</sup> Right at the outset of the work Aristotle indicates that animals are the primary, but emphatically not exclusive, focus of his causal investigation:

Concerning the fact that some animals are long-lived while others are short-lived *and concerning the length and shortness of life in general* [καὶ περὶ ζώης ὄλως μήκους καὶ βραχύτητος], we have now to search for the causes.<sup>27</sup>

There are two explanatory goals on Aristotle's agenda right from the start, and they are clearly related, although we are not told how to move from the first (length and shortness of life in animals) to the second (length and shortness of life in general). Before embarking on his causal investigation, Aristotle takes the time to go through a couple of *aporiai*. The first *aporia* is

<sup>26</sup> In this section I rely on results published in [FALCON 2021d](#). <sup>27</sup> Aristotle, *Long.* I, 464b19–21.

immediately relevant to the question of whether a common study of longevity in both animals and plants is possible.<sup>28</sup> It is not clear, Aristotle says, whether it is the same cause or a different one in animals and plants that makes some of them long-lived and others short-lived.<sup>29</sup> Stating a difficulty is not the same as solving it. Aristotle does not offer a solution to this difficulty. His solution must be inferred from his subsequent discussion.

### 3.1 *The Scope of the Investigation*

The discussion of longevity in animals and plants begins in earnest only in *Long.* 4. In this stretch of text, Aristotle registers a few correlations that fail to occur in nature. For instance, there is no clear correlation between the relative size of the different kinds of animals and their lifespan. We cannot say, for instance, that larger animals live longer than smaller ones, or that smaller animals live longer than larger ones. Nor can we say that all plants live longer than animals. As a matter of fact, some plants live only for a year, or even only for a season. Furthermore, there is no obvious correlation between the presence or absence of blood and longevity. We cannot say that blooded animals live longer than bloodless animals, or that bloodless animals live longer than blooded animals. Finally, the habitat surely has an impact on the duration of life, but we cannot correlate longevity with living on land or in water. There are land animals and plants that live only for a year or for a season. Likewise, there are marine animals that live only for a year or a season.<sup>30</sup>

What is especially interesting about the discussion offered in the first part of *Long.* 4 is that Aristotle is at least in principle willing to make transgeneric comparisons. By “transgeneric comparisons” I mean comparisons across genera of living beings.<sup>31</sup> They are comparisons involving blooded and bloodless animals, or land and marine animals, or even animals and plants. The fact that certain general correlations fail to occur in nature does not take anything away from what is interesting about the exercise offered in this stretch of text. It is telling that, in *Long.* 4, Aristotle

<sup>28</sup> The second *aporia* is concerned with the relation between longevity and health. It is not clear whether long life and healthiness go together or whether they are independent from one another. This second *aporia* points toward a large question that remains at the margins of the present discussion, namely the question of the disciplinary boundaries and systematic connections between natural philosophy and medicine.

<sup>29</sup> Aristotle, *Long.* 1, 464b22–26. <sup>30</sup> Aristotle, *Long.* 4, 466a1–9.

<sup>31</sup> I borrow this expression from Klaus Corcilius ([CORCILIUS 2021a](#): 142).

goes on to register a few *transgeneric facts* that hold in nature and call for a scientific explanation:

In general, the longest-lived creatures are found among plants (for instance the date-palm). Then, they are found among blooded rather than bloodless animals, and among those [animals] that live on land rather than in water. Hence, combining the two features, the longest-lived animals are found among the blooded animals that live on land, like the human being and the elephant. And, indeed, the largest [animals] live for the most part longer than the smaller [animals], for the other longest-lived [creatures] too happen to be of large size as in the case of those mentioned.<sup>32</sup>

Aristotle opens his *transgeneric investigation* with the claim that the longest-lived creatures are found among plants rather than animals. He ends it by returning to the case of plants when he says that the other longest-lived creatures (i.e., other than animals) are also characterized by their large size.<sup>33</sup> In between, Aristotle compares not only the expected duration of life in blooded and bloodless animals but also the expected duration of life in animals that live on land and in water, and finally the expected duration of life in animals and plants. We find this sort of transgeneric investigation elsewhere in the Aristotelian corpus. For instance, the scientific account of animal locomotion requires Aristotle to engage in a causal investigation that operates at a very high level of zoological abstraction.<sup>34</sup> The comparison of flying and swimming animals is a good case in point: any account of animal locomotion that treats flying and swimming in common is expected to proceed at a very high level of zoological abstraction to capture the salient features shared by both modes of locomotion. And yet, the account of longevity is almost unique in the Aristotelian corpus since here Aristotle makes transgeneric claims that involve comparing two very large genera such as animals with plants.

To be sure, Aristotle occasionally makes comparisons that involve plants and animals. For instance, Aristotle compares the morphology of animals and plants right at the outset of his study of the non-uniform parts of animals.<sup>35</sup> In this case, however, his conclusion is largely negative,

<sup>32</sup> Aristotle, *Long.* 4, 466a9–16.

<sup>33</sup> I find support for this reading in *Long.* 5, 466a26–27, where Aristotle says that “*large creatures, animals and also plants* [τὰ μεγάλα καὶ ζῶα καὶ φυτὰ], generally speaking, live longer, *as was said before*.” I take this second passage from *Long.* 5 to refer to our passage from *Long.* 4. Admittedly, this is not the only possible reading. On an alternative reading, the other longest-lived creatures mentioned in *Long.* 4 would be animals to the exclusion of plants. On this reading, Aristotle would be reminding his reader that there are other long-lived large animals besides the human being and the elephant mentioned at 466a13.

<sup>34</sup> More on this topic in [Chapter 3, Section 3.4](#). <sup>35</sup> Aristotle, *PA* II 10, 655b28–656a3.

confirming that his focus is on the bodily parts of animals, to the exclusion of plants. I will return to this interesting stretch of text toward the end of this chapter. For the time being, let me say why the case of longevity in animals and plants is different and potentially more interesting. To begin with, the comparison involving plants and animals follows directly from the stated goal of the work on longevity. We have seen that Aristotle is interested in the phenomenon of longevity in general – that is, longevity not only in animals but also in plants. He wonders *ore aperto* whether the causes of longevity are the same in plants and animals. Moreover, his conclusion is not negative. Quite the opposite: Aristotle explains why some plants live longer than all animals.

### 3.2 *The Explanation of Longevity in Animals and Plants*

In *Long.* 4 Aristotle establishes a few scientific facts. By “scientific facts” I mean facts that call for an explanation in the context of Aristotle’s science of nature. The following one is among them: some plants (mostly trees) live longer than all animals. This is a remarkably complex fact to the extent that it entails a comparison between the lifespans of plants and animals. When he tries to explain this fact, Aristotle goes beyond the domains of animals and plants since he offers an explanation that holds in common for animals and plants. But how does Aristotle achieve this explanatory feat? To answer this question, we must look at the argumentative strategy adopted in the rest of the essay, which is traditionally divided into two chapters: *Long.* 5 and *Long.* 6.

A notable feature of the ensuing discussion is that Aristotle engages in a search for the relevant causes by focusing on the case of animals. This is done in *Long.* 5. The focus on animals suggests that the order in which the two main explanatory goals are given in *Long.* 1 is also the order in which the investigation is conducted in the rest of the work. Aristotle looks *first* for the causes by which some animals are long-lived while others are short-lived, and *then* for the causes of length and shortness of life in general. This strategy explains why Aristotle begins the search for the causes of longevity by narrowing down his discussion to the case of animals. His first move consists in assuming that *the animal* (τὸ ζῷον) is naturally wet and hot, and assuming that to be alive *for an animal* is to be of such a constitution.<sup>36</sup> With this assumption in place, Aristotle goes on to state that *for animals* (τοῖς ζῴοις) the matter of their body consists in the hot and the cold, the

<sup>36</sup> Aristotle, *Long.* 5, 466a18–19.

dry and the wet.<sup>37</sup> From this point on, his overall explanatory strategy consists in showing that not only the relative quantity but also the quality of the material constituents present in the body of the animal are relevant to the explanation of its expected lifespan:

*the causes [of longevity] are two: the quantity and also the quality* [ἴδιο γὰρ τὰ αἴτια, τὸ τε ποσὸν καὶ τὸ ποιόν], so there must be not only a large amount of moisture, but this moisture must also be warm.<sup>38</sup>

This combination of quantity and quality is optimal in the case of the human animal:

This is the reason why the human being lives longer than some larger animals: animals that fall short in quantity of moisture live longer whenever they excel more in the quality of their moisture than they fall short in its quantity.<sup>39</sup>

According to Aristotle, the explanation of why a human being lives longer than a horse, even if a horse is larger in size than the human being and so the horse has a larger quantity of moisture (i.e., blood) in its body, is that the moisture in the human body is of a better quality. While deficient in quantity, the human blood is more resistant to the physical changes related to aging and decay because it is hotter. To appreciate this point, we need to keep in mind that aging and decaying are regarded as processes involving not only a loss of moisture but also a loss of vital heat. For Aristotle, aging is becoming dry and cold.

A full discussion of how Aristotle deals with the explanation of longevity in animals is not required for my argument.<sup>40</sup> Let me only say that Aristotle argues that land animals generally live longer than marine animals,<sup>41</sup> and that blooded animals generally live longer than bloodless animals. In both cases, the explanation has to do with the quality of the moisture present in their body. According to Aristotle, marine animals possess an inner moisture that is water-like and so is more liable to destruction because it is easy to congeal.<sup>42</sup> A similar point is made in connection with bloodless animals.

<sup>37</sup> Aristotle, *Long.* 5, 466a20–22. I follow the text printed in [Ross 1955](#). His apparatus shows that the manuscript tradition is divided between ζῴοις (animals) and οὔσι (beings). The full force of the alternative reading will become apparent shortly.

<sup>38</sup> Aristotle, *Long.* 5, 466a29–31. <sup>39</sup> Aristotle, *Long.* 4, 466a9–16.

<sup>40</sup> A fuller discussion of longevity in animals can be found in [Woodcox 2018](#): 65–78.

<sup>41</sup> This claim is false if cetaceans are included among the marine animals. Either Aristotle was not well informed about the lifespan of cetaceans, or else this is only a claim about fishes, not about all marine animals. I owe this point to James G. Lennox.

<sup>42</sup> Aristotle, *Long.* 5, 466b33–467a2.

Their moisture, which is not blood but rather something analogous to blood, does not contain fatty material and so is less impervious to the physical changes related to aging and decay.<sup>43</sup>

However, the following aspect of Aristotle's explanatory strategy in *Long. 5* is important: *even if his focus is squarely on animals, Aristotle does not hesitate to extend his findings to plants*. Consider the following two passages:

that is why, generally speaking, *large living beings, animals and also plants* [τὰ μέγιστα καὶ ζῷα καὶ φυτὰ] live longer, as we said before. The reason is that it is reasonable to suppose that that which is large contains more moisture. (Aristotle, *Long. 5*, 466a16–28)

if they do not obtain nourishment, *plants and also animals perish* [τὰ φυτὰ καὶ τὰ ζῷα φθείρεται], for they waste themselves away. (Aristotle, *Long. 5*, 466b28–30)

In both passages, Aristotle does not confine himself to animals.<sup>44</sup> But this does not mean that he is oblivious to his original focus on animals; it only means that *Aristotle is willing to extend his findings to plants whenever he is confident that he can do so*. I will return to this interesting aspect of his overall explanatory strategy shortly.<sup>45</sup>

In the meantime, I would like to turn to Aristotle's extended discussion of plants. This discussion is traditionally marked out as a separate chapter (*Long. 6*). We should resist the initial impression that this chapter is an expendable coda. To begin with, it is in this stretch of text that Aristotle most obviously fulfills his promise (made at the outset of the essay) to advance an explanation of longevity that is not restricted to the case of animals. Furthermore, his treatment of longevity in this chapter is expected to help us see not only why a human being or an elephant lives longer than a horse or a dog but also why some plants (mostly trees) live longer than any animal. There are three reasons (or, better, causes) that jointly explain why some plants live longer than any animal. To understand them, we need to keep in mind, once more, that aging and decaying are processes

<sup>43</sup> Aristotle, *Long. 5*, 467a2–5. Both passages may explain why the manuscript tradition at 466a21 is divided between ζῷοις (animals) and οὔσι (beings).

<sup>44</sup> Many thanks to Wei Cheng who made me aware of the importance of these two passages for Aristotle's overall strategy in *Long. 5*.

<sup>45</sup> See next section.

that involve loss of moisture and loss of vital heat.<sup>46</sup> The first cause is that plants have an internal moisture that is less water-like than the one found in animals, and so their moisture is less easy to congeal.<sup>47</sup> The second is that this inner moisture has a viscosity and an oiliness that make it easier for plants than for animals to retain their moisture.<sup>48</sup> These two causes jointly go a long way toward answering the question of why some plants live longer than all kinds of animals. Since inner moisture and vital heat are found in animals and plants, it is possible to give a common explanation of longevity in terms that are common to plants and animals. By themselves, however, the first two causes do not suffice to explain why some plants live longer than animals. At this point, Aristotle recalls a fact that is peculiar to plants and sets them apart from animals:

Plants renew themselves continuously, which is why they last for a long time. There are always new shoots while the old ones grow old, and the roots do the same. But not at the same time. Rather, at one time the trunk and the branches die, and new ones grow up next to them. When they do so, new roots spring from the existing part of the plant, which in this way continues to live while a part dies, and another grows.<sup>49</sup>

Aristotle elaborates further on the claim that, unlike animals, plants renew themselves continuously. Plants have a power to regenerate themselves that has no equivalent in animals. While it is true that some insects can continue to live for a while when they are cut, the principle of life left in the divided insects cannot produce new body parts. By contrast, every part of a plant contains a potential root and a potential stem.

Plants are like insects, as we said earlier. The reason is that when they are cut, they continue to live and become two or more than two from one. But insects, although they manage to live, cannot do so for long. The reason is that they do not have organs and the source of life that is present in them cannot produce them [*sc.* the organs]. But the source [of life] present in plants can; the reason is that *plants have potentially a root and a stem everywhere* [πανταχῆ γὰρ ἔχει καὶ ῥίζαν καὶ καυλὸν δυνάμει]. So it is from this source that the new and the old [in the plant] grow, with the new parts cut from the plant having little difference in terms of longevity. Indeed one might say that in a way the same happens in the case of

<sup>46</sup> In dealing with the case of longevity in animals, Aristotle assumes that “to be an animal is to be wet and hot, and to be alive [for an animal] is to be of such a constitution” (*Long.* 5, 466a18–19: δέῃ γὰρ λαβεῖν ὅτι τὸ ζῶν ἐστὶ φύσει ὑγρὸν καὶ θερμόν, καὶ τὸ ζῆν τοιοῦτον); he goes on to posit that old age is linked to being dry and cold, as is death (466a19–20).

<sup>47</sup> Aristotle, *Long.* 6, 467a6–7. <sup>48</sup> Aristotle, *Long.* 6, 467a8–9.

<sup>49</sup> Aristotle, *Long.* 6, 467a13–18.

propagation by slip, since the shoot cut off is a part [of the plant]. Thus, in the case of propagation by a slip this happens because the slip is separated from the plant, whereas in the other case [this happens] in virtue of its continuity. The reason is that *the source [of life] is everywhere, being present potentially* [ἐνυπάρχει πάντῃ ἡ ἀρχὴ δυνάμει ἐνοῦσα].<sup>50</sup>

In the context of a study of longevity in animals and plants, it is not at all surprising to discover that Aristotle insists on the continuity between animals and plants by looking at the case of those insects that, when they are cut, can go on living for a while as divided animals. Aristotle does not say what insects he has in mind. Elsewhere he explicitly refers to centipedes as animals that continue to live when they are divided into two or more parts.<sup>51</sup> Note, however, that there remains a significant difference between insects and plants. The principle of life that is present in insects and is responsible for their continuing to live even when they are divided does not have the power to generate new organs. The organs in question are the body parts that the animals use as tools for nutrition, reproduction, and locomotion. Without such organs, the divided insects may be able to survive as two or three separate living beings, but they cannot do so for a significant length of time.

By contrast, a part detached from a plant is potentially able to grow into a new plant. Aristotle states this principle by saying that plants “have potentially a root and a stem everywhere.” To fully appreciate this claim, we need to keep in mind that for Aristotle root and stem are the first parts to grow out of the seed.<sup>52</sup> Hence to say that plants have potentially a root and a stem everywhere amounts to saying that any detached part of a plant can reconstitute itself in a self-sufficient living organism. To be sure, this claim requires considerable refinement. It is manifestly not true that any part of any plant has the power to grow a root and a stem. Still, this refinement can be deferred to a separate study of plants where the focus is on what is specific about the different kinds of plants.<sup>53</sup> Although Aristotle stops short of giving a full account of plant propagation, what he says on

<sup>50</sup> Aristotle, *Long.* 6, 467a18–30.

<sup>51</sup> Aristotle, *Juv.* 9 (= *Resp.* 3), 471b20–22 and *IA* 7, 707a27–30. In *Juv.* 2, 468a25–27 Aristotle mentions wasps and bees as animals that continue to life after being cut into two. But their case is different because the claim is that the part that contains the controlling principle continues to live after being cut from the rest of the body. A full discussion of these passages as well as the others in which divided insects are mentioned can be found in LEFEBVRE 2002: 5–34.

<sup>52</sup> Aristotle, *Juv.* 3, 468b21–22.

<sup>53</sup> Theophrastus makes the distinction among the different manners in which plants propagates at the beginning of his study of the modes of generation in plants. I return to this topic in Chapter 5, Section 2.



the topic of longevity in plants is enough to establish that plants are a different kind of perishable living beings from animals because they possess a different kind of principle of life – that is, a different kind of soul.

I would like to conclude my review of what Aristotle says on the topic of longevity in animals and plants with two remarks. To begin with, what Aristotle says in *Long.* 6 does not exhaust the topic of longevity in plants. Quite the opposite: Aristotle explicitly refers his reader to a study of longevity in plants. This is far from being a surprising development. *Long.* 6 is concerned with the rather narrow question of why some plants live longer than all animals. We can restate this point by saying that *Long.* 6 is concerned with the relative longevity of *animals and plants* rather than longevity in *plants*. This leads to my second remark. Aristotle's reference to this further study of longevity in plants is self-consciously crafted in impersonal terms. It is also a reference to a future investigation. Aristotle says that "it will be determined about these things also separately by themselves in the study of plants." The future tense need not have chronological significance; it can be taken to be evidence that there is a definite order in the Peripatetic study of perishable living beings: the study of plants follows not only the study of animals but also the study of what is common to animals and plants *in the order of inquiry*.

In his study of longevity Aristotle applies the more general approach to perishable life that he has outlined in the opening lines of the *Meteorology*. This strategy consists in approaching the study of perishable life through a study of animals. This strategy is implemented also in the study of longevity: *first animals* (*Long.* 5), *then plants* (*Long.* 6). One final observation is in order. Even when Aristotle ventures into a discussion of plants, his primary focus remains on animals. This is an important and often overlooked point that deserves to be stressed. Whatever Aristotle has to say on the topic of longevity in plants, or on the topic of the relative longevity in animals and plants, is embedded in his study of animals. The latter remains his primary concern. What Aristotle tells us at the end of his account of longevity confirms this overall impression:

The cause of length and shortness of life has now been given for animals as well [τῶν ἄλλων ζώων].<sup>54</sup> It remains for us to study youth and old age, life

<sup>54</sup> The words "τῶν ἄλλων ζώων" have been considered problematic. In his *apparatus criticus*, Ross writes: "ἄλλων *delendum aut* ἄλλων ζώντων *scribendum*." In other words, either "ἄλλων" is an intrusive gloss or "ζώων" is a corruption of ζώντων. But perhaps the transmitted text can be saved: ἄλλος can be used attributively with a substantive, which in this case is to be regarded as an appositive (SMYTH 1920: §1272). If we accept this suggestion, the transmitted text can be rendered as I have done here.

and death. *Once these things are determined, the investigation of animals might well come to a conclusion* [τούτων γὰρ διορισθέντων τέλος ἂν περι τῶν ζώων ἔχοι μέθοδος].<sup>55</sup>

In looking ahead to the topic of youth and old age, life and death, Aristotle tells us that as soon as he has dealt with this topic, *his investigation of animals* (μέθοδος τῶν ζώων) may well come to a natural conclusion. Scholars tend to be skeptical (if not outright dismissive) of cross-references that come at the end of a work because these cross-references generally feel like expendable additions. But this is emphatically not the case here. The words at the end of *Long. 6* are a non-trivial addition to the text. If these words are taken seriously, both the inquiry into the longevity of animals and plants and the study of youth and old age, life and death contribute, directly and immediately, to the study of animals. This conclusion confirms that Aristotle has moved away from the study of the soul. In other words, the essays collected in the *Parva naturalia* are not a prolongation of *De anima*; rather, they contribute to a different project altogether. Moreover, this project has a special research focus on animals. This *explicit* suggests that the investigation of animals contains, *as one of its components*, an investigation of whatever may be explained in common for animals and plants. This observation does not contradict what we have seen so far but confirms that the study of perishable life is approached via a study of animals. Whatever can be said in common about animals and plants is said in the context of the study of animals. Among other things, this confirms the somewhat special role that the study of animals plays in Aristotle's research agenda.

#### 4 Beyond Longevity

Aristotle's account of longevity is by far the most promising text for evaluating how he goes beyond his chosen focus on animals to deal with "everything that has life." In the end, the reader comes away with the impression that there is little Aristotle is able, or willing, to say in common for animals and plants. This impression is confirmed when we turn to the last essay transmitted in the context of Aristotle's *Parva naturalia*. This essay is concerned with the explanation of youth and old age, life and death. The pairings youth/old age and life/death, as well as the order in which they are mentioned, are important. Every perishable living being,

<sup>55</sup> Aristotle, *Long. 6*, 467b5–9.

whether animal or plant, goes by nature through a cycle of growth, activity in its prime, decline, and death. In short, perishable life characteristically passes through a few phases, which are arranged in a definite order.<sup>56</sup> Hence, it makes good sense for Aristotle to offer a joint discussion of the powers of the soul (and the corresponding life activities) involved in the explanation of youth and old age, life and death. From the start, however, his research focus is squarely on animals. Tellingly, Aristotle also announces that a treatment of respiration is embedded within the discussion of life and death since, *for some animals*, life is contingent upon respiration:

We must now speak about youth and old age, and life and death: at the same time [we must] equally state the causes of respiration, since *for some animals being alive or not being alive comes about on account of this* [ἐνίοις γὰρ τῶν ζώων διὰ τοῦτο συμβαίνει τὸ ζῆν καὶ τὸ μὴ ζῆν].<sup>57</sup>

This *incipit* has caused embarrassment. Shouldn't Aristotle be concerned with more than just animals? Isn't it true of plants as well that they go through a cycle of growth, activity in their prime, decline, and death? The most recent interpreter of *Juv.* 1–6 takes ζώων to mean “living beings” rather than “animals” on the ground that a restriction to animals, to the exclusion of plants, would be arbitrary.<sup>58</sup> But this reading cannot be accepted. At this point, the meaning of ζῶον is fixed by what Aristotle has established in his research in the soul. It can only mean animal to the exclusion of plants.<sup>59</sup> A better, more convincing move consists in assuming that the research focus on animals is carried forward from what we are told at the end of the treatment of longevity. If so, the *explicit* of *Long.* 6 not only contains instructions on how to understand the explanatory strategy adopted in the work on longevity but also offers a justification for the move made at the outset of *Juv.* 1. The close connection between the end of *Long.* 6 and the beginning of *Juv.* 1 is confirmed by the presence of the adverb “νῦν” in the second text. Aristotle has just completed a study of longevity and he is *now* ready to turn to the topic of youth and old age, life and death.

One may try to resist this reading by objecting that Aristotle does not mention respiration at the end of *Long.* 6. Upon reflection, however, this objection is not very strong. The omission of respiration at the end of *Long.* 6 does not create a tension with what we are told in the opening lines of *Juv.* 1. The investigation of respiration is conceptually subordinated to the

<sup>56</sup> This is a major theme in [KING 2001](#) (especially 1–16). On the life cycle, see by the same author: [KING 2010](#): 171–187 and [KING 2021a](#): 138–139.

<sup>57</sup> Aristotle, *Juv.* 1, 467b10–13. <sup>58</sup> [KOROBILI 2022](#): 21–22. <sup>59</sup> See [Chapter 1, Section 2](#).

investigation of youth, old age, life, and death, so it is perfectly appropriate for Aristotle to look ahead to the next item on his research agenda without making explicit reference to respiration. This reading is confirmed by what we read in *Juv.* 27. As Aristotle looks back at what he has accomplished in the treatise as a whole, he makes no reference to respiration.<sup>60</sup> This does not mean that the account of respiration is expendable but only that this account is embedded in a larger project. Aristotle is interested in the relation between respiration and living, but his primary focus is on life and death (and youth and old age).

Even if the research focus is from the start on animals rather than everything that has life, it remains true that the significance of the treatise greatly exceeds the study of animals. So we need to better understand how Aristotle negotiates his decision to focus on animals with the explanatory requirement to go beyond animals whenever appropriate. My overall approach to this issue is best understood in contrast with a recent reading of the opening lines of *Juv.* 1. According to James G. Lennox, at the outset of *Juv.* 1, Aristotle distinguishes the account of youth and old age, life and death (*Juv.* 1–6) from the subsequent account of respiration (*Juv.* 7–27 = *Resp.* 1–21).<sup>61</sup> Aristotle would do so by indicating, right from the start, that these accounts are given at different levels of generality: while the first would hold in general for all perishable living beings, the second would apply to all those animals that are engaged in the activity of respiration (breathing). Since Lennox is programmatically concerned with Aristotle's account of respiration, it remains to be seen how he thinks that the requirement of giving explanations at the right level of generality is implemented in the first part of our essay (*Juv.* 1–6). I do not find textual evidence that this is how Aristotle proceeds in these chapters. His strategy strikes me to be something like this: *Aristotle stays as close as possible to the case of animals and goes beyond animals whenever it is possible and appropriate for him to do so.*

This strategy is reminiscent of how Aristotle deals with the topic of longevity. In both cases, animals come first in the order of investigation. As a result, Aristotle starts his inquiry by focusing on *animals*; but then, whenever possible and appropriate for him to do so, he extends his results to *everything that has a share in perishable life*. When we accept that the research focus in *Juv.* is from the start on animals, but we also keep in mind

<sup>60</sup> Aristotle, *Juv.* 27, 480b21–22: “so then we have said perhaps everything [which was to be said] on the topic of life and death and the things related to this inquiry.” It is of course open to us to read an indirect reference to the treatment of respiration in the words “the things related to this inquiry.”

<sup>61</sup> LENNOX 2020: 221.

that the power of the soul controlling the full cycle of life from beginning to end has a wider extension than animals, we can better appreciate why Aristotle opens his discussion in *Juv. 1* by distinguishing between *being an animal* and *being alive*.<sup>62</sup> For Aristotle, being an animal and being alive are not one and the same thing; rather, they entail the presence of different kinds of powers. To be sure, both kinds of powers are necessarily present in the same bodily part. But while the life-sustaining powers the animal possesses insofar as it is alive are not existentially separate from its higher (cognitive) powers, they are not exclusive to animals. This opening move creates the conceptual space for an investigation whose significance goes beyond animals even though the primary focus remains on them. A central question for Aristotle in *Juv. 1* is where in the body the life-sustaining powers of the soul are located. This question falls squarely within the project attempted in the *Parva naturalia*. Here Aristotle is programmatically concerned with what is common to the body and the soul. It is perfectly appropriate for him in this context to ask where exactly in the living body the nutritive power controlling growth and decline, life and death is to be found and why.

Let us look at how Aristotle answers this question, with a special concentration on his overall argumentative strategy. The starting point is the observation that *in animals* the basic powers of the soul are conceptually but not physically separate. This starting point confirms that the research focus is on animals. What matters to Aristotle is that the nutritive power controlling the life-sustaining activities of the animal as well as the power responsible for their being perceptually informed about the surrounding world are to be found in the same bodily part.<sup>63</sup> At this early stage of his argument, Aristotle does not argue for the view that these powers are to be found in the heart (or in its bodily analogue). He is content to recall that the power-controlling sense-organ must be located midway between the front and the back of the animal: “there is a single sense-organ common to the special sense-organs, in which it is necessary for actual sense-perceptions to come together, and this must be located between the parts called front and back (‘in front’ means the direction from which perception comes to us, and ‘back’ the opposite).”<sup>64</sup>

To understand this claim, we must recall that the articulation of the living body into a front and a back follows from possessing the power for

<sup>62</sup> Aristotle, *Juv. 1*, 467b13–24.

<sup>63</sup> Aristotle, *Juv. 1*, 467b25–27. The modal statement is found in Aristotle’s text: It is *necessary* (ἀναγκαῖον) for both powers to be in one and the same body part.

<sup>64</sup> Aristotle, *Juv. 1*, 467b30.

sense-perception. The perceptual system is a centralized system with a definite orientation that is captured by the pair front/back. The front of the animal is the part of the body where the sense-organs are implanted. Aristotle does not stop to elaborate on the claim that there must be a common sense-organ in addition to the peripheral sense-organs. Rather, he shifts his attention to the nutritive capacity of the soul. Moreover, he does so in a way that no longer makes the presence of this capacity contingent upon the creature being an animal and having the capacity for sense-perception: “the body of *all living things* [ζώντων πάντων] is divided into an upper and a lower part (for all [living beings] possess upper and lower parts, so plants do too).”<sup>65</sup>

Aristotle goes out of his way to stress that this claim is true for plants as well. We find here a very good instance of his concern for making claims at the right level of generality. This second statement is no longer true of animals to the exclusion of plants, but it is meant to capture a salient feature shared by both animals and plants *qua* perishable living beings. As a result, it must be crafted in a way that is appropriate to the relevant level of generality. This statement exemplifies in a clear way the Aristotelian concern for making claims, or supplying explanations, that apply as broadly as possible while at the same time also grasping salient articulations of the natural world. The conclusion that Aristotle derives from the two premises highlighted above is also conveniently expressed in a way that is true for both kinds of perishable living beings: “it is clear that they [*sc.* animals *qua* living beings] must have the nutritive principle midway between the above parts.”<sup>66</sup> I supplied in square brackets what I take to be the implicit subject: neither animals nor plants nor living beings but rather animals *qua* perishable living beings. This allows Aristotle to reach the following conclusion: in perishable living beings that only possess the nutritive soul, the nutritive principle will be midway between the upper and lower part. But in those that also have perception, this principle is to be found not only midway between the upper and lower part of the living body but also midway between the front and the back.

It does not take long to see that Aristotle is relying on a rather abstract conception of the living body. This conception provides him with the conceptual tools to arrive at a conclusion that holds for everything that has a share in perishable life. The obvious question is how much of what Aristotle has established so far is applicable to plants. To be sure, plants do not have their living body articulated into a front and a back part since this

<sup>65</sup> Aristotle, *Juv.* I, 467b32–33.

<sup>66</sup> Aristotle, *Juv.* I, 468a1.

articulation is contingent upon the presence of the power for sense-perception. But the articulation of the living body into an upper and a lower part applies to them as well if we qualify this thesis. To begin with, the upper part of plants coincides with their roots since plants are stationary and take in their nourishment directly from the soil. In other words, the roots in plants are functionally analogous to what is called mouth (στόμα) in animals.<sup>67</sup> Moreover, plants have their living body articulated into an upper and a lower part even though they do not have a designated part to discharge useless residue. In fact, Aristotle believes that plants do not process their nourishment, but they take it in already concocted from the soil. As a result, there is no leftover to be discharged from their bodies. Admittedly, Aristotle does not alert us to this important difference here.<sup>68</sup>

When we reflect on the argument offered in this stretch of text, we see that animals have their living body *minimally* organized into a front and a back, an upper and a lower part.<sup>69</sup> We also see that this level of bodily organization is not found in plants since the latter have their living body articulated into an upper and a lower part but not into a front and back. Far from being trivial or bizarre, this doctrine provides us with the conceptual tools to generate claims that hold for animals and plants. More to the point: these claims go beyond what is specific about either animals or plants. We can say, for instance, that *here on earth* being alive requires a certain level of organization and claim that *perishable* living beings have their bodies minimally organized into an upper and a lower part.<sup>70</sup> The

<sup>67</sup> Aristotle, *Juv.* 1, 468a9–12. The addition of καλούμενον next to στόμα need not be taken as evidence that Aristotle keeps some distance from what he regards as a popular designation. On the contrary, Aristotle is appropriating a popular designation and turning it into a term of art. Both “mouth” and “roots” are technical terms to designate specific body parts in the Peripatetic study of animals and plants. Both Aristotle and Theophrastus use them to designate the entry point of nourishment in animals and plants. The phenomenon we observe here is far from being unique. Instances of popular designations appropriated by Aristotle and Theophrastus are “birds,” “fishes,” and “trees.” While the first two are the names of two of the largest kinds in Aristotle’s study of animals, the third is the name for the standard of inquiry that Theophrastus adopts in his study of plants. More on this in [Chapter 4, Section 3](#).

<sup>68</sup> But he does so at the outset of *PA* II 10. More on this text momentarily.

<sup>69</sup> I add the qualification “minimally” because animals that can displace their body from one place to another have their living body further articulated into a right and a left part. More on this articulation in [Chapter 3, Section 4](#).

<sup>70</sup> The additions of the qualifications “here on earth” and “perishable” are important. At least for Aristotle, there is plenty of life in the superlunary world. According to him, imperishable life may or may not entail the presence of a body. While the disembodied intellects are incorporeal substances, the celestial bodies are embodied intelligences. However, the body is conceived as a simple one. In this case, what Aristotle finds to be true for perishable ensouled living beings cannot be extended to imperishable ensouled living beings.

link between perishable life and organization may strike us as a commonplace.<sup>71</sup> But what is today a commonplace was at some point a theoretical achievement. To my knowledge, Aristotle is the first to establish a link between forms of perishable life and levels of organization. For him, there are different levels of organization corresponding to different forms of perishable life, so he offers us a non-reductive, and at the same time informative, way to express this fundamental truth.

While the conclusion reached in the second part of *Juv.* 1 holds for everything that partakes of perishable life, the focus of the investigation remains squarely on animals. This becomes clear as soon as we turn to *Juv.* 2. This chapter begins with the observation that perfect (that is to say, complete) *animals* have their body articulated into three parts: the part by which the animal takes in nourishment, the part by which the animal expels the useless residue, and the part between these two, which is called chest.<sup>72</sup> No matter how complex the living body of the animal is, the nutritive principle of the soul is always located in the middle part.<sup>73</sup> The ensuing discussion in *Juv.* 2–4 consists of a set of empirical and logical arguments in support of this claim. The empirical arguments (or arguments *κατὰ τὴν αἴσθησιν*) take up most of *Juv.* 2–3. The logical arguments (or arguments *κατὰ τὸν λόγον*) are advanced in the first part of *Juv.* 4. What is remarkable about the overall strategy employed in this stretch of text is that Aristotle proceeds by concentrating on the most perfect (most complete) animals. They happen to be *blooded animals*. The results achieved in the study of these animals are subsequently extended to the remaining animals. Aristotle calls them *bloodless animals*. This move is an application of the general rule of inquiry introduced in the previous chapter where we learned that our investigation should always start from the most determinate and end with the least determinate.<sup>74</sup> Blooded animals are the most complete (and most perfect) animals for Aristotle, so his study of animals must start from them.

Animals remain not only the starting point but also the primary focus throughout *Juv.* 2–4. This focus confirms, indirectly, that the use of the expression “*animals and everything that has life*” adopted at the outset of *Sens.* 1 not only contains a reference to two distinct objects of study, corresponding to two different explanatory levels in his research project,

<sup>71</sup> This complaint is voiced in THOMPSON 1995: 248–295 (and repeated in THOMPSON 2008: 35–39).

<sup>72</sup> Aristotle, *Juv.* 2, 468a13–16. Here too Aristotle may be signaling to the reader that he is turning a popular designation into a piece of abstract jargon (“στῆθος” means “chest” or “breast” already in Homer and Hesiod, who take it to be the seat of the heart, thought, and the emotions).

<sup>73</sup> Aristotle, *Juv.* 2, 468a21–23. <sup>74</sup> See Chapter 1, Section 3.



but also indicates that the direction of the investigation is from the first (“*animals*”) to the second (“*everything that has life*”). Aristotle turns out to be, once more, a careful writer when it comes to describing what he is going to do in his works. His descriptions contain clear instructions as to how his investigation unfolds and how his works are to be read.

At this point, we are also able to fully appreciate what Aristotle means when, at the outset of *Sens.* 1, he invokes the methodological principle: “*first about what is first.*” Elsewhere Aristotle uses these words (or an equivalent expression) to remind us of how we should proceed within our study of animals.<sup>75</sup> But here, at the outset of his *Parva naturalia*, he uses this expression to indicate how we should proceed beyond his chosen research focus on animals. We need to study animals first because the best organized and most determinate perishable living beings are found among animals. When we have completed this task, we are ready to engage in the study of everything that has a share in perishable life. But we engage in this further project by relying on the results achieved in the study of animals. This methodological insight controls not only how Aristotle organizes his own agenda across the *Parva naturalia* (with an account of longevity and an account of youth and old age, life and death coming at the end of the whole project) but also how he proceeds within the essays contributing to this project. His account of youth and old age, life and death displays this strategy in an especially clear way.

At this point I answered the third question raised at the beginning of the chapter, namely how Aristotle goes about generating common explanations of animals and plants. It is time to turn to the fourth question, which is how far Aristotle is able, or willing, to carry out the project of a common study of animals and plants. Judging from what we read in the rest of *Juv.*, the answer can only be this: *not very far*. To begin with, Aristotle is willing to entertain the view that there must be a middle part in plants as there is one in blooded and bloodless animals. This view is implied by what we read in *Juv.* 1. If a living body is articulated into an upper and a lower part, this body must also have a part located midway between the other two. But what Aristotle says in *Juv.* 1 and 2 does not require him to posit the existence of a centralized vital organ in plants. There is no textual evidence that Aristotle is willing to ascribe such an organ to plants. His argument appears to be carefully crafted to avoid such

<sup>75</sup> Aristotle, *GA* II 4, 737b 25–27: “we must begin from the things that are first.” Aristotle, *PA* II 10, 655b28–29: “let us speak again, as it were from the beginning, first from the things that are first.” Finally, Aristotle invokes this rule of inquiry also in the *explicit* of the *PA* I as he is about to engage in his review of the body parts of animals (*PA* I 5, 646a4).

a conclusion. At the same time, he seems to be able to say that there is a middle part in plants just as there is one in animals. Aristotle goes on to state that plants, like animals, grow from the middle (*Juv.* 3).

This middle (the Greek is τὸ μέσον) is that which is formed first so that it can serve as the starting point for the growth of the other relevant body parts. This is what Aristotle seems to imply when he says that growth from a seed comes to pass for all perishable living beings from the middle.<sup>76</sup> He also invokes grafting and plant propagation by slips and cuttings as evidence for this claim. In these cases, the growth of a new plant takes place from an eye, which serves as the starting point and so the center of a new life.<sup>77</sup> Evidently, Aristotle thinks of plants as having potentially many centers of life in their living body as well as one actual center, the one that is midway between the upper and lower parts of the living body. When the text is read in this way, there is no longer an intolerable tension with what Aristotle says in his account of longevity, where he argues for the view that some plants live longer than all animals because they potentially have life everywhere.<sup>78</sup> Every eye in a plant can serve as the starting point for a new organism with its own upper and lower parts.<sup>79</sup> Finally, Aristotle establishes that life is contingent on the preservation of this inborn natural heat for all perishable living beings (*Juv.* 4). As perishable living beings progress in age, they become increasingly less able to maintain this vital heat; death comes to them when this heat is exhausted or extinguished (*Juv.* 5).

I will return to the thesis that plants and animals *qua* perishable living beings have some internal, natural heat.<sup>80</sup> But at this stage of my argument I only need to drive home the following point: important as it is, this thesis does not appear to constitute a sufficiently secure basis for launching into a common study of animals and plants. At the very least, Aristotle does not appear to think so. In fact, he goes on to underscore the existence of important differences separating animals from plants. When it comes to internal, natural heat, the most conspicuous difference is this: nourishment that plants take from the soil is enough to keep their internal, natural heat somehow constant; as a result, their life ends when the cold coming from the outside extinguishes their vital heat or when the supply of nourishment stops for some reason. By contrast, all animals need a natural mechanism to maintain the temperature of their body. We learn that for some animals

<sup>76</sup> Aristotle, *Juv.* 3, 468b18–19. The dative πᾶσι is slightly ambiguous. I understand it as referring to all [living beings].

<sup>77</sup> Aristotle, *Juv.* 3, 468b23–28. <sup>78</sup> See Section 3.2.

<sup>79</sup> I owe this point to KOROBILI 2021: 155–158. <sup>80</sup> Chapter 6, Section 4.

this natural mechanism entails taking in air to cool their bodies (*Juv.* 6). This observation prompts an extended discussion of the physiological significance of breathing.

This discussion takes up much of the second part of the treatise (*Juv.* 7–27 = *Resp.* 1–21). We do violence to the original train of thought when we isolate this discussion and (following a scholarly tradition that has no textual basis in the manuscript tradition) consider it a separate, relatively self-sufficient work.<sup>81</sup> The link that exists in Aristotle's mind between breathing, vital heat, and the nutritive power of the soul makes it natural for him to discuss the function of breathing in the context of his treatment of growth and decline, life and death. Moreover, this link makes it natural for Aristotle to subordinate the discussion of breathing to the main goal of the essay, which is announced at the end of *Long.* 6 (and, if I am right, it is also repeated at the outset of *Juv.* 1): to offer an account of youth and old age, life and death.

## 5 **Interim Conclusion**

At this point we can draw a provisional conclusion. The epistemic principle mandating that we look for explanations at the right level of generality may be taken to imply that we start our inquiry into perishable living beings from what is common to animals and plants *qua* perishable living beings. But this is not how Aristotle proceeds in his actual investigation. As he moves away from his research into the soul and turns to the study of animals and everything that has a share in perishable life, Aristotle shows little or no interest in starting his investigation into perishable life from what is common to animals and plants. His preferred strategy is an oblique one. *Aristotle concentrates on the case of animals and, whenever it is possible and appropriate for him to do so, he derives a conclusion that holds for everything that has a share in perishable life.* What looks like an idiosyncratic, if not unprincipled, strategy is in fact a straightforward application of the epistemic principle that requires him to begin his study of perishable life from the more organized and more definite form of life (animals). Aristotle appears to build his whole science of perishable living beings starting from this principle.

<sup>81</sup> This editorial practice goes back to Bekker, who is the first to add a separate numeration for the chapters devoted to the zoological significance of breathing. All the modern editors of the *Parva naturalia* have followed him.

In the end, however, there is not much that Aristotle is able to explain in common for both animals and plants. What we read outside the *Parva naturalia* confirms this impression. Let us consider, briefly, what we are told at the outset of *PA* II 10, where Aristotle negotiates the transition from the study of the uniform to the non-uniform body parts of animals. Here Aristotle argues that there are two parts that are most indispensable to animals. They are the part for taking in nourishment and the part for discharging useless residue as it is not possible to grow without nourishment.<sup>82</sup> Since nutrition is common to all living beings, the part for taking in nourishment is found also in plants. This part coincides with their roots. So far there is nothing new; we have already seen that the roots in plants are functionally equivalent to the mouth in animals. This time, however, Aristotle goes a bit further. He makes it clear that plants do not have a part for eliminating useless residue. His reason for this claim is that plants take in concocted nutriment from the soil.<sup>83</sup> But this also means that plants do not have the part between the two most indispensable ones – namely, the part dedicated to receiving and processing unconcocted nourishment. This is in line with what Aristotle says in *PA* II 3, where he tells us that plants employ the soil and the heat in it *in lieu* of having a stomach to prepare their nourishment.<sup>84</sup>

This stretch of text is interesting for us because Aristotle is engaged in the attempt to say something in common for both animals and plants. Both animals and plants, insofar as they are living beings, need nourishment to survive. Both actively maintain their own being by taking in nourishment. But while animals take in unconcocted nourishment, plants take in concocted nourishment. And yet there is not much else that Aristotle is able, or willing, to say on the topic of plants and animals *qua* perishable living beings.<sup>85</sup> This is confirmed by what Aristotle says immediately after our text:

<sup>82</sup> Aristotle, *PA* II 10, 655b30–32.      <sup>83</sup> Aristotle, *PA* II 10, 656a32–35.

<sup>84</sup> Aristotle, *PA* II 3, 650a20–23. In this second passage, Aristotle goes on to say that almost all animals, and surely all those that engage in locomotion, have a stomach (κοιλία), which is equivalent to earth inside their body. In this case, the analogy is reversed. Instead of plants using the earth as their stomach, we read of animals having the equivalent of earth inside their bodies. With this reversal, Aristotle is able to make the following additional point: The blood vessels sink into the stomach like the roots into the earth. The concocted nourishment (blood) is taken from the stomach and distributed to the rest of the body through the blood vessels. There is no need to follow Aristotle's train of thought any further here. What matters is that all animals have one part for taking in nourishment – the mouth (στόμα) – and another dedicated to receiving and processing it – the stomach (κοιλία). While these two parts are different in different animals, they receive a single name. Theophrastus adopts these technical terms in *HP* I. See [Chapter 4, Section 4](#).

<sup>85</sup> A similar point can be made in connection with the parallel passage taken from *PA* II 3 (650a2–31). I singled out the passage from the outset of *PA* II 10 because Aristotle draws the additional conclusion that plants must be treated separately.

The nature of plants, being stationary, does not have a variety of non-uniform parts, for the use of fewer organs is required for fewer activities. *This is why their visible aspect should be studied separately* [διὸ θεωρητέον καθ' αὐτὰ περὶ τῆς ἰδέας αὐτῶν].<sup>86</sup>

Rather than building a bridge between the two relevant domains (animals and plants), this passage confirms their separation. For Aristotle, animals and plants do not appear to constitute a single investigative domain. Admittedly, he never says so explicitly, but he does not seem to be able to find explanatory starting points common to both animals and plants. These starting points alone could justify a unified treatment of animals and plants. Moreover, Aristotle shows no willingness to use the few basic truths that he has established in the context of the *Parva naturalia* as his starting points for a science of perishable living beings. And yet we would expect him to give more prominence to these findings if he were indeed trying to build a systematic study of perishable living beings out of what is common to animals and plants. In fact, these findings are relegated to the margins of the project of the *Parva naturalia*. They are also embedded in the study of animals. In the end, it looks like the only way for Aristotle to pursue a science of perishable living beings is (1) via separate studies of animals and plants and (2) starting from animals rather than from plants.

This conclusion is not a problem for us since we do not share the rather demanding conception of the scientific enterprise advocated by Aristotle in the *Posterior Analytics*. Today we are no longer committed to offering commensurately universal explanations: explanations that are as general as possible while at the same time they also remain sufficiently specific to capture salient articulations of the phenomenon under discussion. While we may still appreciate the value of establishing a truth as broadly as possible, we do not make scientific success depend on the application of this epistemic requirement. For instance, it is perfectly appropriate for us to focus on special cases of long-lived animals or on long-lived plants in order to discover the secret of their longevity. Aristotle would have found this approach unprincipled. If common explanations that apply to both animals and plants exist, failing to give them is not really an option for Aristotle. And yet we do not find explanations given in common for animals and plants outside the *Parva naturalia*.

<sup>86</sup> Aristotle, *PAII* 10, 656a2–4. This is equivalent to saying that the *morphology* of plants is to be studied separately. That plants are to be studied via study of their morphology becomes clear from what we read in *HP* 1. I refer the reader to [Chapter 4, Section 3](#).

More to the point: we do not find very many explanations of this kind even in the context of the *Parva naturalia*. But if we do not find very many explanations given in common for animals and plants, we must conclude that such explanations are the exception to the rule. This is an interesting result, and one that is worth underscoring at this stage of my overall argument. This result confirms that Aristotle conceives of the study of perishable living beings as consisting of two separate studies, namely a study of animals and a study of plants. It also suggests that this way of thinking about animals and plants poses serious limits to what can be said in common (or in general) by Aristotle on the topic of perishable living beings.

*Pre-explanatory and Explanatory Strategies  
in Aristotle's Study of Animals*

**I Introduction**

Aristotle approaches the study of perishable life via separate studies of plants and animals.<sup>1</sup> He deals with certain aspects of perishable life in common for animals and plants in the short essays collectively known as *Parva naturalia*. But it is far from obvious that dealing with those aspects amounts to a full-fledged study of the phenomenon of perishable life. What Aristotle says in common for animals and plants is in fact embedded in his study of animals.<sup>2</sup> Rather than overcoming the division of the study of perishable life into separate investigations of animals and plants, this idiosyncratic strategy ends up strengthening it. In the end, the reader of the *Parva naturalia* comes away with the distinct impression that the study of animals remains Aristotle's primary, and indeed overriding, concern. My task in this chapter is to look at how Aristotle approaches the topic of animals with a focus on the methodological decisions that control and indeed shape it.

The first thing to note is that the writings concerned with animals comprise over 25 percent of the surviving Aristotelian corpus.<sup>3</sup> If we concentrate on the extant works on natural philosophy, this number becomes truly impressive: approximately 60 percent of the extant works on natural philosophy are concerned with the study of animals.<sup>4</sup> This number is even more staggering when we consider that the writings on natural philosophy are over 40 percent of the extant corpus of writings transmitted under the name of Aristotle. Clearly, Aristotle aimed at offering a scientific account of the natural world in which animal life was by far the most conspicuous *explanandum*.

<sup>1</sup> Chapter 1, Section 3.    <sup>2</sup> Chapter 2, Section 3.

<sup>3</sup> In the two-volume edition of Aristotle's works produced by Bekker (BEKKER 1831), which is the first truly critical edition of Aristotle and the most common entry point into the Aristotelian corpus, the study of animals comprises 386 pages out of a total of 1,462 pages.

<sup>4</sup> That is, 386 pages out of a total of 605 in the edition produced by Bekker.

We cannot say with confidence when or where Aristotle wrote these works. For one thing, we know too little about Aristotle's life. For another, we have no independent way to fix the relative chronology of his writings. The first period away from Athens is often regarded as especially important for the development of Aristotle's science because the zoological data collected in the *HA* appear to refer to places on the coast of Asia Minor. Scholars have used this observation to establish a connection between the research activities that constituted the basis of the impressive corpus of writings on animals and the years that Aristotle spent away from Athens – especially the years of residence in the Troads (Assos) and on the island of Lesbos (Mytilene).<sup>5</sup> While suggestive, this connection fails to do justice to the centrality of the study of animals to several aspects of Aristotle's philosophy. It also presupposes that the works on animals that have reached us are a finished product that can be ascribed to a particular period of Aristotle's philosophical development. Scholars have often assumed that Aristotle completed his study of animals and then turned to different endeavors. But this is far from being an obvious, let alone safe, assumption given how little we know about Aristotle. In connection with this last observation, it is worth recalling the conclusion that James G. Lennox has reached in an article explicitly concerned with the question of the place of the study of animals in Aristotle's intellectual biography:

A question I am often asked – “when do you date the biology?” – suggests that all of it was composed during a single period. *But surely the task of amassing, sifting, integrating, and explaining the incredible amount of factual data found in these treatises was the work of a lifetime* – indeed, as [David M.] Balme says, it is *an incompletable task*. The information upon which these highly condensed, organized, and generalized treatises rest must have taken a very long time to amass – not to mention working out the highly integrated, explanatory theory for it all.<sup>6</sup>

For Lennox (and Balme), the writings that have come down to us are best understood as a work in progress. In the rest of this chapter, I would like to give the reader at least an idea of how Aristotle conceives of his task in these writings.

<sup>5</sup> This suggestion was first made by D'Arcy Thompson in the prefatory note to his translation of the *History of Animals* (THOMPSON 1910). It was further elaborated by Desmond Lee (LEE 1948: 61–67). However, it did not go unchallenged. See SOLMSEN 1978: 467–484 (answered in LEE 1985: 3–8). A recent, thorough attempt to reevaluate the extant evidence for possible research trips by Aristotle (and Theophrastus) can be found in KULLMANN 2014c: 78–112.

<sup>6</sup> LENNOX 1996: 247–248 (emphasis mine).



## 2 The Collection and Presentation of the Zoological Data

*Posterior Analytics* II is concerned with scientific inquiry (ζήτησις).<sup>7</sup> At the outset of the book, Aristotle famously states that the things we seek are the same as the things we know scientifically.<sup>8</sup> They are four in number:

- (1) the fact that (τὸ ὅτι)
- (2) the reason why (τὸ διότι)
- (3) whether something is (εἰ ἔστι)
- (4) what something is (τί ἔστιν).

It is possible to know the fact without knowing the reason why. In a similar way, we may know whether something exists without knowing what it is. But whenever we know the fact, we seek the reason why. In a similar way, whenever we know whether something exists, we seek what it is. In other words, there is a natural progression in the scientific inquiry from (1) to (2) and from (3) to (4). While a scientific inquiry directed at (2) aims at an explanation, one geared toward (4) has definition as its goal. For Aristotle, explanation and definition are not two disconnected goals. On the contrary, the search for the explanation and the search for the definition converge toward one and the same result. Consider the following passage:

Clearly, the what-it-is and the why-it-is are the same. What is a [lunar] eclipse? Privation of the moon's light by the interposition of the earth. What is the reason of the [lunar] eclipse? Or: Why does the moon suffer an eclipse? Because of the failure of light due to the interposition of the earth.<sup>9</sup>

I will not deal with the question of how definition and explanation go together in Aristotle's theory of science. What is immediately relevant to the present discussion is that *the scientific enterprise as is understood by Aristotle advances in stages*. At the most general level, science proceeds from a stage in which the existence of the things that are to be studied and the facts about them that need an explanation are established to a stage in which those things are defined and the relevant facts about them are explained.<sup>10</sup> The theory outlined so far is general; as such, it applies to all

<sup>7</sup> A recent, helpful introduction to the topic of scientific inquiry and its relation to scientific knowledge as presented in *APo* II, I can be found in BRONSTEIN 2016: 74–83. See also LENNOX 2021a: 40–64.

<sup>8</sup> Aristotle, *APo* II 1, 89a23–24.

<sup>9</sup> Aristotle, *APo* II 1, 90a24–27. Compare Aristotle, *APo* II 8, 93a4.

<sup>10</sup> According to recent, influential reading (CHARLES 2000: 23–77), the stages of scientific inquiry are three, not two. At the first stage of inquiry, the investigator would only grasp an account of what the name signifies. The second and third stage of inquiry would coincide with the two outlined above. For a critical discussion of this interpretation of Aristotle's theory of scientific inquiry, see BOLTON 2017:

scientific domains.<sup>11</sup> The study of animals is no exception to the rule: a zoological investigation aimed at establishing the facts about animals in need of causal explanation should precede the inquiry into their causes. What Aristotle says about stages of inquiry in his *Posterior Analytics* does not require him to present the facts and their explanations separately in distinct works. In fact, the division of the study of animals into treatises that are concerned with offering causal explanations on the one hand, and a treatise devoted to presenting the facts in need of an explanation on the other, is a *unicum* in the Aristotelian corpus.<sup>12</sup>

Following Lennox, we may want to distinguish between the following three theses:

- (1) A zoological investigation that establishes the facts in need of explanation should precede the inquiry into their causes.
- (2) The writing of a treatise presenting the zoological facts in need of explanation should precede the writing of treatises concerned with their causal explanations.
- (3) The study of a treatise presenting the zoological facts in need of explanation should precede the study of treatises concerned with their causal explanations.<sup>13</sup>

While the general theory of inquiry outlined in the *Posterior Analytics* commits Aristotle to (1) and (3), this theory tells us nothing about (2). Any scientific enterprise should begin by collecting the relevant data, which will then become the object of an investigation that has the explicit goal of explaining them – thesis (1). Moreover, the treatise that collects and presents those data should come before any one of the treatises that explain them in the order of study – thesis (3). But we should refrain from drawing any chronological conclusions as to the relative dating of these writings – thesis (2). The study of animals is no exception to the rule. In fact, this study illustrates this complex situation in an especially clear way.

The Greek manuscript tradition has transmitted a treatise entirely devoted to the collection and presentation of the zoological data – namely,

227–248. While David Charles defends a three-stage account of Aristotle's theory of scientific inquiry, Robert Bolton argues for a two-stage approach. I side with Bolton in this controversy, but I will argue that the two main stages are to be further articulated. See [Chapters 4](#) and [5](#) in this book.

<sup>11</sup> According to Lennox, Aristotle's *Posterior Analytics* provides an erotetic framework for any scientific inquiry – that is, a set of questions that ought to guide any scientific investigation of any given domain ([LENNOX 2021a](#): 38, 122).

<sup>12</sup> [LENNOX 1996](#): 244. Compare [LENNOX 2019b](#). The same division resurfaces in Theophrastus's study of plants, which is consciously modeled after Aristotle's study of animals. More on this in [Chapters 4](#) and [5](#).

<sup>13</sup> [LENNOX 1996](#): 236.

*HA*. This work comes before the writings concerned with the explanation of those data in the order of exposition. But it does not follow from this observation that *HA* was written before those writings. A lifelong engagement with the zoological writings led David Balme to formulate a developmental hypothesis, according to which *HA* is the last of the works on animals written by Aristotle.<sup>14</sup> This hypothesis, known as the Balme hypothesis, entails that Aristotle continued to revise the main results reached in his study of animals until the very end of his life.<sup>15</sup> This hypothesis has not gained universal acceptance.<sup>16</sup> For our purposes we can bracket the Balme hypothesis and concentrate on the aims of *HA*. These aims have been greatly clarified by the work of Balme. Against the prevalent (at the time) view that *HA* is primarily concerned with offering an exhaustive, hierarchic classification of animals, Balme argued that this treatise is “a collection of all observable differentiae, collected *qua* differentiae.”<sup>17</sup> “Differentia” (plural “differentiae”) is the Latin translation of the Greek “διαφορά.” By this term, Aristotle means “any way in which *X* may differ from *Y*.”<sup>18</sup> A possible rendering in English is “difference.” According to Balme, *HA* is primarily concerned with animal differences – namely, the ways in which animal kinds differ from one another; for instance, the ways in which they differ with respect to their modes of generation or their modes of locomotion. On this reading, a first goal of *HA* is definitional: arriving at a definition of the relevant phenomena via the collection and analysis of all the relevant differences. None of these differences are by themselves sufficient to reach an adequate definition of an animal. But if we divide the different kinds of animals by adopting the method of division by multiple differences Aristotle outlines in *PA* I 2–3, then we can reach the relevant definitions.<sup>19</sup> Another, related goal of *HA* is explanatory. Aristotle refers to this second goal in a key methodological

<sup>14</sup> BALME 1987: 18.

<sup>15</sup> The expression “Balme hypothesis” was coined by Lennox, who offers an illuminating discussion of the evidence supporting this hypothesis in LENNOX 1996: 229–248. A more recent (independent) discussion of the evidence can be found in PELLEGRIN 2017: 60–67.

<sup>16</sup> See KULLMANN 2007: 146–156 (followed by ZIERLEIN 2013: 71–77 and SCHNIEDERS 2019: 166–174).

<sup>17</sup> BALME 1961: 212 (reprinted, with amplifications, in GOTTHELF-LENNOX 1987: 86).

<sup>18</sup> The term “διαφορά” does not seem to have a technical meaning in *HA*. See the programmatic statement made in *HA* I 6, where Aristotle promises “to grasp the differences [διαφορές] and the features [συμβεβηκότα] that belong to all animals” (491a9–10). In this case, “differences” and “features” seem to be used interchangeably.

<sup>19</sup> For an outline of this method of division, see FALCON 1997: 127–146. An in-depth analysis of the discussion offered in *PA* I 2–3 (which includes a criticism of the dichotomous method of division) is offered in BALME 1992: 101–105.

passage where he tells us that “after this [collection of all the relevant zoological data] we must try to find their causes.”<sup>20</sup>

This picture of the aims of *HA* has been considerably refined by Allan Gotthelf and James G. Lennox.<sup>21</sup> They have shown that Aristotle is concerned not only with laying out animal differences but also with finding out significant groupings of animal differences. For instance, Aristotle is often interested in what a large kind (e.g., birds) has in common with other large kinds, and only then discussing what distinguishes birds or is even unique to them. The same phenomenon can be observed when Aristotle is concerned with sub-kinds of animals (e.g., kinds of birds). Again, the focus is on what a certain sub-kind shares with other sub-kinds followed by a discussion of what is unique about that sub-kind. The theoretical motivation for this idiosyncratic procedure can be traced back to the requirement that explanations be given at the right level of generality.<sup>22</sup> This requirement shapes Aristotle’s overall research project beyond the study of animals.<sup>23</sup> Hence, we should not be surprised to see it at work also in *HA*. Here Aristotle not only collects the relevant differences but also lays them out with a view to generate explanations that reflect the methodological procedures outlined in his *Posterior Analytics*.

What emerges from this picture is a study of animal differences that is geared toward not only definition but also explanation.<sup>24</sup> Since explanation must conform to the procedures of scientific inquiry outlined in Aristotle’s *Posterior Analytics*, the relevant differences are not only collected but also presented with a view to the subsequent stage of inquiry. So *HA* is not completely innocent with respect to explanation to the extent that the relevant zoological data are not only collected but also organized for the sake of their subsequent explanation. In this sense, it is better to think of the  $\delta\tau\iota$ -stage of inquiry as a *pre-explanatory* (or *pre-demonstrative*) stage of investigation.<sup>25</sup>

<sup>20</sup> Aristotle, *HA* I 6, 491a10–11. The full passage can be found at the end of this section.

<sup>21</sup> LENNOX 1987: 90–119 (reprinted in LENNOX 2001a: 7–38); LENNOX 1991: 269–294 (reprinted in LENNOX 2001a: 39–71); LENNOX 2019b; GOTTHELF 1988: 100–133 (reprinted in GOTTHELF 2012a: 390–314); GOTTHELF 2012b: 261–292. Seminal works in this field of study are also KULLMANN 1974 and PELLEGRIN 1982 (English translation in PELLEGRIN 1985).

<sup>22</sup> See Chapter 1, Section 3.

<sup>23</sup> For an attempt to study how this explanatory requirement is at work beyond the study of life, see FALCON 2018: 181–195.

<sup>24</sup> While there is considerable consensus around this conclusion, there is also room for a *distinguo*. Devin Henry has recently argued (in HENRY 2014: 145–169) against a strong (exclusive) reading of the aims of *HA*. In his view, in addition to the conceptual tools to produce scientific explanations and definitions, *HA* provides us with classificatory tools to arrange animals into a hierarchy of kinds based on shared differences and similarities.

<sup>25</sup> Allan Gotthelf (in GOTTHELF 2012b: 261–292) speaks of a *pre-explanatory* stage of investigation. James G. Lennox (in LENNOX 1991: 269–294, reprinted in LENNOX 2001a: 39–71) prefers to speak

I would like to end this introduction to *HA* by recalling a famous passage that marks the transition from the outline of the relevant animal differences (*HA* I 1–6) to the collection of the zoological data offered in the rest of work. This passage points forward to the goals of explanation and demonstration via a discovery of the relevant causes:

We have stated these things in this way now – in outline – to provide a taste of the range and sorts of things we must study; later we will have to speak in greater detail, in order that we may grasp the differences and the features that belong to all. *After this, we must try to discover the causes* [μετά δὲ τοῦτο τὰς αἰτίας τούτων πειρατέον εὐρεῖν]. For that is the natural way to pursue such an inquiry, once one has completed an investigation concerning each of these: *for it becomes apparent from this investigation both about which things the demonstration must be and from which thing it must proceed* [οὕτως γὰρ κατὰ φύσιν ἐστὶ ποιεῖσθαι τὴν μέθοδον, ὑπαρχούσης τῆς ιστορίας τῆς περὶ ἕκαστον· περὶ ὧν τε γὰρ καὶ ἔξ ὧν εἶναι δεῖ τὴν ἀπόδειξιν, ἐκ τούτων γένηται φανερόν].<sup>26</sup>

### 3 Pre-explanatory Strategies in HA

In this section I would like to look at the way in which Aristotle organizes and presents his zoological data with a special focus on the bodily parts of animals. Animals differ from one another not only by having (or lacking) certain parts but also by having them arranged in different ways. Aristotle's systematic study of how animals differ with respect to their parts takes up most of the first four books of *HA* (*HA* I 7–IV 7). Aristotle tells us that his presentation of the zoological data begins with parts rather than modes of life and activities of animals because it is “chiefly, and firstly, with respect to the parts that the wholes also differ.”<sup>27</sup> According to Aristotle, different animals have different body parts because they are engaged in different activities that are constitutive of different modes of life. For instance, fishes have fins because they are marine animals: they displace their bodies in water by means of their fins. We can restate this insight as follows: fins are useful to fishes for swimming, which is their characteristic activity (πράξις). The explanatory connection between a part such as fins in fishes and the activities that are constitutive of the different modes of life (βιοί)

of a *pre-demonstrative* stage of investigation to emphasize that the collection and presentation of the data *HA* are geared toward the production of demonstrations. We are allowed to use both descriptions as soon as we realize that, at least in principle, all causal explanations can take the form of a scientific demonstration. I add the qualification “at least in principle” because Aristotle's practice in his explanatory treatises never reaches the stage of demonstrative science.

<sup>26</sup> Aristotle, *HA* I 6, 491a7–14. <sup>27</sup> Aristotle, *HA* I 6, 491a15.

becomes a major concern at the explanatory stage of his inquiry. At the pre-explanatory stage, Aristotle's main goal is to offer a survey of those parts with a view to their subsequent explanation. The question that concerns us is how this survey is organized and what are the epistemic principles controlling the presentation of the relevant zoological data.

The first thing to note is that Aristotle is quite explicit about his overall strategy in *HA*. His methodological explicitness is not only remarkable but also unmatched in antiquity. While Aristotle is not the first to engage in a description of the body parts of the human being and the other animals, he is unique in his self-conscious attempt to provide his reader with clear instructions on how the relevant data are collected and presented. Aristotle's most important move is made in *HA* I 6, where he tells us that the review of the parts of animals begins with a discussion of the human body because the human being is the animal that is most familiar to us. Aristotle justifies this decision with the help of an example taken from our everyday life. We establish the value of some money in a foreign currency by translating it into our own currency:

We must speak first about the parts of the human being; for just as each [nation] establishes the value of foreign currency with what is most familiar to itself, so we must do the same in the other cases. *The human being is of necessity the most familiar to us* [ὁ δ' ἀνθρώπος τῶν ζῴων γνωριμώτατον ἡμῖν ἐξ ἀνάγκης ἔστι].<sup>28</sup>

Beginning the review of bodily parts in animals with the human being is introduced as a non-arbitrary decision – indeed, as a first, necessary step. Apparently, as investigators of the animal kingdom, we have no choice but to start our review from the human body because of our proximity to it. This proximity makes the human body the most familiar to us, and so the natural starting point for a systematic review of the body parts of all known animals. Aristotle begins his review of the differences in animals with the *external* parts, starting from the top of the human body and moving down. He then turns his attention to the *internal* parts of the human being. In a second key methodological passage, Aristotle tells us that we face special challenges when we look inside the human body. The internal parts, Aristotle says, are the least known to us.<sup>29</sup> While Aristotle does not elaborate on the reasons

<sup>28</sup> Aristotle, *HA* I 6, 491a19–33. Following Peck, I supply “nation.” But “polis” or “the δοκιμαστής,” namely the person officially in charge with validating the coins to be used in the marketplace, could be equally acceptable amplifications of the Greek text. I owe this point to [BEMER 2014](#): 176.

<sup>29</sup> Aristotle, *HA* I 6, 494b19–26: “the parts that are externally visible are arranged in this way and as we have stated. They have a name and are best known on account of our proximity to them. It is the opposite for the internal parts. The internal parts of human beings are the least known, so our

for our relative lack of knowledge about the inside of the human body, we should keep in mind that the dissection of the human body, including its dissection *post mortem*, was forbidden during almost all Greek antiquity.<sup>30</sup> As a result, ancient Greek knowledge about the internal parts of the human body was largely dependent on knowledge acquired from the dissection of animals. Aristotle's survey of the internal parts of the human being betrays this epistemological dependence. For instance, Aristotle says that the stomach of the human being *resembles* that of a dog; he also maintains that the lower part of the intestinal tract of the human being *is like* that of a pig; finally, he claims that the human liver *is like* that of an ox.<sup>31</sup>

The asymmetry between Aristotle's knowledge of the internal and external parts of the human body is well known.<sup>32</sup> I am recalling this asymmetry here because it suggests that Aristotle's decision to begin his review of the bodily parts of animals starting from the human being cannot be explained only in terms of our familiarity with the human body. As a matter of fact, this familiarity does not extend to include the inside of the human body. If, therefore, we want to understand why Aristotle reviews both the external and the internal parts of the human body *before* turning to the parts of the other animals, we must bring to the fore another methodological assumption that shapes his review of the body parts of animals in *HA* I–IV. This assumption is made explicit in the discussion of the relative position of the external parts in the human body.

The relative position of the parts with respect to up and down, front and back, right and left would seem to be clear to sense-perception in the case of external parts; however, we must speak about this for the same reason as we discussed the other parts – so that an orderly sequence of topics may be observed and the different ways in which these parts are arranged in the other animals as well as in the human being may not be overlooked as we enumerate them.<sup>33</sup>

In this passage Aristotle recalls his thesis that living bodies display up to three functional parts: up/down, front/back, and left/right. These functional parts are most clearly articulated in the human body because of its

examination [of these parts] must trace them back to the parts of the other animals with which they have a natural resemblance.<sup>34</sup>

<sup>30</sup> Helpful remarks on the Greek attitude toward the human body vis-à-vis dissection can be found in VON STADEN 1992: 223–241. On the relation between dissection and anatomy in classical antiquity, see BUBB 2022: 1–8 (with introduction to the relevant secondary literature).

<sup>31</sup> For the stomach, see *HA* I 16, 495b24; for the lower intestinal tract, see *HA* I 6, 495b27; for the liver, see *HA* I 17, 496b24.

<sup>32</sup> LLOYD 1983: 27. <sup>33</sup> Aristotle, *HA* I 15, 494a20–26.

erect posture. Other animals either do not have all three dimensions or they have them confounded to a degree.<sup>34</sup> Aristotle does not mean to say that these functional parts are not present in other animals; he only means to say that in these animals these functional parts are found together in the same place. Of course, we can tell them apart even when they are mixed up in the same place since we can trace them back to different powers of the soul present in the living body. For instance, the front is where the sense-organs are implanted, whereas the up is the entry point of nourishment. While this functional distinction may not be evident to sense-perception, the investigator can always see it by means of reason. Consider a snake: we can easily recognize a front and a back in its elongated body; however, we cannot distinguish, or cannot distinguish easily, an up and a down, or a right and a left, in that body. The reason is to be found in its elongated shape. And yet we possess a theory enabling us to argue for the existence of these bodily distinctions regardless of whether we see them. To the best of my knowledge, Aristotle is the first to equate the living body to an organized body, and he is also the first to distinguish the different kinds of perishable living beings in terms of the different levels of their bodily organization. It should also be clear that different degrees of organic unity correspond to the different levels of bodily organization. The highest level of organic unity is found in the living body that displays the greatest level of organic complexity.<sup>35</sup>

I will not engage in a full review of all the relevant passages where this conception of the perishable living body is at work.<sup>36</sup> I am content to refer the reader to Aristotle's *De anima*, where the soul is defined as the first actuality of a natural, organic body that has life potentially.<sup>37</sup> Much ink has been spilled on the meaning of "organic."<sup>38</sup> To be sure, Aristotle means to say that the living body is an organ of the soul. In other words, the whole living body is an instrument that the soul employs in the exercise its powers.<sup>39</sup> But this living body is to be minimally organized in a certain way if it must perform its function in an optimal way. The brief allusion to parts in plants that follows immediately after in the text may be meant to drive home this very point. When Aristotle says that roots are to plants

<sup>34</sup> Aristotle, *HA* I 15, 494a32. <sup>35</sup> See Chapter 2, Section 4.

<sup>36</sup> The addition of the qualification "perishable" is meant to exclude celestial bodies, which Aristotle envisions as being made of a celestial simple body unique to them.

<sup>37</sup> Aristotle, *DA* II 1, 412a28.

<sup>38</sup> Most useful on this front is MENN 2002: 107–117. Compare KOSMAN 2013: 100–104; KXHIELDS 2016: 171–173.

<sup>39</sup> This claim is repeated in *PA* I 1, 642a11–12, where Aristotle says that not only each of the parts but also the whole body is an instrument for the sake of some goal. Compare also *PA* I 5, 645b12–20.



what mouth is to animals, he reminds us not only of the analogous functions that these parts have in plants and animals but also of the existence of distinct levels of organization in the different kinds of perishable living bodies. So I do not think that the traditional reading is hopelessly misleading. According to this reading, which goes back at least to Alexander of Aphrodisias, the natural body that is potentially alive is organic in the sense that it consists of bodily organs.<sup>40</sup>

What matters for our present purposes is the highly abstract conceptualization of the perishable living body at work in *HA*. A certain idea of organization is invoked when we are told that the human body displays the relevant organization in the clearest possible way. This organization is clear to sense-perception only in the case of the human body, and only with reference to its external parts. What I would like to take away from this brief discussion is the following conclusion: Aristotle begins his review of the parts in animals from the human body not only because the human body is the most familiar to us but also because *the human body can serve as an objective standard of reference*. By offering a review of the parts of the human body, Aristotle launches into a study of what he takes to be the paradigmatic case of the perishable living body. Equipped with the conceptual resources developed in the context of this study, he can engage in the study of the living body of other animals. As Aristotle himself says in the last passage cited above, this strategy ensures that the investigators of the animal kingdom do not overlook anything of importance as they review the body parts of other animals.

Two epistemic principles control the review of the relevant zoological data. While the first requires us to proceed from the *more knowable to us*, the second mandates that we proceed from *the more knowable per se* (alternatively, *more knowable by nature*). These principles need not clash with one another. According to Aristotle, the human body not only happens to display the highest degree of organic unity but it also happens to be the most familiar to us. If this conclusion is accepted, the strategy Aristotle adopts for the review at the pre-explanatory stage of inquiry is close to the one he employs at the subsequent, explanatory stage. Let me return to how Aristotle negotiates the transition from the study of the uniform parts to the study of the non-uniform parts at the outset of *PA II* 10. Aristotle begins his discussion by stating that all animals must have a part by which they take in the nourishment (the mouth), and another part where the nourishment is processed (the stomach). There is, however,

<sup>40</sup> Alexander of Aphrodisias, *De anima* 16.11–12.

a great deal of variation in bodily organization beyond this important commonality. Aristotle recommends handling this variation *starting from the human being*:

Those beings that are equipped with sense-perception in addition to *being alive* [ζῆν]<sup>41</sup> are more diverse in their visible aspect, and some of them more than others. There is still greater variety among those whose nature partakes not only of *living* [ζῆν] but also of *living well* [εὖ ζῆν]. Such is the human being. Among the animals known to us, either the human being alone or the human being most of all partakes of the divine. So, both because of this and because the shape of the external parts of the human being is most familiar [to us], we must speak about it first. *The reason is that the natural parts are disposed right away according to nature only in the human being* [εὐθὺς γὰρ καὶ τὰ φύσει μόρια κατὰ φύσιν ἔχει τοῦτω μόνω], and the upper part of the human being is oriented toward the upper part of the whole: the human being alone among animals is upright.<sup>42</sup>

In this passage Aristotle is more forthcoming about the reasons why we ought to start the study of the non-uniform body parts from those of the human being. While Aristotle still mentions our familiarity with the external parts of the human body, he now adds that the anatomical arrangement of the non-uniform parts in the human body is the most natural. This claim holds not only for the external but also for the internal parts. Finally, Aristotle says that the human body alone displays what he takes to be the most natural arrangement of body parts. When we take all these reasons into account, we have no choice but to start our review of the non-uniform parts from those of the human being.

What is exceptional about the human animal is its erect posture, which aligns the human body with the body of the universe. The human body is regarded as the body that displays the greatest level of organization because the human being partakes of living well (as opposed to merely living). To unpack this idea, we must return to the Aristotelian insight that the body is an instrument employed by the soul to discharge its powers.<sup>43</sup> According to Aristotle, the human soul has the power to live in accordance with reason. The passage just quoted does not elaborate on the connection between displaying a greater level of bodily organization and rationality, but we may think of reason as a power that the human being alone has in addition to the other cognitive powers it shares with the nonhuman animals. It is also

<sup>41</sup> Recall that the distinction between two levels of life, namely plant and animal life, is made with reference to the presence (or absence) of sense-perception. Hence, the living beings that are equipped with sense-perception in addition to life are animals.

<sup>42</sup> Aristotle, *PA* II 10, 656a3–13. <sup>43</sup> See above pp. 86–87.

prima facie plausible that the presence of this additional (higher) power requires an additional (higher) level of bodily organization.

I have elaborated on the methodological remarks Aristotle offers in his review of the internal and external non-uniform parts of the human body to show that Aristotle employs the human animal as a starting point for his anatomical study of nonhuman animals. The implicit rule of inquiry at work is that our study ought to start from that which displays the greatest level of organization since this is also the thing that displays the higher level of unity. The clearest and most general formulation of this rule is found in a fragment from the lost *Protrepticus*.<sup>44</sup> By the end of *HA* I, the review of the human body is complete. Aristotle turns to the parts of the other animals at the outset of *HA* II. His survey of these parts is over only at the end of *HA* IV 6. We should not underestimate how complex is the project of offering a systematic survey of all the parts of all the animals other than the human being. At the very least, the investigator is expected to have developed a strategy to present the zoological information in an orderly manner.

Two conceptual distinctions are at work in Aristotle's survey. The first is the division of bodily parts into external and internal parts; the second is their division into uniform and non-uniform ones. When we combine them, we obtain a survey of the zoological data that begins with the *external non-uniform parts*, continues with the *internal non-uniform parts*, and ends with an examination of the *uniform parts*. But there is at least another key methodological insight that controls how Aristotle presents his zoological data. This is the rule of inquiry that requires us to proceed from those animals that display a more organized, or at least a more determinate, living body. Admittedly, Aristotle never invokes or states this rule; but as he moves away from the human body, he appears to find progressively less organization and less determination. We may object that Aristotle finds progressively less organization and less determination precisely because he is less familiar with these animals. This is certainly true, but we should not forget that these animals occupy a lower position in Aristotle's scale of nature. In his view, they occupy a lower position because they are less complete or even less perfect. We are back to the methodological insight that informs the architectonic decision to begin the examination of the non-uniform parts of animals from the human body because this is the most organized and most articulate living body.

To fully appreciate how Aristotle moves on, and indeed forward, with his project of a systematic review of the bodily parts in animals, we need to

<sup>44</sup> I introduced this fragment in [Chapter 1, Section 3](#).

return to a division introduced in the previous chapter: that between *blooded* and *bloodless animals*. To understand what this division entails, we must return to the outline of animal differences advanced at the outset of *HA*, where we are told that all animals are supplied with moisture, the privation of which results in death.<sup>45</sup> The moisture present in blooded animals is of course blood, which runs in the blood vessels. The presence of blood and blood vessels entails the presence of a few related parts. Among them, I recall the heart, viscera, and flesh. When these bodily parts are absent, we should posit the presence of a set of bodily parts that is functionally analogous. I will return to this important aspect of Aristotle's theory in a moment. For the time being, let me stress that the review of blooded animals grows out quite naturally from the discussion of the bodily parts in the human being since the latter is the most perfect among the blooded animals. When we look more closely at how Aristotle reviews the zoological data about blooded animals, we discover that the following groups of animals are discussed (in this very order): live-bearing four-footed animals, egg-laying four-footed animals, birds, fishes, and snakes. In other words, the review of the zoological data is organized with the help of the large kinds (μέγιστα γένη) introduced in *HA I 6*.<sup>46</sup>

In some cases, these kinds are already identified by the Greek language (fishes, birds, snakes).<sup>47</sup> When they are available, Aristotle is happy to adopt existing names. By adopting these names, Aristotle is also turning them into terms of art. But the absence of a name in a natural language does not prevent Aristotle from recognizing a new group when he has reasons to think that the animals in question possess a common nature. Clearly, Aristotle considers the live-bearing four-footed animals and the egg-laying four-footed to be large kinds even if there is no name in the natural language to designate them.<sup>48</sup> Aristotle elaborates on this front in

<sup>45</sup> Aristotle, *HA I 4*, 489a20–21.

<sup>46</sup> A full discussion of how Aristotle introduces, and indeed defends, his articulation of animals into μέγιστα γένη in *HA I 6* can be found in GOTTHELF 2012d: 293–306. On μέγιστα γένη, compare BEMER 2014: 309–334.

<sup>47</sup> I note, in passing, that it is far from clear that snakes are a large kind (μέγιστον γένος). There is textual evidence that Aristotle considers them a kind (γένος). See Aristotle, *HA I 15*, 505b25–31.

<sup>48</sup> It is quite tempting to treat “live-bearing four-footed animals” and “egg-laying four footed animals” as name-like expressions with a fixed taxonomic meaning. Upon reflection, however, we should resist this temptation. To begin with, Aristotle consistently speaks of “four-footed *and* live-bearing animals” and “four-footed *and* egg-laying animals.” He is also ready to switch the terms around when needed. For instance, Aristotle is interested in the *egg-laying* animals and divides them into *four-footed* animals (lizards and the like) and *footless* one (fishes). This practice, combined with the linguistic usage described above, suggests that Aristotle is not employing these descriptive phrases as name-like expressions and is not primarily concerned with developing a fixed taxonomic vocabulary. Compare GOTTHELF 2012d: 301 and LENNOX 2001: xii–xiii.

the *Posterior Analytics*, where he correlates the following three features: being horned, having a third stomach, and possessing only one row of teeth. All the animals that share these features should be treated as having a common nature even if we lack a name for them.<sup>49</sup>

An extended examination of Aristotle's review of the pre-explanatory strategies adopted in the collection and presentation of the non-uniform parts in blooded animals goes beyond the scope of this chapter. Here I would like to illustrate these strategies with the help of a couple of examples taken from Aristotle's review of the external parts in live-bearing four-footed animals. The first example is this: the live-bearing four-footed animals have front legs instead of arms, and those that have their front legs divided into many toes use them as if they were their hands (with the notable exception of the elephant, which possesses a special organ, the nose, which serves as a grasping and moving instrument).<sup>50</sup> We find here an instance of how Aristotle proceeds in his review of animal differences. He deals first with the feature (or features) common to the whole kind and then turns to the feature (or features) shared by a particular sub-kind, ending with a discussion of exceptional cases. The discussion of the exceptional cases is not merely a coda motivated by an interest in the strange or the marvelous; rather, it is guided by Aristotle's concern for offering a review as complete as possible of the zoological phenomena.

Let us now turn to the second example. In his review of the live-bearing four-footed animals, Aristotle tells us that all *four-footed* animals have legs that are bony, sinewy, and fleshless, and that this is in fact a feature shared by all *footed* animals. Moreover, all *footed* animals lack buttocks (most notably, birds). The only exception is the human animal, whose buttocks, thighs, and calves are the fleshiest part of its whole body.<sup>51</sup> We find here a good illustration of Aristotle's interest in generalizing across large kinds of animals. These generalizations contradict Aristotle's stated intention to study each large kind "separately by grasping its nature individually [χωρίς λαμβάνοντα . . . ἐκάστου τὴν φύσιν]."<sup>52</sup> Recall that investigating *X* separately (χωρίς) involves studying *X* in its own right on the crucial assumption that *X* is a relatively unified domain of investigation.<sup>53</sup> If this programmatic statement is taken seriously, we should expect Aristotle to

<sup>49</sup> Aristotle, *APo* II 14, 98a13–18.

<sup>50</sup> Aristotle, *HA* II 1, 497b13–498a1. The way in which the zoological data are presented here makes sense only if the human body is taken to be the point of reference. Strictly speaking, the human being alone has arms and hands because of its erect posture.

<sup>51</sup> Aristotle, *HA* II 1, 499a31–b5. <sup>52</sup> Aristotle, *HA* I 6, 491a4–5.

<sup>53</sup> Compare Chapter 1, Section 3.

conduct his review of the differences in animals strictly by large kind. And yet Aristotle does not proceed in this way.

To understand why, we need to remain mindful that the large kinds are not his primary, or even most immediate, concern; he is primarily concerned with the commensurate (universal) relationships holding among the relevant animal differences. This concern is dictated by his theory of scientific explanation, which requires the investigator to give explanations at the right level of generality. Aristotle is expected by his own theory to register not only the differentiating features shared by the animals falling under a given large kind but also those that the large kind shares with another large kind (or with a sub-kind of another large kind of animals).<sup>54</sup> This conclusion suggests the following, important observation: the large kinds introduced in *HA I 6* are not meant to be a rigid taxonomy adopted for classificatory purposes; they are best understood as a basic division of kinds of animals subordinated to the achievement of the overriding explanatory goals Aristotle pursues in his study of animals.

We come to the same conclusion when we reflect on how Aristotle uses the division into blooded and bloodless animals. Aristotle does not employ this division because he is motivated by taxonomic concerns, but rather because he hopes to pursue his explanatory goals across the entire animal kingdom. To appreciate this point, we need to return to Aristotle's idea that the absence of blood, blood vessels, and the other related bodily parts entails the presence of functionally analogous parts (they are typically nameless). Two moves are implicit in this idea. The first is this: the parts in bloodless animals are imperfect with respect to their analogous parts in blooded animals; as a result, their description and subsequent explanation is to be conducted by relying on the results achieved in the study of the bodily parts in blooded animals. The second move has to do with analogy, which is the tool that allows us to discover the existence of structural similarities across large kinds of animals.<sup>55</sup> When this tool is first introduced in *HA*, Aristotle employs the following examples: bone is analogous to spine, nail to hoof, hand to claw, and scale to feather.<sup>56</sup>

<sup>54</sup> For full discuss of this aspect of Aristotle's methodology in *HA*, see GOTTHELF 1988: 101–113 (reprinted in GOTTHELF 2012a: 309–324) and, more recently, GOTTHELF 2012b: 272–273.

<sup>55</sup> I will have a great deal more to say on analogy as my argument unfolds in Chapters 4 to 6. For the time being, let me highlight recent discussions of analogy in Aristotle's study of animals and beyond: LLOYD 1996c: 138–159; WILSON 2000: 53–115; RASHED 2005: clii–clxiii; HENRY 2014: 145–169 (to be read along with the LEUNISSEN 2014: 170–181); RAPP 2021: 9–37; SIER 2022: 147–178.

<sup>56</sup> Aristotle, *HA I 1*, 486b19–22.

All these examples are taken from within the group of blooded animals. But the significance of analogy goes emphatically beyond this initial case. Aristotle employs analogy to move not only across large kinds of blooded animals but also from blooded animals to bloodless animals. These two moves jointly control the order of inquiry at the pre-explanatory stage of inquiry: first the differences in blooded animals, then those in bloodless animals. They also control how the differences in bloodless animals are to be approached. These differences are to be introduced and studied based on the results achieved in the study of blooded animals. It does not take long to see that the methodological insight shaping the study of bloodless animals is another incarnation of the methodological principle that the study of the less organized and less determined is to be conducted via the results reached in the study the more organized and more determined rather than vice versa.

The review of the bodily parts in bloodless animals is organized around external and internal parts; but now Aristotle discusses both external and internal parts together for each large kind before moving on to the next large kind. We are not given the reason for this change in the overall strategy. Lennox has suggested that this different organization of the zoological data may be a direct consequence of how the large kinds themselves are fixed.<sup>57</sup> Recall that the large kinds of bloodless animals are four: soft-bodied animals, soft-shelled animals, hard-shelled animals, and animals that have insections in their bodies (i.e., insects).<sup>58</sup> At the outset of *HA IV*, Aristotle adds a brief description for each of these four kinds. Taken together, those descriptions suggest that Aristotle has come to fix these large kinds with reference to the relative differences that we observe with respect to the softness or hardness of their exterior and interior parts, as well as the shape of their whole body. Hence, it makes sense for him to review these differences large kind by large kind.

I conclude this review of the pre-explanatory strategies adopted in presenting the zoological data regarding the parts of animals by recalling these descriptions. The soft-bodied animals (μαλάκικα) resemble blooded animals to the extent that they display soft and flesh-like parts outside and

<sup>57</sup> LENNOX 1987: footnote 29 (reprinted as LENNOX 2001a: endnote 29). It may be helpful to recall in connection with this observation that we are expected to discuss the differences in the bodily parts because it is “chiefly, and firstly, with respect to these that the wholes also differ” (Aristotle, *HA I 6*, 491a15; compare *PA I 4*, 644b8–10).

<sup>58</sup> This is a term of art coined by Aristotle. It is introduced in *HA I 1*, 487a32–33 with the following (nominal) definition: “I call ‘insected animals’ those that have their bodies divided in sections [καλωῶ δὲ ἔντομα [sc. ζῶα] ὅσα ἔχει κατὰ τὸ σῶμα ἔντομάς].”

a hard structure inside (e.g., the cuttlefish and the octopus). The soft-shelled animals (μαλακόστρακα) display the opposite bodily arrangement: they have a hard structure outside and soft and flesh-like parts inside (e.g., the lobster and the crab). The hard-shelled animals (δστρακόδεσμα) have a hard shell protecting a flesh-like inside. The distinction between soft-shelled and hard-shelled animals is traced back to the different nature of their external hard structure, which Aristotle describes in the following way: while the outer structure of the soft-shelled animals is crushable but not crackable, the outer structure of the hard-shelled animals is crackable but not crushable.<sup>59</sup>

A couple of questions loom large at this point. The first is how far Aristotle can pursue his explanatory goals by adopting analogy across the entire animal kingdom. The second has to do with the explanatory costs associated with this strategy. Let us focus on the second question first. Analogy helps Aristotle transfer results reached in the study of the more organized and more definite kind of animal to the study of the other kinds of animals. In this respect, analogy orients how Aristotle is going to study what he takes to be comparatively less organized kinds of animals. But it also determines some of the results he is going to establish in the context of his research. Let me illustrate this point with the help of a well-known example. According to Aristotle, soft-bodied animals like the cuttlefish and the octopus are bloodless animals. These animals do not have a heart but something functionally equivalent to it. Aristotle calls this large central part *mutis*.<sup>60</sup> Today we know better: the cuttlefish and the octopus have three hearts and a bodily organization that is not reducible to the one envisioned by Aristotle. What matters most is not the mistake itself but rather the fact that *the mistake is driven by the theory*.<sup>61</sup> Aristotle does not study these alien forms of life in their own right; he studies them based on his knowledge of blooded animals. An unintended consequence of this strategy is this: Aristotle is unable to appreciate what is unique about animals such as the cuttlefish and the octopus. This last observation raises an important question about the costs of the application of the epistemic principle that requires the investigator to start their inquiry into perishable life from what Aristotle takes to be the

<sup>59</sup> Aristotle, *HA* IV 1, 523b5–7 combined with 523b9–11.

<sup>60</sup> Aristotle, *HA* IV 1, 524b14–15 combined with *PA* IV 6, 681b18–21. In the context of this second discussion, Aristotle makes it clear that the position of the *mutis* at the center of the living body makes it functionally equivalent to the heart in blooded animals (*PA* IV 6, 681b28–30). But we know that the organ that Aristotle calls *mutis* is functionally equivalent to the liver, and not the heart, as is charitably noted in LSJ (s.v. μύτις).

<sup>61</sup> There is further, helpful discussion of this mistake and its methodological implications in LLOYD 1996c: 138–159 (especially 155–156).



most organized and most determinate form of life. This principle has an architectonic relevance that goes beyond the study of animals, but its costs may be assessed by remaining within the domain of animal life.<sup>62</sup>

Let us now turn to the first question raised above. Under the rubric of bloodless animals Aristotle deals with vastly different kinds of animals: insects, soft-bodied animals, soft-shelled animals, and hard-shelled animals. Aristotle cannot be content with highlighting the similarities that hold across these large kinds; he is also expected to engage in a vigorous study of each of those kinds with an eye toward what is specific about each of them. Put differently, the general and the specific are to be integrated into a single account since only the combination of the two gives us perfect, and so scientific, knowledge. There is no reason to think that the study of bloodless animals is meant to be an exception to the rule. But how far, and indeed how well, is Aristotle able to pursue his explanatory goals as he moves away from his study of blooded animals? I will try to answer this question by turning to the διότι-stage of inquiry, with a concentration on Aristotle's explanation of animal locomotion.

#### 4 Explanatory Strategies in *IA*

Let us begin by stating the obvious: we do not have a single discussion of all the bodily parts of animals in Aristotle.<sup>63</sup> In addition to the official treatment offered in *PA* II–IV, we are given separate treatments of the locomotive and generative parts.<sup>64</sup> While the locomotive parts are studied in the short treatise known with the Latin title of *De incesu animalium* (*IA*), the generative parts are discussed in the first book of the *Generation of Animals* (*GA* I 3–16). Aristotle does not elaborate on his decision to organize his explanatory work in this way, but we can offer an educated guess on his behalf. Reproduction and locomotion are the two most conspicuous life activities in which animals are engaged. It is surely no coincidence that two

<sup>62</sup> What Aristotle says on the octopus and the cuttlefish can be usefully compared (and contrasted) with what we read in a recent book on this topic (GODFREY-SMITH 2017). It seems that when we approach an alien form of life, we have no choice but to register the commonalities and the differences with a more familiar form of life (ours). In this respect, the overall strategy adopted in this recent work is not so different from the one followed by Aristotle. And yet, we do not find the additional idea that there is a paradigmatic form of life (ours) that shapes our discussion of the alien form of life. Upon reflection, this is what leads Aristotle astray.

<sup>63</sup> In this section I am relying on results published in FALCON 2021a.

<sup>64</sup> Recall that *PA* I is a general introduction to the study of animals, with a focus on the specific norms of inquiry required to engage in a successful investigation of animal kingdom. As such, the book has a more general significance. I borrow the phrase “norms of inquiry” from LENNOX 2021a.

of the large kinds that Aristotle isolates in his zoological writings, namely the four-footed egg-laying animals and the four-footed live-bearing animals, are identified by means of their distinctive modes of reproduction and locomotion. Considering this, it is no surprise to discover that the study of the relevant bodily parts involved in animal reproduction and locomotion requires not only extensive but also separate discussions.<sup>65</sup>

Here is the opening statement of *IA*:

As regards the parts that are useful to animals for movement with respect to place, we must investigate due to what sort of cause each part is such as it is and for the sake of what it belongs to them, and also the differences in the parts of one and the same animal as compared to the parts of animals different in kind.<sup>66</sup>

Right from the start Aristotle adopts a resolutely teleological approach to the phenomenon of animal locomotion: he promises to deliver a causal explanation of the presence of the locomotive parts by asking for what reason animals have them. Among other things, such an explanation entails finding out the relevant final cause.<sup>67</sup> Moreover, Aristotle promises an explanation not only of why animals have the bodily parts they do but also of why they have them in the way they do. This requires an explanation of why the bodily parts involved in locomotion differ within the same animal (e.g., why front and hind legs in live-bearing four-footed animals bend in opposite ways) as well as across different kinds of animals (e.g., why egg-laying four-footed animals bend their legs in a different way, unique to them – namely, laterally and away from their own body).

What makes the *IA* an especially interesting case study is the methodological explicitness by which Aristotle first introduces and then uses the relevant theoretical framework to fulfil the promises outlined above. Aristotle provides his reader with three explanatory principles. The first principle is the axiom that “nature does nothing in vain, but it always does what is best from among the possibilities for the substance of each kind of animals.”<sup>68</sup> While Aristotle invokes this teleological principle several times

<sup>65</sup> A separate review of the reproductive parts is offered at the pre-explanatory stage. See *HA* I 13–14; *HA* II 1, 500a15–25; *HA* III 1; *HA* IV 11 (secondary sexual characteristics). Activities related to reproduction are discussed in *HA* V–VI. For an attempt to explain why the reproductive parts are explained in the context of Aristotle’s *GA*, see [GOTTHELF-FALCON 2017: 17–21](#).

<sup>66</sup> Aristotle, *IA* 1, 704a4–9.

<sup>67</sup> The emphasis placed on final causality does not mean that the other causes are not relevant to our attempt to account for animal locomotion.

<sup>68</sup> Aristotle, *IA* 2, 704b15–17. There is fuller discussion in [FALCON 2021b: 19–31](#). The nature in question is not cosmic nature but rather the internal source of change and rest introduced in *Phys.* II 1, 192b20–23.

in the course of his natural investigation,<sup>69</sup> he offers its fullest and most precise formulation here.<sup>70</sup> The second principle is the abstract but powerful way of thinking about the living body we have already seen at work in *HA*. For Aristotle, a perishable living body must be organized in a certain way to support life. This body can display up to six functional dimensions: up/down, front/back, and left/right.<sup>71</sup> A perishable living body engaged in locomotion requires all of them. In other words, an upper and a lower part, a front and a back, and finally a right and a left side must be present in a living body equipped with the power to displace itself.<sup>72</sup> The third, and final, principle is about motion: pushing and pulling are the sources of all *per se* motion from one place to another.<sup>73</sup> While the first two principles are native to Aristotle's study of animals, the third originates in Aristotle's general discussion of motion.<sup>74</sup> This is a relatively unsurprising development. To the extent that Aristotle is about to engage in an investigation of the locomotive parts insofar as they are useful for locomotion, he is concerned not only with certain bodily parts but also with a special kind of motion, namely animal locomotion. So it is perfectly appropriate for Aristotle to remind us (and himself) of a general principle of motion immediately relevant to his project. Unsurprising as it is, this development is not trivial. It shows that Aristotle does not conceive of the study of animal locomotion as a separate, let alone independent, investigation; on the contrary, his investigation is guided by the theoretical framework developed in *Phys.* I–VIII.

As we proceed in the study of how Aristotle explains animal locomotion, we should bear in mind the following distinction, which also marks the beginning of Aristotle's actual investigation: bodily displacement takes place either by jumping or by progression (the Greek term is *πορεία*). While in jumping the living body is displaced all at once, in progression the

<sup>69</sup> For instance: Aristotle, *DCI* 4, 271a33; *DCII* 11, 291b13–14; *DA* III 12, 434a31; *PA* II 13, 658a8–9; *PA* III 1, 661a23–24; *GA* II 5, 741b–5; *GA* II 6, 744a36–37. It is worth noting that this explanatory principle is also invoked by Theophrastus in his study of plants (*CP* I 1.1). On Theophrastus and teleology, see [Chapter 5, Section 3](#).

<sup>70</sup> This teleological principle has been closely studied: [LENNOX 1997](#): 199–214 (reprinted in [LENNOX 2001a](#): 205–223); [LEUNISSEN 2010](#): 119–121, 124–135; [HENRY 2013](#): 225–263; [MOREL 2016](#): 9–30; [STAVRIANEAS 2021](#): 165–193; [RANGOS 2021](#): 233–265.

<sup>71</sup> Aristotle, *LA* 2, 704b19–22.

<sup>72</sup> None of this applies to celestial bodies. Aristotle explains celestial motion in terms of a special simple body that naturally move in a circle. See [FALCON 2005](#): 55–84.

<sup>73</sup> Aristotle, *LA* 2, 704b22–23.

<sup>74</sup> The proof that all motion in place is *per se* or *per accidens*, and all *per se* motion can be reduced to pushing and pulling, is offered in *Phys.* VII 2, 243a11–244a6. Here Aristotle takes upon himself the task of showing that all motion in place can be reduced to a case of pushing and pulling.

living body is displaced part by part.<sup>75</sup> This second mode of bodily displacement is Aristotle's primary focus in *IA*. The parts of the living body involved in progression are called "instrumental parts."<sup>76</sup> By adopting this expression, Aristotle indicates that these parts are used by the animal as tools to move its body from one place to another. Finally, Aristotle tells us that an animal that can displace itself must exhibit the following (minimal) level of bodily complexity: one part of its body is acted upon by being pressed, while another acts on it by pressing. An important corollary of this zoological theorem is that without bodily parts nothing can displace itself.<sup>77</sup>

Up to this point Aristotle has proceeded at a very general level of investigation, but now he turns to the explanation of the vastly different ways in which animal progression takes place in nature. While some animals progress on land, others do so in water or in air; moreover, some use their feet as an instrument of locomotion, whereas others employ different bodily parts (e.g., wings or fins); finally, there are also animals that can move quickly and efficiently even though they are footless (e.g., snakes). It does not take long to see that a strategy is needed to handle the richness and complexity of the animal world. The strategy devised by Aristotle consists of two steps. The first is the decision to concentrate on the animals that progress on land by means of feet. Aristotle begins his explanation of how animals locomote with an examination of *footed animals*. He takes the foot to be the paradigmatic instrument of animal locomotion.<sup>78</sup> But this does not solve all our problems given that animals progress on land by means of either two, four, or many feet. In addition, there are animals that progress on land without feet (snakes). Where should we start looking for an explanation of how these different kinds of animals displace their bodies? Aristotle answers this question by developing an explanatory model that works for *blooded animals*. These animals are either two-footed or four-footed. A direct consequence of this strategy in two steps is that the study of many-footed animals is temporarily bracketed since these animals are all bloodless.

<sup>75</sup> Aristotle, *IA* 3, 705a3–6.

<sup>76</sup> Aristotle, *IA* 3, 705a20. Compare *HA* I 6, 491a25–26: All non-uniform parts are instrumental parts – namely, tools the animal uses to engage in the activities that are constitutive of its distinctive mode of life (e.g., flying or swimming).

<sup>77</sup> Aristotle, *IA* 3, 705a20–24.

<sup>78</sup> Aristotle defines the foot as the part that is in contact with the ground and as such is productive of locomotion (*IA* 5, 706a31–32).

Aristotle's first and most important goal is to develop a model that explains how blooded animals progress on land by means of feet. This model is subsequently extended (with the relevant adjustments) to explain how bloodless animals progress on land. IA 6 plays a central role in his overall argument. Here Aristotle develops an abstract model for the explanation of how animals that are footed and blooded progress on land. This model is quite general. It is meant to apply to both two-footed and four-footed animals.<sup>79</sup> Aristotle thinks of blooded animals as abstract locomotive units and asks under what conditions they can engage in locomotion. His answer is that these locomotive units must have a common origin of motion, and this origin must be equally well disposed with respect to all the body parts involved in locomotion. All the locomotive units Aristotle envisions in IA 6 are *centralized locomotive systems*: they have a single source of locomotion that is at an equal distance from all the locomotive parts. Aristotle makes this single source of motion the ultimate cause of bodily displacement.<sup>80</sup>

This highly abstract analysis generates the following important result:

It is clear then that motion with respect to place belongs either *only or above* all [ἢ μόνοις ἢ μάλιστα] to those animals which make their own change with respect to place by means of two or four points [of motion].<sup>81</sup>

To understand the force of this pronouncement, we must keep in mind that Aristotle's focus is still on animals equipped with two or four feet. When Aristotle says that locomotion belongs only or above all to these animals, he signals to his reader that he is treating these animals as his paradigmatic locomotive systems. Momentarily, we will see how Aristotle goes beyond these *paradigmatic locomotive systems*. For the time being, it is important to clarify what Aristotle means by "point of motion." This expression is native to his theory of animal locomotion. With it Aristotle refers to the bodily part that makes contact with the ground (or the surrounding water or air).<sup>82</sup> Given his focus on two-footed and four-footed animals, Aristotle must refer, first and foremost, to the feet of these animals. In his view, these animals progress on land either by

<sup>79</sup> Four-footed animals can be either live-bearing or egg-laying animals.

<sup>80</sup> Aristotle, IA 6, 707a12. Aristotle is committed to cardiocentrism, so this source of motion must be a perceptual soul to be found in the heart of blooded animals. Yet, it is significant that Aristotle refrains from talking about the soul or the heart in IA 6. For a perceptive reflection on the self-imposed constraints controlling Aristotle's discussion in IA 6, I refer the reader to [CORCILIVS 2021a: 141–164](#).

<sup>81</sup> Aristotle, IA 7, 707a16–19.

<sup>82</sup> Compare Aristotle, HA I 5, 490a26–32. This text may presuppose the discussion offered in IA (rather than vice versa).

means of two or four points of motion. In due course Aristotle clarifies that blooded animals move by means of *exactly* four points of motion. He does so by replying to the possible objection that birds and humans move by fewer than four points of motion. His reply is that birds use their legs when they fly and their wings when they progress on land, just as humans use their shoulders and their arms when they walk.<sup>83</sup> But at this stage of his inquiry this conclusion is not yet available.

In *IA* 6 Aristotle develops a highly abstract account of what a locomotive unit of a certain kind requires to perform its primary function, which is to move from one place to another. Aristotle generates this account for the explanation of how *blooded animals* progress on land. He subsequently adopts, indeed adapts, it to explain the motion with respect to the place of *bloodless* animals. Aristotle's overall strategy becomes clear as soon as we realize that he conceives of bloodless animals as locomotive systems to which *additional* points of motion are attached to the original four. Moreover, because additional points are attached to the original four, these systems do not display the same level of integration and unity as the one envisioned for blooded animals. One concrete example may help us appreciate how Aristotle approaches the study of bloodless animals. An ant moves by means of six feet. For Aristotle, the ant is neither a two-footed nor a four-footed animal; rather, it is a *many-footed* animal. Aristotle conceives of the ant as a locomotive system consisting of four + two points of motion. We may think that having more than four feet allows an animal to displace its body in a better, quicker, and more efficient way. However, Aristotle never makes this observation. Instead, his first and foremost concern is to highlight that a unit consisting of more than four points of motion is a less unified, and less well-integrated, locomotive system. It is a less unified, and less well-integrated, locomotive system because Aristotle thinks of this organic unit as having four +  $n$  points of motion (where  $n$  must be an even number).<sup>84</sup> According to him, there must be a controlling center in this second kind of locomotive system too, but this center cannot be equally well disposed with respect to all the (four +  $n$ ) points of motion.<sup>85</sup>

<sup>83</sup> *IA* 10, 709b20–26.

<sup>84</sup> Aristotle defends the claim that, unless mutilated or defected, animals move by an even number of points. He does so in connection with his explanation of how footed animals progress on land, which is his initial case study (*IA* 8, 708a21–b21).

<sup>85</sup> Recall that bloodless animals do not possess a heart, but they have something that plays an analogous role in their physiology. The controlling center is to be found in the part functionally analogous to the heart, or so Aristotle would like to argue.

Aristotle conceives of bloodless animals as less perfect locomotive systems. These locomotive systems are less perfect because *they exhibit a lower level of organic unity*. This explains why he claims that, unlike blooded animals, these animals can survive for a while if they are severely mutilated. Some of them, Aristotle adds, can even move with the same type of locomotion with which they were moving before they were mutilated. They can do so because they are “just as if they were compounded out of several animals.”<sup>86</sup> Aristotle mentions the centipede. In his view, all animals that have an elongated body and are like the centipede enjoy a weaker type of unity compared to blooded animals. In a few cases, their organic unity is so weak that these animals consist of a few relatively independent locomotive units. In these extreme cases, each locomotive unit can not only survive but also displace itself when it is separated from the others. Or at least this is what Aristotle seems to believe.<sup>87</sup>

In a few passages Aristotle engages in the explanation of specific aspects of the locomotion of bloodless animals while he is still concerned with the study of blooded animals, and under a common rubric. He does so because he thinks that this strategy results in an optimal treatment of certain topics. Recall that if a common explanation can be given, then it must be given. Offering a serial explanation instead of a common explanation is no viable alternative in such cases for Aristotle.<sup>88</sup> When we keep in mind this (self-imposed) explanatory constraint, we see why Aristotle is not imposing a too rigid structure on his discussion of locomotion. Aristotle remains flexible to adapt to the complexity of his task, which is to provide as complete a study as possible of how animal progress on land, in water, or in air. A good illustration of his flexibility is the explanation of the role of the tail in flyers.<sup>89</sup> Aristotle finds it convenient to discuss the flight of insects in this very context. He tells us that their flight is slow and is not efficient because they lack a tail. Aristotle must think that dealing with the flight of insects here strengthens his claim that the tail in flyers is functionally equivalent to a rudder.

The occasional, indeed common, treatment of blooded and bloodless animals does not mean that Aristotle has second thoughts about his momentous decision to study how bloodless animals displace their body after his study of locomotion in blooded animals is in place. To see what licenses this approach, we need to recall the methodological insight we

<sup>86</sup> Aristotle, *IA* 7, 707b3.      <sup>87</sup> Aristotle, *IA* 7, 707a27–29.

<sup>88</sup> See [Chapter 1, Section 3](#) for additional reflections on the principle requiring the investigator to give explanations at the right level of generality.

<sup>89</sup> Aristotle, *IA* 10, 710a4–24.

have already discussed in connection with *HA*: bloodless animals do not have blood, blood vessels, and a heart, but they have something functionally *analogous* to those bodily parts.<sup>90</sup> Analogy is the tool that allows Aristotle to progress beyond his paradigmatic locomotive systems. It is an especially useful tool because it does not reduce or eliminate the complexity of the data, but it gives us a way to map that complexity.<sup>91</sup>

The explanatory strategy outlined so far allows Aristotle to offer a unified account of animal locomotion that applies to both blooded and bloodless animals without reducing or eliminating the differences between the two groups of animals. This strategy is not without explanatory costs. One is obvious even at a cursory glance: *the treatment of locomotion in bloodless animals is disappointingly selective*. Bloodless animals become the primary focus of the discussion only at the tail end of *IA* (i.e., in *IA* 16–19). Aristotle has already explained why bloodless animals equipped with feet must be many-footed animals. As a result, questions about number of feet and points of motion are no longer addressed. Instead, Aristotle concentrates his discussion on the explanation of how feet are attached to the body of bloodless animals, and on the reason why they bend their limbs in the way they do. Aristotle appears to be especially interested in the case of crabs and *karaboi*. Both are soft-shelled animals, and this is relevant to the explanation of the way in which they bend their limbs: while crabs use their limbs for progression on the ground, *karaboi* employ them for swimming.

It is difficult to resist the impression that Aristotle's answer to the question of how bloodless animals progress would have been significantly different if his answer did not depend on the assumption that all animal progression ought to be understood in light of the results achieved in the study of blooded animals. For one thing, this discussion would have been more detailed. For another, it would have been more convincing. But adopting an alternative route was not a real option for Aristotle. Beginning the study of animal progression by focusing on bloodless animals and moving from there to the case of blooded animals would have been a complete non-starter for Aristotle. It would have amounted to engaging

<sup>90</sup> Aristotle, *HA* I 4, 489a22–24.

<sup>91</sup> For recent discussions of the use of analogy in the context of Aristotle's study of animals, see LLOYD 1996: 138–159 (with an emphasis on the heuristic value of analogy for Aristotle) and HENRY 2014: 145–169 (with an emphasis on the classificatory and explanatory role of analogy in Aristotle). The second essay is to be read along with the comments offered in LEUNISSEN 2014: 170–181. I return to the topic of analogy and its overall impact on the Peripatetic study of perishable living beings in Chapter 4, Section 4, and in Chapter 6, Section 3.



in the study of animal locomotion starting from a less perfect and less developed form of animal life. We are not obligated to follow Aristotle since we do not accept his assumption that bloodless animals represent a less perfect and less developed form of animal life. We can easily object to Aristotle that crabs or octopuses have a very high degree of bodily organization and articulation. And yet this is emphatically not how Aristotle thinks. If one accepts his starting point, one is also compelled to follow his explanatory strategy.

One final aspect of Aristotle's overall strategy deserves close attention. A definite explanatory pattern can be observed at several junctures of Aristotle's treatment of locomotive parts. Aristotle always begins his inquiry by explaining the presence of a given locomotive part in certain kinds of animals (e.g., the presence of feet in *footed* animals), and then explains the absence of the same part in other kinds of animals (e.g., the absence of feet in *footless* animals). Consider the explanation of how snakes progress either on land or in water. Snakes are blooded animals, so they must displace their body by means of four points of motion. But the only way to move efficiently at four points of motion while having an elongated body is by bending it. So snakes progress by bending their body. They touch the ground (or the water) at two points, one in the front and one in the back of their bodies. Because of their narrow and elongated shape, we cannot see four but only two points of motion. But even if we do not see the four points by means of sense-perception, we can discriminate a functional right from a functional left at each of the two points we see. In other words, snakes are locomotive systems that fit the model elaborated for all blooded animals.<sup>92</sup>

While important, the explanation of how snakes progress by bending their body is only a first, *interim* result. A full explanation of how snakes move requires an explanation of why they are footless. Snakes are a *prima facie* exception, and so also a potential challenge, to the basic account of animal locomotion developed for what Aristotle takes to be the paradigmatic case of locomotion – namely, the progression on land by means of feet. By explaining how snakes progress on land (or in water) without employing feet, Aristotle can show that they are no exception to his basic account of animal locomotion. Their motion, properly explained, not only confirms but also strengthens the case for his basic account. In this respect, Aristotle's discussion of why snakes do not have feet is not a digression from the stated task of explaining why animals have the parts they do. It is

<sup>92</sup> Aristotle, *IA* 8, 708a9–20.

rather an integral part of Aristotle's larger task, which is offering an account of the different modes of locomotion that does full justice to the complexity of the zoological data.

The stretch of text concerned with the explanation of why snakes are footless is one of the best known, and most intensely discussed, because it also contains crucial information on how Aristotle would like to apply the teleological principle that nature does nothing in vain but always the best given the nature of the animal.<sup>93</sup> Here, suffice it to say that Aristotle takes the properties of having an elongated body and being blooded as the two starting points of his explanation. Aristotle regards them as basic facts that belong to the essence of snakes.<sup>94</sup> In other words, to be a snake is to be blooded and to have an extra-long body. Given this, there are only two theoretical options on the table: either snakes have a foot placed at each of the four points of motion or they have no feet. But having four feet is far from being ideal in the case of an extra-long body. A four-footed animal with an extra-long body would move with great difficulty and very slowly. Snakes are clearly better off without feet. Instead of progressing on land (or in water) by using feet, they move by bending their extra-long body. This turns out to be an extremely effective mode of locomotion.

Among blooded animals, fishes too are footless. In their case, however, the absence of feet is explained by invoking their distinctive mode of life rather than the shape of their body. Like snakes, fishes are blooded animals, so they must move at exactly four points of motions. Unlike snakes, they are marine animals. Since they live in water, they have fins rather than feet. The attachment of their fins, as well as the presence of a tailfin, is explained by exploiting the analogy between swimming and flying, which are regarded as analogous modes of locomotion. At this point, Aristotle has already explained the mechanics of flying. Therefore, he can also adopt the result achieved in the explanation of how flyers move in air to explain how swimmers displace themselves in water.

The above remarks go some way toward mitigating what appears to be a way too brief and cursory discussion of progression in water (swimming). To be sure, swimming is a highly distinctive mode of locomotion, but it is also a mode that can be approached by adopting a comparative method of study. Aristotle's view must be that the adoption of such a method allows us to know all we need to know about swimming and the bodily tools marine

<sup>93</sup> I refer the reader to *STRAVRIANEAS 2021*: 165–193.

<sup>94</sup> For the claim that the definition of what the animal is ought to refer to its being blooded or bloodless, see *PA IV 5*, 678a33–34.

animals employ to displace themselves in water (fins and tailfin). As a result, Aristotle's strategy in dealing with the different modes of locomotion is this: he *first* develops an explanation for how animals progress on land by means of feet; he *then* extends this explanation by considering what is specific about progression in air by means of wings and a tail. By the time he gets to the mode of locomotion characteristic of swimmers, there is not much left to explain. At this point, Aristotle keeps his discussion very short, since he can rely on the explanatory resources already introduced for progression on land (walking) and progression in air (flying). This strategy may also explain why there is no mention of cetaceans. There is nothing distinctive about their mode of locomotion. Like all blooded animals, cetaceans move by means of four points of motion. Like fishes, they displace their body in water by means of fins and a tailfin. By contrast, there is a great deal that is interesting about the way in which cetaceans control their bodily temperature. This explains why they feature in Aristotle's discussion of respiration but they are absent from his treatment of locomotion.

Aristotle's study of animal locomotion ends with a discussion of a difficult case: the displacement of hard-shelled animals. Some of these animals appear to be able to displace themselves, but it is far from clear how they move, and whether they are engaged in the form of locomotion that is Aristotle's primary concern in *IA* – namely, animal progression. Aristotle approaches this whole topic by announcing that the motion of these animals is a real puzzle (*aporia*): while they move, it is unclear whether they have a right and a left in their body. His solution to the puzzle consists in considering hard-shelled animals a maimed or mutilated kind of animal. Once more, Aristotle invokes analogy. The implication is that hard-shelled animals have a principle of motion in their body, so we should be able to detect a right and a left side apart in their body. What Aristotle says seems to contradict this. He says that the hard-shelled animals move, but they do so against nature because they are not naturally able to move.<sup>95</sup> Perhaps we can shed further light on this issue with the help of what Aristotle says on the topic of the imperfectly developed animals in the context of his discussion of the locomotive soul. Aristotle claims that imperfectly developed animals move but they do so in an indefinite way.<sup>96</sup> In other words, the capacities of the soul needed for locomotion, as well as the relevant bodily distinctions, are present in them but in an equally indefinite way.<sup>97</sup>

<sup>95</sup> Aristotle *IA* 19, 714b14–15.   <sup>96</sup> Aristotle, *DA* III 11, 434a4.

<sup>97</sup> Aristotle appears to ascribe indeterminate *phantasia*, desire and perception, to these animals in *DA* III 11, 434a5.

Aristotle seems to be saying that the distinction between a right and a left is also present in the hard-shelled animals, but he would add that this distinction is present in them *in an indefinite way*. Be this as it may, the discussion of the difficult case of the hard-shelled animals is the last topic on Aristotle's agenda. It is regarded as a sort of coda to the study of animal locomotion for at least two reasons. First, it is no longer a case of progression, which is the stated focus of the treatise. Second, the whole kind is regarded as an intermediate group between stationary and non-stationary animals. Hence, any attempt to explain their motion is naturally placed at the very end of the discussion of animal locomotion.<sup>98</sup>

It is time to take stock. Aristotle's treatment of animal locomotion is far from a random discussion of how animals displace themselves from one place to another. Aristotle adopts an intricate but at the same time principled approach to the topic. His strategy involves recourse to the two epistemic principles we have encountered not only in the *Parva naturalia* but also in *HA*. While the first requires us to look for explanations that are commensurately universal, the second mandates that we start our study of locomotion from the form of life that exhibits the highest degree of bodily organization and articulation. Aristotle does not favor one principle over the other but tries to apply both as well as he can. His intricate discussion is also a by-product of his attempt to negotiate the different requirements imposed on him by these principles. The role of apparent exceptions to the rule is a remarkable feature of the overall argument of *IA*. It does not take long to see that Aristotle's interest in what is perceived as an exception to the rule, or a borderline case, is entirely dictated by the application of the second epistemic principle outlined earlier. As Aristotle tries to do justice to the complexity of the zoological data, he is required to go beyond the explanation he has developed for his core case: the centralized locomotive unit progressing on land by means of four feet. The discussion of apparently difficult or odd cases contributes directly to this goal. Yet this strategy has its own limitations. The reader of *IA* comes away with the distinct impression that the locomotion of bloodless animals is, to say the least, understudied. Aristotle does not develop additional principles for the study of the modes of locomotion of bloodless animals; he adapts the principles developed for the study of blooded animals to the study of bloodless animals. The outcome is not entirely convincing. In the end, Aristotle does not appear to be able to do

<sup>98</sup> Hard-shelled animals are also regarded as an intermediate kind between animals and plants (*GA* I, 731b8–13).

full justice to what is specific, or even unique, about the ways in which these animals move from one place to another.

If we accept the idea that Aristotle's extant zoological writings are not a complete science but are best understood as a work in progress, we can try to save Aristotle by suggesting that his account of animal locomotion can be revised and supplemented with additional observations. But it is important to stress that the shortcomings highlighted above cannot be fixed unless a drastic change in the overall approach to the study of animal life is accepted. At the very least, Aristotle would have to give up one of the epistemic principles that shape his whole approach to animal life. But there is no textual evidence that Aristotle is ready for such a drastic move. It does not take long to see that such a move would imply rethinking his explanatory strategy from scratch – I mean the strategy to explain the whole domain of animals and not just the phenomenon of animal locomotion.

I would like to end my analysis of how Aristotle explains animal locomotion on a bright note. Notwithstanding all the shortcomings discussed, the explanatory strategy Aristotle adopts allows him to generate a comprehensive map of how animals progress on land, in water, and in air. This result is very important to him. Arguably, it is less important to us today. It is perfectly acceptable for us to focus on a wonderful case of animal locomotion and try to extrapolate from there a few general truths about locomotion. We can easily imagine a scenario in which a great deal of research is devoted to understanding how certain kinds of animals can move easily, almost effortlessly, on a vertical surface. Unlocking the secrets of how these animals perform this feat is a result Aristotle would have surely appreciated. At the same time, he would have considered such a narrow research focus unsatisfying from a theoretical point of view. He would have insisted that we develop a comprehensive account of animal progression rather than try to learn everything about a particular case. More to the point: he would have stressed that such a comprehensive account of animal progression would have to highlight the commonalities existing in nature and would have to give a common explanation for each of them. In the end, Aristotle operates on a more demanding conception of the scientific enterprise. The bar for what counts as epistemic success in this enterprise is set higher for Aristotle than it is for us today.

## 5 Explanatory Strategies in *GA*

Aristotle's *GA* offers a comprehensive and systematic account of how animals reproduce, including a study of their generative parts. This account employs

and connects all the four Aristotelian causes, with a special concentration on the moving (i.e., efficient) cause of the generation of animals. A few additional facts surrounding generation are explained; they include hybridity, birth defects, diseases of pregnant females, and lactation. When we look at what Aristotle accomplishes in *GA*, we can safely conclude that we are in the presence of one of Aristotle's most mature, most sophisticated, and indeed most carefully organized scientific writings. In this section, I would like to illustrate some of the explanatory strategies adopted, as well as some of the decisions made, in what turns out to be a long and complex tour de force across five books. My goal is to confirm some of the results reached so far and add to them as is appropriate.<sup>99</sup>

Aristotle's initial move in *GA* consists in a three-part observation: in many cases, animals come to be from (1) the coupling of (2) a male and (3) a female.<sup>100</sup> This is our initial observation – what we observe when we first look. It is one observation (rather than three) because the items that constitute it are interdependent. Neither male nor female nor coupling, as we observe them in most cases, makes sense without the other two. This initial observation establishes our first *explanandum*. Since we want to explain a process that begins from the coupling of the male and the female, our explanation must include an explanation of the male and the female *qua* generative principles. This comprises an explanation of their respective generative parts. In other words, an optimal study of animal reproduction must comprise a study of the reproductive capacities of the male and the female, which in turn requires a reference to their generative parts. The outcome is a single, complex argument that consists of a study of generative parts followed by a study of how animals come to be, which first requires us to deal with the moving cause (alias principle) of animal generation:

This is why our argument has put together a unified whole by placing these parts [*sc.* the parts that contribute to generation] last in our account of the parts and placing right after them the principle in the account of generation.<sup>101</sup>

<sup>99</sup> For an introduction to the overall argument and unity of *GA*, I refer the reader to GOTTHELF-FALCON 2017: 16–34 and LEFEBVRE 2017: 35–55. Both articles agree that the five books exhibit a high level of unity. Disagreement is about the details of the argument.

<sup>100</sup> Hereafter I rely on the results achieved in GOTTHELF-FALCON 2017: 16–34. When I depart from those results, I indicate it in an ad hoc footnote.

<sup>101</sup> Aristotle, *GA* I 1, 716a2–4: διόπερ ὁ λόγος εἰς ἓν συνήγαγε, τῶν μὲν περὶ τὰ μόρια τελευταῖα ταῦτα, τῶν δὲ περὶ γενέσεως τὴν ἀρχὴν ἔχομένην τούτων τάξας. The Greek is difficult and is open to more than one reading. I follow the interpretation defended in LEFEBVRE 2017: 47–50.

There are at least two ways to understand this programmatic passage. On a first reading, the two studies outlined correspond to the two main sections of *GA I* – namely, a study of the generative parts (*GA I* 3–16) followed by a study of the moving principle of generation (*GA I* 17–22).<sup>102</sup> As an alternative, the parts that contribute to the generation of animals are not only the non-uniform parts but also semen, menses, and milk. If we adopt this second reading, what Aristotle has in mind when he refers to an account of the generative parts is a fuller account than the one advanced in *GA I*. This fuller account is not over until at least the discussion of milk offered in *GA IV* 8.<sup>103</sup> I adopt this second reading because it has the exegetical advantage of showing that *GA II* is a natural development of a discussion that starts much earlier in *GA I*.<sup>104</sup>

To understand how *GA V* contributes to an account of animal generation, we must place an emphasis on the following (often overlooked) fact: nothing Aristotle says in the first four books establishes that the generative process stops at birth. In fact, this generative process comes to an end only with the coming to be of a mature organism. We can restate this important insight by recalling a well-known Aristotelian dictum: “it takes a human being to generate a human being.”<sup>105</sup> By Aristotle’s lights, generation is a natural and continuous process from two fully developed human beings (the parents) to another fully developed human being. Consequently, the study of generation need not (in fact, cannot) stop at the birth of the offspring but must continue with a logical focus on the mature organism.<sup>106</sup>

If this reading is correct, a first consequence of the initial move – namely, the tripartite observation that many animals come to be from

<sup>102</sup> BALME 1992: 61.

<sup>103</sup> A third reading of how the argument unfolds in the five books of the *GA* is outlined in LEUNISSEN 2017: 56–74 (especially 57–58). She thinks that there is a first strand of investigation (*GA I* 1–II 3) that provides the conceptual framework for what follows. While *GA II* 4–8 covers embryogenesis in the most perfect among the blooded animals (the human being and the four-footed live-bearing animals), *GA III* covers embryogenesis for each of the remaining kinds of animals. On this reading, *GA IV* covers sexual differentiation, heredity, and phenomena surrounding birth.

<sup>104</sup> The view that *GA II* is a new beginning (defended, most notably, in BALME 1992) is rejected in GOTTHELF-FALCON 2017: 22–27. But this article equates generative parts with non-uniform sexual organs. I no longer endorse this equation.

<sup>105</sup> Aristotle, *Phys.* II 1, 193b; II 6, 198a26; III 2, 202a11; *GC* II 6, 333b7; *PA* I 1, 640a25; II 1, 646a33; *GA* II 1, 735a21; *Metaph.* VII 7, 1032a25 and b32; IX 8, 1049b25, XII 3, 1070a8, XIV 5, 1092a16.

<sup>106</sup> Klaus Corcilus has recently argued that *GA V* is better understood as a coda to the main argument than as an integral part of the project (CORCILUS 2022: 67–100). To give us an idea of what he means by “coda,” Corcilus refers us to the fourth meaning of the word in Stainer and Barret’s *Dictionary of Musical Terms*: “that closing adjunct of any movement, or piece, especially intended to enforce a feeling of completeness and finality.” His reading occupies a middle position between the view that *GA V* is a self-standing piece (see, e.g., KULLMANN 2021: 124–125) and the view advocated here.

the coupling of a male and a female – is the decision to begin the study of animal generation with an account of the generative parts of the female and the male. Another important consequence of this move is the decision to postpone the explanation of animals that (Aristotle thinks) reproduce spontaneously. This explanation is deferred until the main lines of the account of sexual reproduction are firmly in place. This means that the study of spontaneous generation is given only at the very end of *GA* III (i.e., *GA* III 11). This study is treated as a coda to the main discussion. Along with a few insects, this study attends to the generation of hard-shelled animals and other stationary animals that Aristotle considers close to plants. Finally, it is also important to stress that this study is conducted within the theoretical framework developed for the explanation of sexual generation. Aristotle is quite forthcoming about this aspect of his explanatory strategy at the outset of *GA* I 2:

As for the generation of the other animals [*sc.* those that do not reproduce sexually] we must speak about each of them according to the ongoing argument, *building it from what has been said* [ἀπὸ τῶν εἰρημένων συνείροντος].<sup>107</sup>

This is exactly how Aristotle's argument unfolds in *GA*: it begins with a study of sexual generation and ends with a discussion of the generation of those animals the coming into existence of which is spontaneous. It does not take long to see that this procedure entails a reversal of the explanatory strategy adopted by Aristotle's predecessors. Most of them worked within a cosmogonic framework. It was quite natural for them to take spontaneous generation as their model, and indeed their starting point, for an explanation of how life emerged from the earth. Among other things, this style of explanation had the advantage of relating their explanation to the ancient myths of the autochthonous birth of cultural heroes.<sup>108</sup> By contrast, Aristotle does not believe that life emerged from nonlife. His view is that life is a necessary feature of the natural world order.<sup>109</sup> More to the point: animal life is one of the two basic ways in

<sup>107</sup> Aristotle, *GA* I 1, 716a2–4.

<sup>108</sup> This aspect is explored in [CAMPBELL 2014](#): 233–247. I briefly discussed the role that spontaneous generation plays in the zoogonic account offered by Empedocles in [Chapter 1, Section 1](#).

<sup>109</sup> By Aristotle's lights, the natural world order is necessarily ungenerated and indestructible. The ultimate source of this necessity is metaphysical rather than physical. It can be traced back to the existence of a first unmoved mover that alone secures that the world order cannot be otherwise. Very few, even within the Aristotelian tradition, followed Aristotle on this point. For a review of eternalism in Aristotle and the Aristotelian tradition, see [FALCON 2022a](#): 7–22.



which life necessarily manifests itself here on earth.<sup>110</sup> The only way to explain how animal life perpetuates itself is to start from sexual generation, which becomes the paradigmatic type of animal generation. As a result of this strategy, spontaneous generation is dislocated from the center of the argument of *GA*. It ends up being equivalent to an exception to the rule that must be explained based on the results reached in the study of the central case, namely sexual generation. Beginning an explanation of animal reproduction from spontaneous generation would be equivalent to trying to explain animal life starting from bloodless animals. This would be a complete non-starter for Aristotle.

In *GA* III II spontaneous generation is explained as a two-stage process that is analogous to sexual reproduction. In sexual generation we have a two-stage process: *first* the material principle is formed in the female; *then* it is acted upon by the male principle. In spontaneous generation we have an analogous complex situation. The heat in the surrounding environment, by a process of concoction, produces something analogous to the female residue. In rotting earth or earthy water, we find what Aristotle calls *pneuma*, and in *pneuma* we find vital heat. Whenever some of the latter gets enclosed, it leads to the generation of the animals. The language Aristotle uses to describe this process suggests that the agent is envisioned as an *analogue* to the immediate moving cause in the process of sexual reproduction. Unlike the power transmitted by the male, the vital heat is a non-species-specific potential for life. This means that eventual differences in the outcome cannot depend on differences in the nature of the potential for life. Rather, they depend on differences in the nature of the enclosed material. In the case of the hard-shelled animals produced in the sea, the earthy water of the sea becomes the shell as the result of a process of solidification *analogous* to the one that occurs in the case of bodily materials such as bones and horns.<sup>111</sup>

A third and final consequence of the initial move is the need to understand the respective contribution to the generative process of the male and the female, including the extent to which each contribute seed (σπέρμα).<sup>112</sup> It is quite telling that, already in the opening chapter of *GA*,

<sup>110</sup> The other one is, of course, plant life.

<sup>111</sup> I follow the reading adopted in GOTTHELF 1989: 181–193 (reprinted in GOTTHELF 2012a: 45–66). On spontaneous generation, see also LLOYD 1996d: 104–125; STAVRIANAS 2008: 303–338; WILBERDING 2022: 367–390.

<sup>112</sup> The term “σπέρμα” is ambiguous in *GA*. To begin with, σπέρμα can be used to refer to the spermatic residues produced by both the male and the female. When it is used in this way, σπέρμα can also refer to the menses. But σπέρμα is also used to refer to the exclusive contribution of the male. For a review of the relevant passages, I refer the reader to CONNELL 2016: 90–120 and LEFEBVRE 2016: 38–45. When σπέρμα is used in the former way, I render it as “seed.” When it

the study of seed is predicted to be of the utmost importance in understanding the distinctive roles of the male and the female in the coming to be of the offspring:

In accordance with what we said, one might posit the male and the female as sources of generation . . . *one would most of all come to believe this if one studied how the seed is produced and from where* [τοῦτο δὲ μάλιστα ἂν τις πιστεύσειε θεωρῶν πῶς γίγνεται τὸ σπέρμα καὶ πόθεν].<sup>113</sup>

In view of this anticipation, it is not surprising to find out that Aristotle turns to the study of seed as soon as he has completed his study of the reproductive parts. The question whether both the male and the female emit seed is linked to the question whether the seed comes away from all the body. Apparently, this thesis was quite widespread in antiquity. It was linked to the view that both the male and female contribute seed (σπέρμα).<sup>114</sup> For Aristotle, disarming the dual-seed theory is equivalent to disarming pangensis and vice versa. This is his first step toward a positive account of the nature of seed, and toward establishing how the male and the female contribute to the generative process.

Aristotle is centrally concerned with these questions in the second part of *GA I* (*GA I*, 17–23). His starting point is to search for the nature of the seed. First, he establishes that the seed is a residue, and then that it is a useful residue at its final stage – blood concocted and somehow particularized. Thereafter Aristotle turns to the female contribution. He establishes that the blood-like secretion produced in the female (the menses or καταμήνια) is a spermatic residue, having its nature because of the colder (and thus weaker in the ability to concoct) character of the female. By Aristotle's lights, the menses are the *matter* from which the offspring will

is used in the latter way, I opt for “semen.” The word “σπέρμα” is surely ambiguous at the outset of *GA* given that Aristotle has still to establish how the male and the female contribute to generation. See LÉFEBVRE 2016: 36–37. Last but not least, in *GA I* 18, Aristotle uses σπέρμα to refer to the first mixture (the first κύημα) that contains the generative contributions coming from the male and the female principles of generation. While this passage is often considered a possible interpolation, Ignacio De Ribeira Martín defends its authenticity (in DE RIBEIRA 2019: 87–124). Far from creating a textual problem, this apparently anomalous use of the term “σπέρμα” suggests that there is a genuine Aristotelian notion of seed that is common to both animals and plants. This is an important result, indeed a result that is far from obvious, since Aristotle envisions a separate study of animals and plants and programmatically confines himself to the study of animal generation to the exclusion of generation in plants. More on this in Chapter 5, Section 2.2.

<sup>113</sup> Aristotle, *GA I*, 716a4–8.

<sup>114</sup> For instance, the Hippocratic author of *On Generation* and *On the Nature of the Child* adopts the view that the seed (γούνη) comes from the seed of each of the two parents (*On Generation* 8), and that the seed is secreted from the whole body (*On Generation* 3). More directly, the seed is drawn from the brain via the spinal marrow (*On Generation* 1).

come into being. It is only at this point that Aristotle turns to the male contribution with the stated goal of establishing what it is. He argues that the male does not contribute any matter but rather an active power or a potential (δύναμις) that is based on certain movements (κινήσεις) conveyed by the semen.<sup>115</sup> Aristotle uses the craft analogy to argue that the male contributes the *form* by means of its role as the source of motion. In those animals that emit semen (σπέρμα), nature uses the latter as a tool just as a craftsman uses specific tools to produce a certain outcome.<sup>116</sup> At this point, the main lines of Aristotle's *reproductive hylomorphism* are in place.<sup>117</sup> More directly, Aristotle adopts hylomorphism in the second part of *GA I* (*GA I* 17–23) to explain the different contribution of the male and the female to generation. While *GA I* is not meant to stand on its own, the book provides us with an explanatory framework to proceed in the actual investigation of animal reproduction as it can be observed in the natural world around us.

### 5.1 *Explanatory Strategies in GA II*

*GA II* is not a fresh start; rather, it is a natural and inevitable continuation of the search for the moving cause of animal generation. Arguably, the first and most important step in this direction is the decision to adopt hylomorphism as the theoretical framework for the explanation of the respective contribution of the male and the female to animal reproduction. But how does sexual reproduction take place in different animals? To answer this question, Aristotle makes a second observation: there is great variation in the degree of completeness (and perfection) of the immediate outcome of the process of coming to be. While some animals produce similar, complete, live young, others give birth to something that is not yet articulated: eggs in the case of blooded animals and grubs in the case of insects. Furthermore, Aristotle traces the variation in the degree of completeness (and perfection) at birth back to the nature of the generative parts: the hotter and moister the nature, the more complete their product at birth.<sup>118</sup> This is our second observation. While the three-part observation made at the outset of *GA* controls the whole argument as it unfolds across

<sup>115</sup> What we observe in the case of certain insects where the male does not insert a part of itself into the female, but the female inserts a part of itself into the male, and the heat and the *dunamis* of the male does the causal work, confirms this suggestion. Compare Aristotle, *GA I* 11, 729b22–33.

<sup>116</sup> Aristotle, *GA I* 22, 730b19–23.

<sup>117</sup> I borrow the expression “reproductive hylomorphism” from HENRY 2006: 257–288.

<sup>118</sup> Aristotle, *GA II* 1, 732b27–32.

the five books, the second observation shapes and controls the argument in *GA* II and *GA* III. As Aristotle progresses in his explanation of the coming to be of animals beyond the general lines of his reproductive hylomorphism, he must take into account what is specific about the different modes of animal reproduction. In *GA* II I, Aristotle establishes that this study must begin from the live-bearing animals, must continue with the egg-laying animals, and must end with those animals that produce a grub. While a study of reproduction in live-bearing animals is offered in *GA* II, the discussion of the other two modes of reproduction is postponed to *GA* III.

At the outset of *GA* II I, Aristotle finds himself in a situation that is equivalent to the one we have discussed for the collection, presentation, and explanation of the parts of animals (*HA* and *PA*), and the explanation of how animals displace their bodies (*IA*). As soon as Aristotle has observed that there is great variation in the degree of completeness in the outcome of generation, he has no choice but to account for what is specific about the different modes of reproduction. But how does he proceed in the explanation of the different modes of animal reproduction? Where should he start, and more importantly, why? His answers to these questions can be extracted from the following passage:

Now, *we must start first from what is first* [τῶν πρώτων ἀρκτέον πρώτον]. *The perfect animals are first* [ἔστι δὲ τὰ τέλεια ζῶα πρώτα], and such are the live-bearing ones, *and first among them is the human being* [καὶ τούτων ἀνθρώπος πρώτων].<sup>119</sup>

From an operational point of view, the rule of inquiry recalled in this passage requires Aristotle to begin his account of sexual reproduction from the live-bearing animals because they are the most perfect; furthermore, this account must start from the human being because the latter is the most perfect among the live-bearing animals. We find here a version of the methodological insight that requires investigators to start their investigations from the most complex outcome, which in this case is the production of a human being. This mode of procedure can be captured with the help of the following catchphrase: *perfect animals first, and the human beings first*.<sup>120</sup>

*GA* II 4–6 is best described as a study of live-bearing animals via a study of the human being. Aristotle begins his investigation from the results achieved in the general study of generation. He applies those results to the case of the live-bearers. The structure of his explanation remains the same as before: it

<sup>119</sup> Aristotle, *GA* II 4, 737b26–27. The most complex animal is also the one that displays the higher level of organic unity. For more on this idea, see [Chapter 1, Section 3](#).

<sup>120</sup> Mariska Leunissen (in [LEUNISSEN 2017](#): 58–66) comes to a similar conclusion.

moves from the actual parents and their respective roles in the coming to be to the formation of the embryo (and, at least in principle, to everything that follows from there). *GA* II 4 begins with the male and the female contributions as spermatic residues of the nutritive process (with a concentration on the female residue and how it is formed). It continues with the formation of the embryo and, finally, turns to the question of its development. Aristotle calls this process “differentiation” (διόκρισις). He offers an outline of the process: the heart is the first part to be differentiated, and this is clear to both sense-perception and in theory. He adds that the formation of the parts does not happen as some think because the like is carried toward the like. Rather, the female residue has the potential to be acted upon by the male residue, so whenever the two spermatic residues come into contact and the one acts, and the other is acted upon right away. More directly, and more boldly: nothing else is required to explain a complex process such as the differentiation of the parts except the contact of the active and the passive potentials provided, respectively, by the male and the female.

But how does the actual διόκρισις of the body parts take place and why? Aristotle answers this question in *GA* II 6. Right after the heart and the blood vessels that extend from the heart, the upper half of the body appears in outline. The head is formed first, and the brain right after the heart to compensate for the heat of the latter. The eyes come to be early, but they are completed only at a later stage, after the birth of the offspring, due to the nature of their material constitution. The formation of flesh and the other sense-organs uses the purest materials. What remains is earthy, so it is used to produce bones and sinews. The bones are differentiated together with the most important internal parts. Nails and hair (but also hoof, horns, and the spurs of cocks) are formed out of the nourishment taken after birth and not used up for the growth of the other parts. This explains why they, unlike bones, keep growing throughout a lifetime (and even after death). Teeth pose a special difficulty (an *aporia*): they are bone-like, but unlike bones, they are formed after birth. A discussion of this difficulty, including a discussion of why some teeth fall out and grow back, is postponed. A full discussion of teeth is given in the context of the generative processes that take place after birth (*GA* V).

### 5.2 *Explanatory Strategies in GA III*

*GA* II and *GA* III are two parts of a single argument. The observation that there is great variation in offspring made at the beginning of *GA* II provides the platform for a study of what is specific about the different modes of

reproduction. The opening lines of *GA* III establish contact with what has been achieved in the second part of *GA* II; they also announce what is next in the order of explanation:

Now, we have spoken about the infertility of mules and about the animals that bear live young, both outside and inside themselves.<sup>121</sup> As for those blooded animals that produce eggs, in one way the things to do with generation are similar in them and in the land animals, and it is possible to seize upon something that is the same about them all; but in another way they have differences both among themselves and in relation to the land animals.<sup>122</sup>

To appreciate what Aristotle tells us in this passage, we must return to the beginning of *GA* II. After remarking that some animals bear live young while others lay eggs, and yet others produce grubs, he adds:

all the animals that bear young or lay eggs are blooded animals and all the blooded animals either bear live young or lay eggs (if they are not infertile).<sup>123</sup>

If we combine what we are told at the outset of *GA* II with this observation, we obtain the following explanatory strategy: as we proceed in our argument, we must keep in mind that certain facts about the generation of egg-laying animals are not specific to this kind of animals but are shared with live-bearing animals. These facts remain outside the scope of the investigation conducted in *GA* III because they can (indeed should) be explained in common for both live-bearing and egg-laying animals *qua* blooded animals. By contrast, the research focus of *GA* III is on the causes of those facts that *distinguish* the animals that produce eggs from those that bear live young. As we proceed in this way, we must not overlook the differences that exist among the egg-laying animals, so our discussion will also deal with the causes of what distinguishes the animals that lay eggs from each other.

The study of egg-laying animals is conducted in *GA* III 1–8. Aristotle adopts the methodological principle spelled out in *GA* II 4: *first what is first*. He begins his discussion of egg-laying animals with those that lay a perfect (i.e., hard-shelled) egg and continues with those that lay an imperfect egg. The overall explanatory strategy remains the same as in *GA* I and *GA* II. Since we are concerned with a single causal process that can be traced back to the actual parents, our explanation must start from the actual parents.

<sup>121</sup> The discussion of live-bearing animals ends with the discussion of a special problem: the infertility of mules (*GA* II 8).

<sup>122</sup> Aristotle, *GA* III 1, 749b10–15. <sup>123</sup> Aristotle, *GA* II 1, 732b8–9.

What is specific to the mode of reproduction under review is that an egg is produced, so our explanation must include an explanation of the egg. The explanation is given for the perfect egg. This too is a direct consequence of the adoption of the explanatory principle “first what is first.” If there are differences that distinguish the imperfect from the perfect eggs, they will be discussed in connection with the study of the animals that lay imperfect eggs.

The topic of egg-laying animals ends with a discussion of what is specific about the bloodless animals that lay eggs. The soft-bodied animals (the cuttlefish and the other μαλάκικα) and the soft-shelled animals (*karaboi* and creatures akin to them) are discussed in *GA* III 8. *GA* III 9 deals with insects. Most of them produce a grub. This is the third and final mode of sexual reproduction. The grub is regarded as the least complete (i.e., the most undifferentiated) outcome of the mixture of the male and female contribution. So it is described as the first outcome of sexual reproduction.<sup>124</sup> What is distinctive about the production of a grub is discussed in *GA* III 9. The generation of bees poses an *aporia*. With the discussion of this *aporia*, the explanation of sexual generation comes to an end. At this point we have both a general account of how the male and the female contribute to generation, with a concentration of what is specific to each of them (*GA* I and *GA* II 1–3), and a detailed study of what is specific about the different modes of sexual reproduction (*GA* II 4–III 10).

*GA* completes Aristotle’s study of animals for two orders of reasons. To begin with, *GA* offers a much-needed account of animal generation. This account follows a methodological principle that is stated in its clearest form in *PA* I 1:

*We must also consider whether we should follow the procedure of our predecessors, by studying how a thing naturally comes to be rather than how it is [δεῖ δὲ μὴ λεληθέναι καὶ πρότερον προσήκει λέγειν, ὥσπερ οἱ πρότερον ἐποιοῦντο τὴν θεωρίαν, πῶς ἕκαστον γίγνεσθαι πέφυκε μᾶλλον ἢ πῶς ἔστιν]. It matters quite a bit which procedure we follow. . . . In the case of building too, this comes about because the form of a house is of this sort, whereas it is not true that a house is of this sort because this is how it comes to be; the reason is that coming to be is for the sake of being, and not being for the sake of coming to be [ἡ γὰρ γένεσις ἔνεκα τῆς οὐσίας ἐστίν, ἀλλ’ οὐχ ἡ οὐσία ἔνεκα τῆς γενέσεως].*<sup>125</sup>

Here Aristotle outlines an aim for both *PA* and *GA*: while *PA* is concerned with the explanation of why animals have the parts they do, *GA* deals with

<sup>124</sup> DE RIBEIRA 2019: III–II3.

<sup>125</sup> Aristotle, *PA* I 1, 640a10–19.

the process (or processes) by which those parts come to be present in animals. Clearly, the account of the process (or processes) by which these parts come to be present in animals follows in the order of explanation. We first need an understanding of why animals have the parts they do. Hence, *PA* comes before *GA* in the order of study. Moreover, the explanation of the process (or processes) involved in the explanation of animal generation must start from the nature of what is to be produced. Aristotle illustrates this claim with the help of housebuilding. He also supplies a historical example when he recalls how Empedocles explained the formation of the (human) spinal column. Empedocles argued that the vertebrae are formed when the spinal column is twisted as the baby turns in the womb of the mother. Aristotle is not impressed by this explanation. He points out that a spinal column with its distinctive shape and number of vertebrae is already present in the generator (the father). According to Aristotle, it is a mistake to explain the spinal column by focusing on the process of its formation. The explanation of the spinal column must take its lead from the functional role that a fully formed spinal column plays in a fully developed human being. At least for Aristotle, it is because the spinal column is articulated into vertebrae that its formation takes place in the way it does and not vice versa.<sup>126</sup>

But *GA* completes the study of animals for another reason. Recall that the study of generative parts is postponed in *PA*.<sup>127</sup> Aristotle could have spoken about these parts in the context of his official study of body parts. Instead, he decided that it was better and more efficient to explain them in

<sup>126</sup> For a full discussion of this Aristotelian example, see [CODE 1997: 127–143](#). We have independent evidence that Empedocles adopted this genetic approach to the explanation of the human being:

But some doctors and *sophistai* say that it is impossible for anyone to know medicine who does not know what the human being is; anyone who is going to treat patients correctly must, they say learn this. *Their account* [λόγος] *tends toward philosophy* [φιλοσοφία]. *Just like Empedocles or others who have written about nature* [περὶ φύσεως] *from the beginning* [ἐξ ἀρχῆς], *saying what human being is, how it originally came into being, and from what things it was compounded*. But I think that what has been written by a *sophistês* or a doctor on nature pertains less to the art of medicine than to the art of writings. ([Hippocrates] *Ancient Medicine* 20; translation and emphasis mine)

The author of *Ancient Medicine* singles out Empedocles as the most obvious and best-known example of a more general practice shared *by doctors and sophistai alike*. This testimony confirms what we read in Aristotle, who describes a practice universally accepted at the time. According to Aristotle, *all his predecessors* – no one excluded – employed this practice in their attempt to make sense of the world around them. In other words, they all adopted the same style of scientific explanation: For any given *X*, they explained what *X* is by giving an account of how *X* has come into existence.

<sup>127</sup> *PA* IV 4, 678a21–26.



the context of a study of the capacities and functions of the male and the female. Such a study is announced at the outset of *GA*:

*There remain of parts the ones that contribute to generation, about which nothing was delineated earlier* [λοιπὸν δὲ τῶν μὲν μορίων τὰ πρὸς τὴν γένεσιν συντελοῦντα τοῖς ζῴοις περὶ ὧν οὐθὲν διώρισται πρότερον], and in regard to the moving cause, what the source is. To inquire about this cause and about the generation of each animal is in a way the same thing.<sup>128</sup>

*GA* provides the missing study of the generative parts and the study of the moving cause. Both were left out of the study of *PA*. However, the focus on the moving cause is not (and cannot be) regarded as exclusive. The explanatory priority of complete nature over the process (or processes) giving rise to it ensures that a teleological dimension is needed for a scientifically adequate account of the coming to be of any animal. When we take this teleological dimension into account, we see that there is methodological unity across the whole project attempted in *PA* (augmented by *IA*) and *GA*.

## 6 Conclusion

Nothing short of a full-length monograph would do justice to what Aristotle has accomplished in his systematic study of animals. My goal in this chapter was a more modest one. I wanted to give the reader an idea of how this study is guided by certain explanatory and methodological concerns. I reached two main results. I argued that the ὄτι-stage of inquiry as collected in *HA* is shaped by the way in which these explanations are to be offered at the διότι-stage. In this sense, the ὄτι- and the διότι-stage of inquiry are interdependent and complement each other. The second result is that at the pre-explanatory and also at the explanatory stage of inquiry Aristotle follows a definite strategy encapsulated in the catchphrase “*first what is first.*” When we look in detail at how Aristotle proceeds in his practice of scientific explanation, we see that he first identifies a paradigmatic case, which is the most determined and most articulated kind of animal, and then he tries to explain the non-central cases by applying the results achieved in the study of this paradigmatic case. This strategy is implemented by recourse to analogy. I have argued that it comes with some explanatory costs, since significant aspects of the non-paradigmatic cases are not convincingly accounted for.

<sup>128</sup> Aristotle, *GA* I 1, 715a11–14.

Aristotle concentrated on the study of animals to the exclusion of plants. But this does not mean that he was not interested in the study of plants. His scattered remarks on this topic suggest that he was quite knowledgeable about plants.<sup>129</sup> Aristotle thought that a study of plants was best pursued as a *separate* explanatory project. Unfortunately, we no longer have what Aristotle wrote on plants, so we are not in a position to evaluate how he transitioned from the study of animals to the study of plants or how he implemented a systematic study of plants. But we do have an impressive corpus of writings on the topic of plants left by Theophrastus. It is time to turn to these writings. My main goal in the next two chapters is to see whether, and eventually to what extent, the research on plants conducted by Theophrastus is shaped by the explanatory and methodological concerns that animate Aristotle's study of animals.

<sup>129</sup> For a survey of what Aristotle says on the topic of plants, see [WÖHRLE 1997](#): 387–396.

## *The Transition from the Study of Animals to the Study of Plants* (History of Plants I)

### 1 Introduction

As we turn to Theophrastus and his study of plants, we must recall that, according to the procedures of inquiry mandated in Aristotle's *Posterior Analytics*, the scientific enterprise proceeds in stages, and the two main stages of any scientific inquiry are the collection and organization of the relevant data followed by their explanation – respectively, the ὅτι and the διότι stages of inquiry. I speak of two main stages of inquiry because the διότι-stage itself may unfold in various stages. In other words, the work that is required to arrive at an adequate (i.e., scientific) explanation may take place in steps and may require accomplishing various tasks. In [Chapter 5](#) I will look at how Theophrastus adopts this style of inquiry in his explanation of the ways (rather than way) in which plants propagate. In this chapter I would like to concentrate on the ὅτι-stage of inquiry, with the caveat that the distinction between a ὅτι- and a διότι-stage of investigation in Aristotle and Theophrastus is not as sharp as we often think it is because the collection of the data is never innocent with respect to their subsequent explanation. Quite the opposite: the selection of the relevant data is always an explanatorily sensitive selection of features that are important to characterize each *explanandum* as the *explanandum* it is.<sup>1</sup> In light of this, the ὅτι-stage is best understood as a *pre-explanatory* rather than a *non-explanatory* stage of inquiry.<sup>2</sup>

The insight that the scientific inquiry unfolds in stages, with an emphasis on the distinction between a pre-explanatory and an explanatory stage of investigation, can hardly be overestimated. It shapes the scientific enterprise as understood by both Aristotle and Theophrastus. And yet this key methodological insight is subordinated to another one, which is even more fundamental for the Peripatetic practice of science: a proper study of

<sup>1</sup> [ANGIONI 2019: 144–177.](#)    <sup>2</sup> See [Chapter 3, Section 2.](#)

perishable living beings is to be approached through separate studies of animals and plants. It is because of this second insight that the Peripatetic tradition has left us two separate scientific enterprises: a study of animals and a study of plants, both organized into a collection and organization of the relevant data followed by their explanation.

The  $\delta\tau\iota$ -stage of Theophrastus's research into plants is collected in the nine books of *History of Plants* (*HP*). It is now clear that the actual organization of this work goes back to Andronicus of Rhodes, who reorganized and consolidated a previous edition of *HP* in ten books.<sup>3</sup> Evidence of a *HP* in ten books is found in the Hellenistic catalog preserved by Diogenes Laertius in his *Life of Theophrastus*.<sup>4</sup> The discrepancy between this now lost version in ten books and the extant in nine is not necessarily the result of the loss of a book. It can be explained by invoking the fact that the last book circulated as two separate entities in Hellenistic times.<sup>5</sup>

The  $\delta\iota\omicron\tau\iota$ -stage of the study of plants is transmitted in the work *On the Causes of Plants* (*CP*). In its present form, this work consists of six books. However, the Hellenistic catalog preserved by Diogenes Laertius mentions a treatise in eight books. This second discrepancy is resolved if we accept the hypothesis that the lost work *On Wine and Olive Oil* mentioned by Diogenes Laertius and the extant essay *On Odors* were respectively the seventh and the eighth book in the Hellenistic edition of *CP* known to the source of Diogenes Laertius.<sup>6</sup> The advantage of this hypothesis is that it gives us a conceptual context for the extant treatise *On Odors*. On this hypothesis, *CP* IV would be a self-contained and relatively independent essay on natural juices and odors.<sup>7</sup> The lost work *On Wine and Olive Oil* and the extant treatise *On Odors* would complement the discussion of natural juices and odors with a discussion of artificially produced juices and

<sup>3</sup> For a review of the evidence for the Hellenistic and post-Hellenistic editorial work on *HP*, see AMIGUES 1998: 191–202 (reprinted in AMIGUES 2002: 45–54). Compare KEANEY 1968: 293–298, which is not superseded.

<sup>4</sup> Diogenes Laertius V 42–50.

<sup>5</sup> A full discussion of the evidence regarding the ancient transmission of the last book of *HP* is available in AMIGUES 2006: vii–xiii, xli–lvii.

<sup>6</sup> This hypothesis was first formulated by G. R. Thompson in an unpublished PhD dissertation from 1941 (THOMPSON 1941: 8–34). It is now defended in WÖHRLE 1998: 3–13. A more nuanced interpretation of the extant evidence is offered in AMIGUES 2017: xiii–xvii. She suggests that the work *On Odors* is a sourcebook for our *CP* VI. In the introduction to her critical edition, Amigues defends the unity and self-sufficiency of our *CP* in six books (with *CP* VI as an integral part of that project).

<sup>7</sup> Tellingly, the title *On Juices and Odors* is registered for this book in the manuscript tradition (MS U, *Vaticanus Urbinas* gr. 61). This conventional title reuses the first words of the book, which is announced as a study of juices and odors with a concentration on their kinds and causes. See Theophrastus, *CP* VI 1.1.

odors. While the lost work would deal with the two most important juices artificially produced by the human being, namely wine and olive oil, the work on odors would be concerned with fragrant preparations like perfumes, ointments, powders, and the like.<sup>8</sup>

The Hellenistic list of writings reported in Diogenes Laertius also registers a work *On Juices* in five books. An educated guess is that this title groups together all the extant and lost essays on plant juices. Recall that the last book of *HP* (our *HP IX*) is concerned with plant juices, and that this book circulated as two separate monographs in the Hellenistic period. If we add these two monographs to the three books on juices known to us, we obtain a work in five volumes. In this scenario, the lost work *On Juices* in five books did not add new materials; rather, it was a Hellenistic edition that collected everything Theophrastus wrote on the topic of juices. At the very least, we can say that the corpus of writings on plants that has partly survived was available in more than one edition in antiquity.<sup>9</sup>

So much for what concerns the transmission of the botanical corpus by Theophrastus. The present chapter is centrally concerned with the ὄτι-stage of his research. I will not consider the full collection of botanical data transmitted in *HP*. I will concentrate my attention on *HP I*. This is not as arbitrary a restriction as it might appear at first sight. *HP I* is a prolegomenon to the whole study of plants. It is also a liminal space where Theophrastus negotiates the transition from the study of animals to the study of plants. A closer look at how Theophrastus introduces and motivates his research into plants will help us advance our research agenda. It is worth recalling that there are two main items on our agenda at this point. First, we want to know why the Peripatetic study of perishable life is approached through separate studies of animals and plants rather than a common study of perishable living beings. Second, we want to understand why the study of perishable living beings begins with the study of animals rather than the study of plants. *HP I* provides circumstantial evidence that helps us make significant progress on both fronts.

<sup>8</sup> An idea of the contents of the lost essay *On Wine and Olive Oil* can be gathered from the few ancient testimonies collected and translated in FHS&G 427–429.

<sup>9</sup> Two more titles concerned with plants are transmitted in the *Life of Theophrastus*: a work *On Fruits* (one book) and a work *On Honey* (one book). This last work was still accessible to Photius (tenth century AD), who has left a summary of its contents (FHS&G 435).

## 2 The Opening Lines of *HP*

Theophrastus introduces his task at the outset of *HP*. He does so without fanfare:

The differences in plants and the rest of their nature are to be understood with respect to their parts and their qualities, as well as their modes of generations and modes of life; for they do not have character traits and activities as *animals* do.<sup>10</sup>

It is striking how little Theophrastus says by way of introduction to motivate the investigation he is about to launch. To be sure, a similar point can be made in connection with Aristotle's *HA*. There too there seems to be hardly any need to motivate the reader to read on. And yet a few things are obvious enough from this passage. To begin with, Theophrastus conceives of his study of plants as a contribution to a research project that is already underway. This research project includes a study of animals as one of its two main components. Moreover, from the way Theophrastus refers to animals, we can safely infer that the study of animals comes before that of plants in the order of inquiry. Finally, Theophrastus appears to be confident that his reader is familiar with the study of animals since he takes the conceptual schema adopted for the collection and organization of animal differences as a starting point that does not require elaboration, let alone justification.

I will elaborate on this conceptual schema momentarily. First, however, I would like to venture a guess as to where the importance of engaging in a systematic study of both animals and plants is defended and motivated. To my mind, the most obvious candidate is the exhortation to the study of animals and plants offered at the end of the first book of Aristotle's *PA*. We have good reasons to consider this exhortation to be a relatively independent and self-sufficient protreptic piece.<sup>11</sup> Aristotle takes it for granted that the natural world is constituted by a celestial and a sublunary part and argues that the study of each of these two parts has its own appeal. Aristotle contrasts the study of the heavenly objects with the study of plants and animals: while there are serious limitations to what can be known by us about the heavenly objects because of their remoteness, we live next to plants and animals, and the wealth of knowledge gained by engaging in

<sup>10</sup> Theophrastus, *HP* I 1.1.

<sup>11</sup> See BALME 1992: 69, 122–123; PELLEGRIN 1995: 25–26; LENNOX 2001b: 172. The view that *PA* I is a protreptic piece is defended in JOHNSON 2021: 12–29.

their close study more than compensates for the fact that they are arguably an inferior object of study:

we are better provided in relation to knowledge about *perishable plants and animals* because we live among them.<sup>12</sup>

Plants are listed before animals in this passage. Is this a problem for my claim that we ought to study *first* animals, *then* plants? I do not think so. We need to remain mindful of the larger context in which this claim is made. Aristotle is not immediately concerned with the structure of his science of nature in this protreptic piece. By contrast, this structure becomes a primary concern when he offers us a conceptual map of how his science of nature is organized at the beginning of his *Meteorology*. Hence, we should not expect Aristotle to employ the same words, let alone employ them in the same order, every time he makes a reference to his larger explanatory aims.

Still, Aristotle has chosen his words carefully. The knowledge of the divine (*sc.* celestial) objects is described as *philosophy* (φιλοσοφία). Although animals and plants are a lesser object of study, they can supply extraordinary pleasures to those who are by nature *philosophers* (φιλοσοφοί). Aristotle's emphasis is placed on "philosophy" and "philosophers." Of course, the philosophy in question is natural philosophy (alias second philosophy). Aristotle has in mind the philosophical knowledge that can be gained from a systematic study of the natural world. Many, if not most, in antiquity may have been tempted to think of the study of plants and animals as an expendable coda to such a project. Aristotle is resisting this thought. His considered view is that the results reached in this study contribute, directly and immediately, to the highest form of knowledge, namely philosophical knowledge. In other words, explanations and theories advanced in the context of the study of animals and plants are regarded by him as an integral part of a single and coherent attempt to arrive at a full account of the natural world. What makes the student of animals and plants a philosopher rather than merely a possessor of expert knowledge is the fact that the relevant knowledge is inscribed within a comprehensive explanation of the natural world.

The theoretical orientation of the Peripatetic study of animals and plants is too often taken for granted. It is worth stressing that a few in antiquity felt that this was a weakness rather than a strength of the Peripatetic project. As a result, they also criticized Aristotle and

<sup>12</sup> Aristotle, *PA I 5*, 644b24–35.

Theophrastus on the basis that their works were of little or no practical use. In Varro's *De re rustica*, for instance, Stolo criticizes Theophrastus because "his books [on plants] are of use not to those who want to cultivate the land but [only] to those who want to spend time in the schools of philosophers."<sup>13</sup>

We cannot be certain that Theophrastus is relying on what Aristotle says in *PA* I 5 at the outset of his study of plants. We can only say that he makes explicit contact with the study of animals. As Allan Gotthelf noted in a seminal paper on the shared explanatory strategies adopted in the early Peripatos,<sup>14</sup> the opening statement of *HP* presents striking similarities, both in language and content, with the following programmatic passage taken from *HA*:

The differences in animals are with respect to their modes of life and their activities and their characters as well as their parts. Let us first speak in outline about them, and then with attention to each kind.<sup>15</sup>

We have seen that *HA* is a pre-explanatory collection of zoological data. In *HA* Aristotle is concerned with finding out and grouping all the ways in which animals differ from one another – namely, all their differences.<sup>16</sup> In the above passage, Aristotle tells us that these differences are organized around the following categories: modes of life, activities, characters, and bodily parts. The relevant activities are those that are constitutive of a given mode of life (βίος).<sup>17</sup> When, therefore, we study the characteristic activities in which an animal is engaged, we study its distinctive way of life (and vice versa). By "character" Aristotle means whether an animal is good-tempered or ferocious, whether it is courageous or timid, and so on. A review of all the ways in which animals differ from one another with respect to their character is advanced in *HA* VIII (IX). The data on their distinctive way of life and characteristic activities are collected in *HA* V–VII (VIII).<sup>18</sup> Finally, the data about their bodily parts are to be found in *HA* I–IV.

<sup>13</sup> Varro, *De re rustica* I 5.2: *libri non tam idonei iis qui agrum colere volunt quam qui scholas philosophorum* (= FHS&G 387). In this case *philosophi* appears to be used as a disparaging term. On the Roman use of the term *philosophus* to describe a professional philosopher, see HINE 2016: 15–31.

<sup>14</sup> GOTTHELF 1988: 100–133 (reprinted in GOTTHELF 2012a: 390–314). The existence of shared explanatory strategies in Aristotle's study of animals and Theophrastus's study of plants is already discussed in STRÖMBERG 1937: 23–37.

<sup>15</sup> Aristotle, *HA* I 1, 487a11–14. <sup>16</sup> Chapter 3, Section 2.

<sup>17</sup> The conceptual link between *activities* (πράξεις) and *modes of life* (βίος) is explored in LENNOX 2010a: 239–258 and LENNOX 2010b: 329–355. See Chapter 6, Section 1 for more on the Peripatetic conception of a βίος.

<sup>18</sup> *HA* V–VI are concerned with the activities that can be subsumed under the label "animal reproduction." The activities concerned with character and food are studied in *HA* VII. What the Greek



When we compare the opening lines of *HP* with the programmatic statement found in *HA I*, we immediately see that Theophrastus not only adopts the theoretical framework developed for the collection and organization of the zoological data but also adapts it to what is specific about his subject matter. Theophrastus tells us that we should not expect to find a complete correspondence between animals and plants. For one thing, we have nothing in plants that corresponds to activities and characters in animals. For another, the study of the parts of plants poses special challenges to the investigator. As we will see shortly, these challenges have to do with how we should think about the bodily parts that are regarded as constitutive of a plant. For the time being, I would like to elaborate on the following observation: *Theophrastus builds his whole theoretical edifice on the results achieved in the study of animals.* I have chosen my words carefully. More directly, I refrained from speaking of *Aristotle's* study of animals. Theophrastus never mentions Aristotle by name when he refers to the study of animals, so we should not jump to the conclusion that Theophrastus is referring to Aristotle's *HA*, or think that Theophrastus has our *HA* on his desk when he writes *HP*. Allan Gotthelf may have succumbed to the temptation to see a cross-reference to our *HA* in the opening statement of *HP*. While his original thesis is that there is "theoretical affinity" between the two works, he subsequently claims that "the parallels, in short, are overwhelming, and there cannot be any question but that Theophrastus had *HA* before him as a model for his work so far as his distinct subject matter permitted it."<sup>19</sup> But we can never be certain that Theophrastus is referring to our *HA* even when he is explicitly referring to an ἰστορία of animals as in *CP II* 17.9. The reason is that all his references to a study of animals are self-consciously impersonal. They never take the form of a reference to any of the works written by Aristotle.

A similar point can be made in connection with the references to plants in the Aristotelian corpus. Let us return, briefly, to the short essay on longevity examined. In [Chapter 2](#) I argued that the few remarks that Aristotle makes on the topic of the relative longevity of animals and plants do not constitute a complete discussion of longevity in plants. Aristotle ends the section on the relative longevity of animals and plants by referring his reader to a separate discussion of longevity in plants.<sup>20</sup> Are we entitled

manuscript traditions transmits as *HA VII* has become *HA VIII* after Gaza's edition and translation of *HA*. For more on this, see footnote 43 in [Chapter 1](#).

<sup>19</sup> GOTTHELF 2012a: 327.

<sup>20</sup> Aristotle, *Long.* 6, 467b5–6: "It will be determined about these things also separately by themselves in the study of plants [περὶ μὲν τούτων καὶ καθ' αὐτὰ ἐν τοῖς περὶ φυτῶν διορισθήσεται]."

to conclude that Aristotle wrote (or planned to write) a work on longevity in plants? Upon reflection, this question can only be answered in the negative. The future tense in this reference need not be an indication that Aristotle took it upon himself to write a separate work on longevity in plants. It can be taken to be a reference to a *research slot in the Peripatetic study of perishable life*. This slot could be filled out either by Aristotle himself or by another researcher. Can this researcher be identified with Theophrastus? I do not think so. No separate essay on longevity in plants has been transmitted to us as part of the Peripatetic study of animals and plants. While Theophrastus deals with the topic of longevity in *HP IV 13* and *CP II 11*, it is not easy to connect his discussion with what is accomplished by Aristotle. In *HP IV 13*, Theophrastus collects data about wild and domesticated trees and argues (among other things) that wild trees and plants live longer than domesticated ones. In *CP II 11*, he establishes a correlation between being fruitless and being long-lived, and a correlation between bearing many fruits and being short-lived. For Theophrastus, fruiting “takes away a great deal of the nature of the plant, and indeed the most important part” (*CP II 11.1*). He also notes that this is analogous to what happens in animals (*CP II 11.1* and 4). The link with what Aristotle accomplishes in his discussion of longevity is, to say the least, tenuous.<sup>21</sup>

More instances of the same phenomenon can be found. Perhaps most striking is a passage from Aristotle’s *Sens.* 4 where we are told that what we read there on the topic of flavors has to be supplemented with what we read on the same topic in “*the part of the study of nature concerned with plants*” (τῆ φυσιολογίᾳ ἐν τῇ περὶ τῶν φυτῶν).<sup>22</sup> This is the only occurrence of the term “φυσιολογία” in the Aristotelian corpus.<sup>23</sup> By employing this expression, Aristotle signals that the study of flavors offered in *Sens.* 4 and the study of flavored juices offered in the context of the study of plants must be integrated into a single account. He also indicates that this account contributes to, and is inscribed in, the larger study of nature. Scholars tend to read into this passage a reference to the study of flavored juices and

<sup>21</sup> So I disagree with Luciana Repici when she tries to connect the discussion of longevity by Aristotle with what Theophrastus says on the same topic in *HP* and *CP* (REPICI 2000: 188–192).

<sup>22</sup> Aristotle, *Sens.* 4, 442b24–26. See Appendix II.

<sup>23</sup> This abstract noun is derived from φυσιολόγος. Aristotle uses this second term in connection with the ancient (by his lights, old-fashioned) student of nature. For instance, Aristotle tells us that it is more appropriate to call Empedocles a φυσιολόγος rather than a poet even if the latter writes in hexameters like Homer (*Poet.* 1, 1447b19). The reason is that Empedocles writes about nature in a certain style. This is also the style adopted by Plato in the *Timaeus*, and Aristotle tells us that, in the *Timaeus*, Plato engaged in φυσιολογεῖν about the soul of the cosmos (*DA I 3*, 406b26).

odors offered in the sixth book of Theophrastus's *Causes of Plants* (*CP VI*).<sup>24</sup> To be sure, *CP VI* begins with a definition of flavored juices and odors that agrees with what Aristotle says in *Sens.* 4:

*Now, the nature of flavored juices and odors, what each of the two is, was defined elsewhere [ἡ μὲν οὖν φύσις ποῖα ἑκατέρου τοῦ γένους ἐν ἄλλοις ἀφώρισται], [when it was stated] that both somehow result from compounds of some definite proportions. On the one hand, a flavored juice is a mixture of dry and earthy components in a liquid, or it is produced when heat draws and filters the moist through the dry. Perhaps there is no difference between these two processes. Odor, on the other hand, is produced by the dry component of the liquid flavor in that which is transparent, which is a property of air as well as water. (Thompson's translation, slightly modified)<sup>25</sup>*

I highlighted in italics the putative reference to Aristotle. When Theophrastus tells us that he is relying on what is said elsewhere, it becomes almost irresistible for us to see in this passage a reference to the treatment of flavors and odors offered in *Sens.* 4. In this scenario, Aristotle would be referring to Theophrastus in *Sens.* 4, and Theophrastus to Aristotle in his essay *On Juices and Odors* (*CP VI 1*).<sup>26</sup> If confirmed, these cross-references would be a prime example of the existence of a shared research agenda in the Peripatos. Unfortunately, they cannot be substantiated beyond any reasonable doubt. They cannot precisely because both Aristotle and Theophrastus have chosen to express themselves in an impersonal way.

### 3 How to Build on the Study of Animals

The foregoing reflections on the elusive nature of the cross-references in Aristotle and Theophrastus help us appreciate the limits of any attempt to use them as positive evidence for the existence of a joint effort in the Peripatos to produce separate but coordinated studies of animals and plants. I am nevertheless confident that we can still secure this important result by taking a longer route. This alternative route consists in looking in some detail at how Theophrastus proceeds in his actual study of plants. Let us return to the opening statement of *HP*. What matters is not whether

<sup>24</sup> We have already seen that this book is a self-contained and relatively independent work transmitted under the title *On Juices and Odors*.

<sup>25</sup> Theophrastus, *CP VI 1.1*.

<sup>26</sup> For example, EINARSON-LINK 1976: 201n3. For more on how Theophrastus opens his account of juices and odors and the possible reference to Aristotle's *Sens.* 4, see THOMPSON 1941: 72–74, 224.

Theophrastus is referring to *HA* (or to any other extant or lost work by Aristotle). What really matters is that *Theophrastus is relying on the study of animals as something that is already in place when he is about to embark on his study of plants*. At the very least, we can say that Theophrastus expects his reader to have already mastered the results reached in the study of animals. This expectation depends on the assumption that the study of animals comes before the study of plants in the order of inquiry. This overall approach to the topic of perishable life confirms what we have seen in previous chapters. *In the early Peripatos, the relevant order of study is first animals, then plants*. In his extant writings on animals, Aristotle generally looks ahead to a study of plants.<sup>27</sup> Once more, this kind of references need not be given a chronological meaning. Even if it is very likely that Theophrastus wrote on plants after Aristotle wrote on animals and wrote his works several years after the death of Aristotle, his references to the study of animals are best understood as evidence that the study of plants follows that of animals in the order of investigation.<sup>28</sup>

The study of plants follows the study of animals in the order of inquiry, so Theophrastus is allowed to start his own investigation from certain results achieved in the study of animals. However, this does not mean that he can mechanically transpose those results. Right from the beginning of his inquiry, Theophrastus is quite forthcoming on the existence of specific or even unique challenges that the study of plants poses to the investigator. It is worth quoting the opening paragraph of *HP I* in full:

The differences in plants and the rest of their nature are to be understood with respect to their parts and their qualities, as well as their modes of generations and modes of life; for they do not have characters and actions as animals do. *While their differences with respect to generation, qualities, and modes of life are more discernible and easier to study, those that have to do with*

<sup>27</sup> See, for example, Aristotle, *PA* II 10, 656a2; *Long*, 6, 467b4; *Juv.*, 2, 468b1; *GA* I 1, 716a1; *GA* V 3, 783b20. There are exceptions to the rule. In *GA* I 23, 731a29, Aristotle appears to refer to a study of plants as something that is already in place as he writes on the topic of animal generation. Compare also *HA* V 1, 539a15–20. These passages are collected in [Appendix I](#).

<sup>28</sup> I will not venture into chronological speculations even though the wealth of information reported in *HP IV* (where the focus is on plants indigenous to the various regions of the known world) became available only after the conquest of Alexander the Great in Asia. Alexander himself is evoked several times in this context (see *HP IV* 4.4). This information derives mostly from the literature generated by his military expedition. A well-informed and balanced attempt to evaluate the scanty evidence for the sources as well as the absolute date of *HP* is offered in [AMIGUES 1988: xx–xxx](#). Compare [REGENBOGEN 1950: 1455–1466](#). *HP IV* 8.4 also contains a reference to a historical event that can be dated after the death of Alexander: Antigonus the One-Eyed and his use of the papyrus grown in Syria to make the ropes for his fleet of Phoenician ships (c. 315 BC). The reference is in the past, which suggests that by the time Theophrastus reports this information Antigonus is presumably dead.

*their parts display a great variety. To begin with, this very thing is not sufficiently determined but rather is a source of some difficulty – namely, what are and are not to be called parts* [εἰσι δ' αἱ μὲν κατὰ τὴν γένεσιν καὶ τὰ πάθη καὶ τοὺς βίους εὐθεωρητότεραι καὶ ῥάους, αἱ δὲ κατὰ τὰ μέρη πλείους ἔχουσαι ποικιλίας. αὐτὸ γὰρ τοῦτο πρῶτον οὐχ ἰκανῶς ἀφώρισται τὰ ποῖα δεῖ μέρη καὶ μὴ μέρη καλεῖν, ἀλλ' ἔχει τινὰ ἀπορίαν].<sup>29</sup>

I highlighted in italics the section that is immediately relevant to our purposes. Theophrastus thinks that the parts of plants present special challenges to the student of nature. The first and most serious one is that it is not clear what counts as a constitutive part of a plant. Theophrastus elaborates on this front in the stretch of text immediately following the one quoted above. Unlike animals, plants appear to have a variable number of parts to the extent that some of those parts are annual. For example, leaves are annual. Moreover, everything else that has to do with the production of the fruit is annual. Finally, the new growths in the area above the ground as well as around the roots are also to be counted among the parts of a plant. This situation creates the following dilemma. If we take the seasonal parts to be constitutive of the plant, then we must conclude that the latter has a variable, and indeed indeterminate, number of parts. But if we refuse to consider those parts as constitutive of the plant, we end up saying that the parts that contribute most to making the plant what it is at its bloom are not really its parts. Neither option is theoretically attractive.

It does not take long to realize that the dilemma is especially difficult for someone who expects the study of plants to follow the study of animals very closely. We have seen that this is the implicit assumption made at the outset of *HP*. And yet Theophrastus gets out of this difficulty by arguing that we should not look for a complete correspondence between animals and plants after all.<sup>30</sup> His remarks on this front create the theoretical space for an investigation of plants that does not follow what has been achieved in the study of animals in a slavish or unthinking manner. At the same time, Theophrastus tries to bridge this gap as soon as he has created it. He notes that the shedding of annual parts is not unique to plants. He recalls the shedding of horns in deer and the shedding of feathers and hair in birds and four-footed animals that hibernate.<sup>31</sup> He makes a similar point in connection with the bodily parts involved in the reproduction of animals and plants. It is true that in plants the parts that are involved in the

<sup>29</sup> Theophrastus, *HP* I 1.1.    <sup>30</sup> Theophrastus, *HP* I 1.3.

<sup>31</sup> We can expand on Theophrastus's examples by recalling that snakes shed their old skin and insects cast off the outer layer of their bodies.

production of the fruit are annual. But in animals too some parts are separated from the parents when the offspring is born, while others are cleansed away.<sup>32</sup>

The discussion of the perceived similarities between parts in animals and plants may seem at first to blur any sharp distinction between animals and plants. But the point Theophrastus would like to take away from this discussion is that plants and animals are different kinds of perishable living beings, so we should not try to assimilate plants to animals; rather, we should focus on what is specific about each of the two kinds of perishable living beings. Consider the passage that immediately follows in the text and brings the whole discussion to a natural conclusion:

*In general, just as we said, it should not be assumed that there is a complete correspondence with animals [ὅλως, καθάπερ εἶπομεν, οὐδὲ πάντα ὁμοίως καὶ ἐπὶ τῶν ζώων]. That is why the number of parts is indeterminate: a plant has the capacity to sprout everywhere because it is alive everywhere [πανταχῆ γὰρ βλαστικόν, ἅτε καὶ πανταχῆ ζῶν]. As a result, we should assume that things are in this way not only with respect to what is being discussed now but also with a view to what we are going to discuss later. To try to assimilate what cannot be assimilated is futile in order that we not lose sight of what is the proper object of study [ὅσα γὰρ μὴ οἶον τε ἀφομοιοῦν, περίεργον τὸ γλίχεσθαι πάντως. ἵνα μὴ καὶ τὴν οἰκείαν ἀποβάλωμεν θεωρίαν].*<sup>33</sup>

The final words in this passage are best understood as implying that we should not try to assimilate plants to animals. If we tried to do so, we would end up losing sight of what is specific about plants. This passage is often taken to be evidence that, right from the start of his study of plants, Theophrastus wants to distance himself from Aristotle.<sup>34</sup> But I do not see any compelling reason for thinking that Aristotle is a critical target in this passage, let alone for concluding that Theophrastus is trying to distance himself from what Aristotle has achieved in his study of animals. Firstly, Aristotle is not even mentioned in this stretch of text. Theophrastus refers to the study of animals in a rather impersonal way. He refers to this study as something that can be appropriated and considered scientific background for the investigation he is about to launch. Secondly, and more importantly, this passage implements a key Aristotelian insight Theophrastus endorses and makes his own: scientific progress requires attention to

<sup>32</sup> Theophrastus, *HP I* 1.3.    <sup>33</sup> Theophrastus, *HP I* 1.4.

<sup>34</sup> See *AMIGUES 2010a*: 61–70 and *AMIGUES 2010b*: 4n2. But it is important to stress that she is here giving voice to a firmly entrenched view that goes back at least to *SENN 1930*: 113.

what is specific to the object of study. What Theophrastus tells us can be restated as follows: if we do not pay attention to what is specific to our present subject matter, we are bound to fail as scientists.

What is specific to the subject matter under examination can be traced back to the fact that plants are a distinct form of perishable life. Theophrastus is very clear on this point: when he refers to the fact that a plant has life everywhere, he refers to the fact that there is no single center of life in plants as there is in animals. Evidence that this is the case is the ability of a plant to grow everywhere. This is a view that Aristotle shares with Theophrastus. Let me recall the passage from the essay on the length and shortness of life where Aristotle argues that some plants live longer than all animals because “they have potentially life everywhere” (i.e., “they have potentially a root and a stem everywhere”):

Plants are like insects as we said earlier. The reason is that when they are cut, they continue to live and become two or more than two from one. But insects, although they manage to live, cannot do so for long. The reason is that they do not have organs and the source of life that is present in them cannot produce them [*sc.* the organs]. But the source [of life] present in plants can: the reason is that *plants have potentially a root and a stem everywhere* [πανταχῆ γὰρ ἔχει καὶ ρίζαν καὶ καυλὸν δυνάμει]. So it is from this source that the new and the old [in the plant] grow, with the new parts cut from the plant having little difference in terms of longevity. Indeed one might say that in a way the same happens in the case of propagation by slip, since the shoot cut off is a part [of the plant]. Thus, in the case of propagation by a slip this happens because the slip is separated from the plant, whereas in the other case [this happens] in virtue of its continuity. The reason is that *the source [of life] is everywhere, being present potentially* [ἐνυπάρχει πάντῃ ἢ ἀρχὴ δυνάμει ἐνοῦσα].<sup>35</sup>

At this point, we have reached the most obvious strength of the Peripatetic approach to study of perishable life. We can restate this strength in the following terms: as soon as we realize that there is no single thing called perishable life, but rather there are different forms (or levels) of perishable life, we have no option but to engage in the study of the various forms (or levels) of perishable life without overlooking what is specific to, or even unique about, each of them. In other words, our prospects of making progress in the study of animals and plants depends, crucially, on our ability to develop an appropriate strategy to approach what is specific, or even unique, about each of them. It is very telling that Theophrastus

<sup>35</sup> Aristotle, *Long.* 6, 467a18–30. See the full discussion in [Chapter 2, Section 3](#).

reminds us of this important insight right at the start of *HP*. We have now to see how Theophrastus remains true to this insight in dealing with the question that is at the heart of his whole discussion in *HP* 1 – namely, how to study the parts of plants.

#### 4 How to Study the Parts of Plants

In the opening statement of *HP* Theophrastus tells us that he is interested in collecting and presenting all the relevant differences (διαφοράι).<sup>36</sup> We have already seen that διαφορά is a technical term in the early Peripatos. It refers to any way in which *X* may differ from *Y*.<sup>37</sup> Plants may differ from one another because of the presence or absence of certain bodily parts. When the same parts are present, those parts may still differ with respect to their appearance, size, or arrangement. For instance, plants may or may not have leaves and fruit. But when they have leaves or fruit, the latter may differ in shape, color, and texture. Differences in juices are also relevant. Finally, leaves and fruits may be arranged in different ways: for instance, some plants may have their fruits located below the leaves, while others may have them above the leaves. Theophrastus makes it clear that his example is meant to be nothing more than an outline.<sup>38</sup> His strategy is reminiscent of the one Aristotle adopts at the outset of *HA*. Like Theophrastus, Aristotle begins his collection and presentation of all the ways in which animals differ from one another with an outline that has the stated goal of giving us a foretaste of the task that is ahead of us.<sup>39</sup> In both cases, the key word is “outline.” To speak in outline (εἰπεῖν ἐν τύπῳ) is to provide an initial sketch; when the investigators have grasped this initial sketch (ἐν τύπῳ λαβεῖν), they are ready to turn to their actual investigation. Both Aristotle and Theophrastus want the investigators to embark on the study of either animals or plants with an initial grasp of the task that lies ahead of them.<sup>40</sup>

The task of collecting and presenting all the ways in which plants differ is truly daunting. How can we possibly accomplish this feat? It is time to look a bit more closely at the explanatory strategies Theophrastus adopts in

<sup>36</sup> Theophrastus, *HP* I 1.1. <sup>37</sup> More on this in [Chapter 3, Section 2](#).

<sup>38</sup> Theophrastus, *HP* I 1.6. I come back to this interesting phrase, which is a piece of Peripatetic jargon, in [Chapter 5, Section 2](#).

<sup>39</sup> Aristotle, *HA* I 6, 491a6–7: “we have stated these things in this way now – *in outline* – to provide a taste of the range and sorts of things we must study [ταῦτα μὲν οὖν τοῦτον τὸν τρόπον εἶρηται νῦν ὡς ἐν τύπῳ, γέυματος χάριν περὶ ὄσων καὶ ὄσα θεωρητέον].”

<sup>40</sup> More on the use of outlines and sketches in the Peripatetic practice of science in [Chapter 5, Section 2](#).



his study of plants. What he says immediately before giving his initial outline is quite important:

(a) The research into plants, to speak generally, is either about their external parts and their whole form or about their internal parts, *just like the data from dissections in the case of animals* [ὡσπερ ἐπὶ τῶν ζῴων τὰ ἐκ τῶν ἀνατομῶν]. We must consider which parts are the same in all plants alike, which parts are proper to each kind, and which of them are similar – I mean, for instance, leaves, roots, and bark.

(b) This too must not be overlooked if something ought to be studied by means of analogy: just as in the case of animals [we must] trace it back to the clearest and the most perfect thing. And, in general, *things in plants are to be assimilated to the corresponding things in animals, to the extent that one can assimilate what is analogous* [καὶ ἀπλῶς δὲ ὅσα τῶν ἐν τοῖς φυτοῖς ἀφομοιωτέον τῶ ἐν τοῖς ζῴοις, ὡς ἂν τις τὸ ἀνάλογον ἀφομοιοῖ].<sup>41</sup>

I divided this programmatic passage into two parts. In the first, marked as (a), Theophrastus recalls the division into *internal* and *external* parts already employed in the study of animals. This time, however, he does not refer generically to the study of animals but he makes a specific reference to the data available to him from the dissections of animals. We have seen that dissections are required for the study of the internal parts of animals.<sup>42</sup> We cannot rule out that Theophrastus refers to a formal presentation of data like the lost *Dissections* that Aristotle himself mentions several times in his extant works on animals.<sup>43</sup>

What matters, however, is not whether we have here an allusion to a book by Aristotle (or by someone else), but rather that Theophrastus relies on a pre-existing familiarity with the study of animals for his basic distinction between internal and external parts. The study of animals is in the background as something that can provide us with a helpful platform for our research into plants. As in the case of animals, the task of the investigator consists in collecting and presenting all the ways in which the plants differ from one another. This may entail recourse to dissections. This task entails registering the features that are common to all plants as

<sup>41</sup> Theophrastus, *HP I* 1.4–5.   <sup>42</sup> See [Chapter 3, Section 2](#).

<sup>43</sup> In his catalogue of Aristotle's writings, Diogenes Laertius lists eight books of *Dissections* and a *Selection from Dissections* (V 25). Similar but not identical information is found in the so-called *Vitae Herychii*: six books of *Dissections*. These *Dissections* are now lost, so we can only guess about the role Aristotle envisions for them in his explanatory project. In a few places Aristotle jointly refers to the *Dissections* and the *HA*. An educated guess is that the *Dissections* are meant to serve as an auxiliary support to the collection and organization of the relevant zoological data advanced in the *HA*. A full list of the Aristotelian references to the *Dissections* with an in-depth discussion of each of them can be found in [LENNOX 2017: 249–272](#).

well as those that make them different kinds of plants. If we adopt the language that has been introduced to describe the aims that Aristotle sets for himself in *HA*, we can say that Theophrastus is concerned with “laying out the differences” as well as finding out “the relevant groupings of differences.”<sup>44</sup>

In the second part of our passage, marked as (b), Theophrastus recalls a rule of inquiry that appears to control his entire study of plants. This rule should guide the investigators in their attempt to offer an account as complete as possible of all the parts present in all the different kinds of plants. At the most general level, this rule mandates that, as we have already done in the study of animals, we employ analogy as a tool for the collection and explanation of the botanical data. This requires us to single out a kind that may serve as standard of reference in the study of all kinds of plants. In what looks like a natural development stemming from the rule of inquiry, Theophrastus adds the following piece of advice: assimilate plants to animals only to the extent that analogous things allow for it. This piece of advice works together with the recommendation that we should not look for a complete correspondence in animals and plants, but rather we should consider what is specific to each of the two kinds of living beings. Clearly, animals and plants are regarded as distinct investigative domains; as such, they are the objects of separate studies; however, it turns out that there exist structural similarities which can be exploited as we move from the first field of study (animals) to the second (plants). Hence, these two separate studies can (indeed, should) be coordinated in some way.

## 5 Steps in the Study of the Parts of Plants

What Theophrastus says in the second part of the passage, marked as (b), outlines two main steps in any scientific attempt to study the parts of plants. The first step goes something like this: we ought to study the parts of plants by singling out a kind we can use as a standard of reference as we proceed in the examination of the other kinds of plants. To perform the function of a standard of reference, this kind must be the clearest and the most perfect one.<sup>45</sup> I take Theophrastus to mean that the kind we choose must display all the natural articulations present in the other plants and must display them in the clearest possible way. This paradigmatic case will

<sup>44</sup> I adopt the language employed by Allan Gotthelf (in [GOTTHELF 2012b](#): 261–292) to characterize the aims of Aristotle’s *HA*. See [Chapter 3, Section 2](#) for the reasons behind the use of this language.

<sup>45</sup> The Greek is τὰ ἐμπερέστατα καὶ τελειότατα.

serve as our model as we proceed in our subsequent inquiry, so we will employ the results achieved in the study of the model as we turn to the other, less perfect, kinds of plants. These kinds are less perfect either because they do not possess all the natural articulations present in the paradigmatic case or because they display them in a less distinct way.

Like Aristotle, Theophrastus does not shy away from using the language of perfection. Some of us may be uncomfortable with this language because we take it to involve an unwarranted projection of normative values onto the natural world. By now, however, it should be clear that we can rework the reference to perfection in terms of relative organization and structure. Recall that, at least for Aristotle, to be a living body is to display a certain level of organization and structure. The level of organization is different in animals and plants. Animals exhibit a higher level of bodily organization and structure because they are minimally organized into an upper and a lower part, a front part, and a back part. Animals that can displace themselves show an even higher level of organization and structure because they also display a right and a left side in their bodies. Since plants are stationary and, at least according to Aristotle, cannot perceive, they only display the distinction into an upper and a lower part, which is the distinction that can be traced back to the basic activity of nutrition shared by animals and plants. Moreover, since the roots are the entry point of nutrition, they are the upper part of plants. As a result, branches, leaves, and flowers appear to us to be the upper part of plants, but they are in fact their lower part. This is an important theoretical insight. Aristotle recalls it several times in his zoological works.<sup>46</sup> Although this catchy image is never used by Theophrastus, it surely captures an important truth: life as encountered here on earth (i.e., perishable life) entails organization and structure.<sup>47</sup>

Theophrastus is not as explicit as Aristotle on the basic truth that a living body is an organized body. But his references to perfection can be cashed out as claims entailing the existence of different levels of bodily complexity in plants. In particular, the kind of body that we plan to employ as our paradigmatic case must display the highest level of organization and structure among plants. Furthermore, the organization and structure in this kind must be transparent for us to be able to apply it as we progress in the study of various kinds of plants. So our first and arguably most

<sup>46</sup> For example, Aristotle, *IA* 4, 705a26–28. The image of plants as upside-down animals is quite suggestive. It has been used in the title of the most recent and most comprehensive survey of ancient Greek ideas on plants ([REPCI 2000](#)).

<sup>47</sup> According to Aristotle, this truth cannot be extended to the celestial world.

important decision in the study of plants is to establish a model, for which we must then develop an exhaustive description of its bodily organization and structure. I will return to this point shortly.

For the time being, however, let us turn to the second step in a truly scientific study of parts of plants. This step can be introduced as follows: we ought to launch our study of plants, including the study of our paradigmatic case, on the assumption that plants are analogous to animals, at least in some respects. The qualification is important: *Theophrastus is not envisioning a complete assimilation of plants to animals*. On the contrary, he is forthcoming that we are expected to exercise our judgment as to when, and to what extent, the insights gained in the study of animals can be used to make progress in the study of plants. Proceeding in any other way would amount to an outright violation of the Peripatetic insight that animals and plants are separate domains of investigations.

At this stage of our inquiry, the two rules outlined above are still quite abstract. Before trying to be a bit more concrete by looking at how Theophrastus implements them, I would like to return briefly to Aristotle. These two rules are at work in his study of animals as well. At the most general level they are spelled out in a passage from the lost *Protrepticus* where we are told that the natural way to proceed in any inquiry is from what is more knowable by nature, and we are told that our investigation must proceed from what is most organized and most determinate to what is less organized and less determinate.<sup>48</sup> We have seen that this is how Aristotle proceeds at the pre-explanatory and also at the explanatory stage of inquiry.<sup>49</sup> In both cases Aristotle begins his investigation from blooded animals with a concentration on the case of the human being. As a result of this overall strategy, Aristotle first develops an account for blooded animals and then extends it to the study of bloodless animals. The transition from the first to the second group of animals is made on the assumption that bloodless animals are *analogous* to blooded animals. All blooded animals have a heart. Aristotle takes this observation as his starting point to infer that all bloodless animals must possess a body part *analogous* to the heart. This example illustrates how analogy can be used to make new discoveries in any given field of study. Aristotle extends what he has learned about one group of animals – the group he takes to be his model and standard of reference – and applies it to another group of animals.

<sup>48</sup> Aristotle, *Protr.* B 33 Düring (= Iamblichus, *Protr.* 38.7–8 and *De comm math sc.* 81.7–11).

<sup>49</sup> Chapter 3, Section 2 (concerned the pre-explanatory stage of inquiry) and Chapter 3, Section 3 (dealing with the explanatory stage of inquiry).

Like Aristotle, Theophrastus begins his inquiry into plants from what he takes to be the clearest and most perfect kind of plant. He makes the study of this kind a suitable platform from which to launch a study of all the other kinds of plants. For Theophrastus, this kind of plant is *the tree* (τὸ δένδρον). At least two observations can be made in connection with this momentous choice. The first is that Theophrastus begins his investigation from what may be regarded as a very large kind. The second is that this very large kind is isolated by an everyday word. Theophrastus is emphatically not the first to employ the Greek name “δένδρον” in his scientific discourse. Empedocles used this term in his poem on nature. The latter famously compared seeds to eggs: “*the tall trees lay their eggs, olives, first.*” This comparison is recalled by both Aristotle (*GA* I 23, 731a5) and Theophrastus (*CP* I 7.1–3). We will see in due course that Theophrastus criticizes this comparison.<sup>50</sup> Here I am content to stress that while Theophrastus appropriates the same popular designation as Empedocles, he uses it in a different way. Unlike Empedocles, Theophrastus does not employ the term “tree” as a *pars pro toto*; rather, he uses it to refer to the large kind he takes to be his core case. Starting from this core case, Theophrastus develops a scientific discourse about plants that goes emphatically beyond his initial case. Part of our task in the rest of this chapter is to see how this explanatory feat is achieved.

To make progress on this front, let us see, first, how Theophrastus introduces his very large kinds of plants. Next to the tree, the other kinds are *shrub* (τὸ θάμνος), *under-shrub* (τὸ φύγανον), and *herbaceous plant* (ἡ πτόα).<sup>51</sup> For each of them, Theophrastus offers an initial definition that, by his own admission, grasps in outline what the name signifies. In all these cases, the definition is given by relying on the *morphology* of plants, namely their visible characteristics:

A *tree* is a plant that rises from the root with a single stem, having many branches and knots, and it is not easy to uproot (for instance, olive-tree, fig-tree, and vine). A *shrub* is a plant that rises from the root with many branches (for instance, bramble, and the jujube). An *under-shrub* is a plant that grows from the root with many stems and many branches (for instance, savory and rue). An *herbaceous plant* is a plant that rises from the root with leaves and has no stem; the seed is borne on the branch (for instance, corn and vegetables).<sup>52</sup>

At least two observations can be made in connection with this passage. The first is that Theophrastus begins his study of plants with a *diairesis* that

<sup>50</sup> Chapter 5, Section 2.2.    <sup>51</sup> Theophrastus, *HP* I 3.1.    <sup>52</sup> Theophrastus, *HP* I 3.2.

divides the domain under investigation. He justifies this initial move by saying that our object of study becomes clearer as soon as it is divided into kinds and that we should adopt this procedure to the extent that it is possible.<sup>53</sup> It has long been noted that the division employed in this stretch of text reminds us of how Aristotle introduces his largest kinds in *HA* I 6.<sup>54</sup> Admittedly, we do not find equivalent terminology in Theophrastus; and yet the parallels between the two texts are striking. Note, however, the following important difference: unlike animals, plants show considerable variation. Depending on domestication or the impact of their surrounding habitat, the same plant may display considerable variation. The same plant, depending on whether it is wild or domesticated, or whether it grows in a sunny or a shady place, may bear fruit or be fruitless, may have flowers or be flowerless, and so on and so forth. So our division into large kinds, including their initial characterization, is only a first approximation. Theophrastus signals what is peculiar about his subject matter when he says that we should divide our subject matter “to the extent that it is possible.” He returns to this point when he says that these definitions must be taken to apply “in general and on the whole.”<sup>55</sup> Finally, toward the end of his discussion, he reiterates that these “distinctions [are] made in outline.”<sup>56</sup> Further evidence that Theophrastus rejects any hard and fast classification of plants is that he does not rule out that a few plants may remain outside his initial *diairesis*. At the very least, we can say that Theophrastus is not motivated, or at least not primarily, by taxonomic concerns. Rather, his first and foremost concern is to supply us with a useful framework to organize and present the botanical data rather than providing an exhaustive, hierarchic classification of plants.<sup>57</sup>

The second observation is that our initial definitions of the four very large kinds of plants are best understood as *nominal definitions*. These definitions give us nothing more than a first orientation, indeed a first grasp, of the phenomena to study. Armed with this first grasp, we are in a position to begin our research. At this early stage of our investigation, our cognitive state is not unlike the one that Aristotle ascribes to those

<sup>53</sup> Theophrastus, *HP* I 3.1.

<sup>54</sup> GOTTHELF 1988: 100–133 (reprinted as GOTTHELF 2012a: 390–314). For an insightful discussion of *HA* I 6, including its role in laying out the animal differences in *HA*, I refer the reader to GOTTHELF 2012d: 293–306.

<sup>55</sup> Theophrastus, *HP* I 3.2.      <sup>56</sup> Theophrastus, *HP* I 3.5.

<sup>57</sup> The same point can be made in connection with the study of animals offered in *HA*. Aristotle is emphatically not motivated by classificatory concerns. See GOTTHELF 2012b: 261–292 for a useful summary of the scholarly consensus reached on this front.

investigators who have *non-accidental knowledge of the existence of the relevant thing*. Consider the following passage from *Posterior Analytics* II:

It is impossible to know what a thing is when we are ignorant that it exists. Sometimes we grasp that something exists in an accidental way, and sometimes by grasping something of the thing itself (for instance, that thunder is a certain kind of noise in the clouds, that eclipse is a certain kind of loss of light, that the human being is a certain kind of animal, or that the soul is that which moves itself). . . . To search for what something is without grasping that it exists is to search for nothing. But when we grasp something [of the thing itself] it is easy to search. Thus, as we are aware that something exists, so is our awareness directed toward what it is.<sup>58</sup>

Aristotle argues that we can try to offer a definition of what something is only when we are aware of its existence.<sup>59</sup> In addition, he claims that when we know in a non-accidental way that a thing exists, we grasp something of the thing itself and our awareness is directed toward what the thing is. In this case, our non-accidental knowledge that the thing exists comes with some provisional understanding of what it is. This understanding is conveyed by a preliminary account. Aristotle's examples are that thunder is a certain kind of noise in the clouds, eclipse is a certain kind of loss of light, and the human being is a certain kind of animal.<sup>60</sup> The definitions of the very large kinds of plants Theophrastus offers at the beginning of his presentation of the botanical data meet these epistemic requirements.

## 6 Non-Uniform, Uniform, and Annual Parts of Plants

It is time to look at how Theophrastus proceeds in establishing which bodily parts are relevant to the study of plants. Theophrastus tells us that the primary and most important parts, which are also those common to most plants, are the following four: root, stem, branch, and twig.<sup>61</sup> He regards these parts as the most widely shared *non-uniform* parts of plants and compares them to the *limbs* (μέλη) of animals. In both cases, the part is a non-uniform one and the whole, either the animal or the plant, is a composite body made out of these parts.<sup>62</sup> The reader who is interested in exploring the systematic connections between the study of plants and the study of animals should return to the opening paragraph of *HA*, which

<sup>58</sup> Aristotle, *APo* II 8, 93a20–29.

<sup>59</sup> The seminal papers on this passage, and its implications for Aristotle's scientific method, are BOLTON 1976: 514–544 and BOLTON 1987: 120–166. See also SORABJI 1981: 213–219; DEMOSS-DEVEREUX 1988: 133–154; and CHARLES 2000: 23–56.

<sup>60</sup> Aristotle, *APo* II 8, 93a23–24. <sup>61</sup> Theophrastus, *HP* I 1.9. <sup>62</sup> Theophrastus, *HP* I 1.9.

offers a definition of uniform and non-uniform parts, with a focus on the so-called limbs. The latter are described as wholes that are themselves constituted of non-uniform parts. Aristotle's examples are the head, the hand, and the whole arm.<sup>63</sup>

Theophrastus offers an initial definition for each of these four non-uniform parts.<sup>64</sup> *The root* is the part by which the plant draws its nourishment, whereas *the stem* is the one that grows above the ground and is single. *The branch* is the part that splits off from the single one that we call stem, whereas *the twig* is growth that springs from the branch regarded as a single whole.<sup>65</sup> After these brief definitions, which at this stage of the investigation can only be taken to serve the function of interim definitions, Theophrastus states that these parts, which are constitutive of the nature of a plant, belong especially to trees in the sense that this partition is most appropriate and most apparent in their case. This is why we ought to make trees our standard of study and to begin our investigation of plants by investigating trees: they display the structure and complexity of plant life in the fullest and clearest way. We will have to use whatever we have found out in the study of trees as we turn to the study of the other kinds of plants.

Although the above parts are commonly shared by plants, they are not present in all of them. In connection with this observation, Theophrastus adds the following, general remark:

As a rule, the kinds of plants are manifold, various, and difficult to study in general terms. Evidence of this is that we cannot grasp anything that belongs in common to all plants, *just like mouth and stomach in animals* [καθάπερ τοῖς ζῴοις στόμα καὶ κοιλία].<sup>66</sup>

The comparison with animals invokes a zoological fact that Aristotle registers in *HA I 1* and discusses at the outset of *PA II 10*.<sup>67</sup> In both passages, Aristotle tells us that animals have a body part they use to take in the nourishment and another body part they employ to process the nourishment. “Mouth” and “stomach” are names borrowed from our everyday language; they become technical terms as they are appropriated for the Peripatetic study of perishable living beings. Our passage confirms this picture. It also supplies an additional reason why we should start our

<sup>63</sup> Aristotle, *HA I 1*, 486a9–14.    <sup>64</sup> Theophrastus, *HP I 1.10*.    <sup>65</sup> Theophrastus, *HP I 1.9*.

<sup>66</sup> Theophrastus, *HP I 1.10*. The claim that the world of plants exhibits not only more complexity but also specific challenges is repeated in *HP I 2.3*. More on this later in this chapter.

<sup>67</sup> For *HA I 1*, see [Chapter 3, Section 2](#); for a discussion of *PA II 10*, see the interim conclusion offered in [Chapter 2, Section 5](#).



study of life with animals rather than plants: as a subject matter, plants are considerably more difficult to study than animals.

After the non-uniform parts, Theophrastus lists what he takes to be the *uniform* parts of plants: bark, wood, and core. He adds that there are bodily parts that are even prior to these and from which these parts are composed: sap, fiber, vein, and flesh. Bodily parts that belong to this second group are common to all plants. These parts are common to all because they are their first principles.<sup>68</sup>

Along with non-uniform and uniform parts, Theophrastus lists *annual* parts. Theophrastus has already referred to these parts at the outset of *HPI*, where he has stressed that plants have annual parts. For instance, deciduous plants shed their leaves. The question raised but not answered at the outset of *HPI* is whether the study of annual parts is an integral component of the study of plants. By now this question has been answered in the affirmative. Here Theophrastus takes it for granted that the study of parts must comprise a discussion of the annual parts, which are all related to the production of the fruit: leaves, flower, stalk, tendril, and the fruit itself. By “fruit,” Theophrastus means the compound of the seed and the surrounding covering that contains the seed.<sup>69</sup> He also makes a final point that clarifies his overall strategy: the tripartition into non-uniform, uniform, and annual parts is made in relation to trees rather than annual plants because in the latter all the parts last for only one year. As a result, this distinction would not apply.

Theophrastus ends his review of the three kinds of parts – non-uniform, uniform, and annual – by stating that the task of the investigator is to look for a first definition of each of these parts. I speak of a “first definition” because this definition will tell us what these parts are only in outline.<sup>70</sup> Evidently, our investigation is still at a preliminary stage. What is important at this early stage is to provide the investigators with a first orientation and an initial sketch before they turn to the actual investigation. The reader who is familiar with how the argument unfolds in *HA I* will notice that there is here a similarity with how Aristotle proceeds in the first six chapters of *HA I* (*HA I* 1–6, all the way to 491a14).

There is at least one other passage that sheds considerable light on the explanatory strategy Theophrastus employs in his study of plants:

Not all plants have root, stem, twig, branch, leaf, flower, or fruit; or again bark, core, fibers, or veins (e.g., mushrooms and truffles [do not have

<sup>68</sup> Theophrastus, *HP I* 2.1.

<sup>69</sup> See Chapter 5, Section 3.2 for more on this distinction.

<sup>70</sup> Theophrastus, *HP I* 2.1.

them]). And yet, the substance of a plant is in these parts (or in such like parts). *But, as we have already stated,*<sup>71</sup> *these parts are present above all in trees, and this partition is more appropriate in them, and it is right to trace the parts of the other plants back to them* [ἀλλὰ μάλιστα ταῦτα ὑπάρχει, καθάπερ εἴρηται, τοῖς δένδροις κἀκείνων οἰκειότερος ὁ μερισμός, πρὸς ἃ καὶ τὴν ἀναφορὰν τῶν ἄλλων ποιεῖσθαι δίκαιον].<sup>72</sup>

We can restate the point Theophrastus makes here by saying that, in addition to non-uniform parts (roots, a single stem, branches, and twigs), we are required to study annual parts (leaves, flowers, and fruit), as well as uniform parts (bark, core, fiber, and vein). The reason is that the substantial being (οὐσία) of a plant consists of all these parts. This does not mean, I hasten to say, that all plants must display all the above parts. Theophrastus mentions mushrooms and truffles because he takes them to be an especially difficult case as they do not show most of the above parts.

Both mushrooms and truffles remain at the margin of the Peripatetic study of plants. While Theophrastus mentions mushrooms twice more (*HP* III 7.6 and *HP* IV 7.2), he never returns to the topic of truffles. Here we can feel the limits of the Peripatetic approach to the study of animals and plants. Of course, Theophrastus does not have the option to treat mushrooms and truffles as a class of perishable living beings distinct from both animals and plants since he approaches perishable life starting from the basic distinction between animals and plants. Like Aristotle, he does not think there is room for an intermediate class of perishable living beings. But there is at least one other point that is worth stressing in connection with mushroom and truffles. Beginning a systematic study of plants from these creatures would be a complete non-starter. Even if Theophrastus does not say so, we can venture to say that starting a study of plants from mushrooms and truffles would have been equivalent to engaging in a study of animals starting from alien creatures such as the octopus and the cuttlefish. His view is that we must begin our study from those plants that display all the relevant bodily parts and display them in an especially clear way. So we must begin our study of plants from trees. To be a tree is to have roots, a single stem, many branches, and twigs (non-uniform parts). A tree also displays the partition into bark, core, fibers, and veins (uniform parts). Finally, most trees have leaves, flowers, and fruit (annual parts). In short, all three kinds of parts we are required to study are “present *above all* [μάλιστα]

<sup>71</sup> The reference is to *HP* I 1.9.

<sup>72</sup> Theophrastus, *HP* I 1.11.

in trees.”<sup>73</sup> We can try to capture the force of this statement by saying that this tripartition is not only most appropriate but also most evident in trees.<sup>74</sup> Hence, we must focus *first* on how these body parts are realized in trees. We will turn to the study of the other kinds of plants that either do not display this tripartition or display it in a less clear and less perfect way *only at a later stage*. We will find out our account of these other kinds of plants by relying on the results achieved in the study of trees.

## 7 Analogy in the Study of Plants

Analogy is the explanatory tool that enables Theophrastus to make progress in his study of plants. A couple of passages taken from the discussion of *uniform parts* illustrate how he makes his transition from the study of animals to the study of plants by means of analogy:

Fibers and veins have no special names in relation to plants, *but they are known in virtue of the resemblance they share with the parts in animals* [τῆ δὲ ὁμοιότητι μεταλαμβάνουσι τῶν ἐν τοῖς ζώοις μορίων].<sup>75</sup>

The wet and the hot are the primary things: *every plant has some amount of innate moisture and heat, just like [every] animal* [ἅπαν γὰρ φυτὸν ἔχει τινὰ ὑγρότητα καὶ θερμότητα σύμφυτον, ὥσπερ καὶ ζῶον]. When their moisture or heat fall short, then age and decay ensue; when they fail altogether, death and withering. *Now, while in most plants the moisture is without a name, in some it has a name, as we have said. The same thing happens in the case of animals. The moisture of blooded animals alone has a name. This is why they are also divided with respect to this by privation: some animals are called blooded while others [are called] bloodless* [ἐν μὲν οὖν τοῖς πλείστοις ἀνόνομος ἡ ὑγρότης, ἐν ἐνίοις δὲ ὀνομασμένη ὥσπερ εἴρηται. τὸ αὐτὸ δὲ τοῦτο καὶ ἐπὶ τῶν ζῴων ὑπάρχει. μόνη γὰρ ἡ τῶν ἐναίμων ὑγρότης ὀνόμασται. διὸ καὶ διήρηται πρὸς τοῦτο στερήσει. τὰ μὲν γὰρ ἄναιμα τὰ δὲ ἐνάιμα λέγεται].<sup>76</sup>

Let us begin our discussion from the second passage. We have already seen that, very early on in *HA*, Aristotle claims that all animals are supplied with

<sup>73</sup> The main division adopted here is not between external and internal parts but rather between uniform and non-uniform parts. Compare Theophrastus, *HP I* 1.12.

<sup>74</sup> Theophrastus seems to make a comparative claim with each of the other large kinds taken one by one. In other words, the partition into uniform and non-uniform parts is more appropriate (and more evident) in trees than in shrubs; it is more appropriate (and more evident) in trees than in under-shrubs; it is more appropriate (and more evident) in trees than in herbaceous plants.

<sup>75</sup> Theophrastus, *HP I* 2.3. <sup>76</sup> Theophrastus, *HP I* 2.4–5.

some inner moisture, the privation of which results in death.<sup>77</sup> We have also seen that Aristotle regards aging and decaying as processes that involve loss of inner moisture and loss of vital heat. For Aristotle, becoming old amounts to becoming increasingly dry and cold. Finally, death is equated by him with the complete loss of vital heat and moisture.<sup>78</sup> In light of all this, it is not surprising to discover that Theophrastus adopts the same theoretical framework in his study of plants. Note, however, that Theophrastus introduces the notion of innate heat and innate moisture with reference to animals: every plant has some connate moisture and heat, *just like [every] animal* (ὡσπερ καὶ ζῷον). At first sight, one might be tempted to think that Theophrastus is making a generic reference to a more familiar case (animals) without any reference to a specific truth established in the study of animals. What follows in our passage, however, suggests a different, indeed more interesting, scenario. Theophrastus has in mind a precise distinction. This is the distinction between *blooded* and *bloodless animals*. Moreover, he adopts the way in which this distinction is established in the study of animals to suggest that a similar procedure should be employed in the study of plants. More directly, we have a name for the most common moisture in animals: *blood*. The presence of blood (and what we would call a cardiovascular system) can be used to distinguish blooded animals from the other animals collectively known by means of a privative term: “bloodless animals.” Theophrastus is self-consciously invoking the adoption of a similar procedure for the study of plants. In a few cases, we have a name for the moisture present in plants. But whenever the name is not available, we should make recourse to a privative term as we do in the case of bloodless animals.

There is no need to see a reference to any specific passage in the zoological corpus by Aristotle. What we have here is something more interesting and at the same time more meaningful, namely the reference to a scientific procedure that is regarded as common practice in the early Peripatos. This procedure has been fully worked out for the study of animals and is now adopted for the study of plants. As we move from the study of animals to the study of plants, we ought to remain mindful of the fact that we are dealing with a different subject matter. At most, we can expect to find a few resemblances. Of course, they should not be taken to be resemblances we find in things that belong to the same kind (either

<sup>77</sup> Aristotle, *HA* I 4, 489a20–21. More on this in [Chapter 3, Section 2](#).

<sup>78</sup> [Chapter 2, Sections 4 and 5](#).

specific or generic resemblances); rather, they are the sort of resemblances we find in *analogous* cases.

It is time to turn to the first passage cited above, where we are told that fibers and veins have no special names in relation to plants and are also invited to adopt the designations used for the equivalent parts in animals. The mention of animals gives Theophrastus the opportunity to return to the claim that plants present special challenges to the investigator because the kind taken is manifold (πολύχουν). What follows is another methodological statement emphasizing the importance of analogy:

Since it is by means of what is better known that we ought to pursue the unknown, and better known are the things that are larger and more obvious to sense-perception, it is clear we must speak about these things in the way indicated: *we will trace the other things back to these [sc. the better known] to the extent and in the manner in which each of them participates in likeness* [ἐπαναφορὰν γὰρ ἔξομεν τῶν ἄλλων πρὸς ταῦτα μέχρι πῶς καὶ πῶς ἕκαστα μετέχει τῆς ὁμοιότητος].<sup>79</sup>

This methodological principle is formulated in very general terms: we need to start from what is better known, which is also what is more easily accessible and more obvious to sense-perception. We will use what is better known as our model and standard of inquiry as we turn to the things that are not known. We will do so by exploiting the similarities that exist between the two kinds of things. Note, however, that the reference to similarity is carefully qualified: “to the extent and in the manner in which each participate in likeness.” Given the context, the things that are still unknown must be the bodily parts *in plants*, whereas the things that are better known and clearer to sense-perception must be the equivalent bodily parts *in animals*. Once more, we cannot (indeed, should not) expect that plants can be completely mapped onto animals even though the study of the latter can provide us with some of the conceptual resources we employ in the study of the former.

At this point, it should be clear that for both Aristotle and Theophrastus the study of animals is prior to the study of plants in the way in which the study of blooded animals is prior to the study of bloodless animals. Moreover, it should also be clear that analogy is the tool that Aristotle employs to engage in a study of the less perfect and less complete kinds of animals (bloodless animals); his study is conducted in light, and indeed on the basis, of the results reached in the study of the more perfect or more

<sup>79</sup> Theophrastus, *HP I* 2.3–4.

complete kinds of animals (blooded animals). Finally, it should be obvious that Theophrastus too make use of analogy to deal with a less perfect and less complete kind of living beings (plants) in light, and indeed on the basis, of a more perfect and more complete one (animals). Aristotle and Theophrastus are committed to biological gradualism. Both acknowledge that there is some important continuity in nature.<sup>80</sup> Still, they consider this continuity to be fully compatible with the view that animals and plants are different kinds of perishable living beings. They are different kinds of perishable living beings because they constitute different levels of perishable life. As a result, they agree that animals and plants ought to be studied separately.

Analogy is the tool that enables Aristotle and Theophrastus not only to make progress in the context of their separate studies of animals and plants but also to go beyond those separate studies. Let us concentrate on the case of Theophrastus. His use of analogy in *HP I* does not eliminate the differences that exist between animals and plants and does not obscure the fact that we are dealing with two separate subject matters, namely animals and plants. In other words, analogy does not entail the reduction, let alone the elimination, of the existing differences between animals and plants. On the contrary, the whole point of using analogy is to recognize these differences. Animals and plants remain distinct domains of investigation, but there is nonetheless something that holds the same place or plays the same functional role in each of them. We are quite distant from the mindset adopted by the Hippocratic author of the work *On the Nature of the Child*.<sup>81</sup> While scholars have often credited this unknown author with analogical thinking, his account of the formation and development of the human embryo does not suggest a self-conscious use of analogy. By contrast, in the *HP* we find not only a self-conscious use but also a fully developed theory of analogy. This is no coincidence: analogy is an explanatory tool specifically designed to deal with reality without reducing or eliminating its complexity.

## 8 Plants As Ensouled Beings

I would like to conclude this chapter by addressing a concern a perceptive reader may have about the reading I have developed so far. This concern

<sup>80</sup> The famous dictum *natura non facit saltus* can be traced back, ultimately, to the Peripatetic study of living beings.

<sup>81</sup> See [Chapter 1, Section 1](#).

can be presented in the following terms: a commitment to the existence of different forms of life is registered in Aristotle's *De anima*; by contrast, we do not find an explicit commitment to this effect in Theophrastus. The latter never says *expressis verbis* that plants are a different kind of ensouled beings, let alone that they are ensouled beings. Moreover, there are no explicit references to Aristotle's *De anima* in his whole botanical corpus. This silence is quite remarkable for someone who is supposed to be working within the theoretical framework established by Aristotle. Shouldn't we take this silence as circumstantial evidence that Theophrastus is in fact trying to mark his distance from Aristotle?<sup>82</sup>

To begin with, I would like to recall that the absence of any explicit reference to Aristotle's *De anima* is in line with the self-consciously impersonal style that Theophrastus adopts in his own writings on plants. We have already seen that there is no explicit reference to any of the writings by Aristotle in his whole corpus of writings on plants. And yet we have seen that we cannot make sense of Theophrastus's overall approach to the study of plants without assuming that Aristotle's *De anima* is a foundational text for him as well. Consider, once more, the brief reference to mushrooms and truffles.<sup>83</sup> Theophrastus regards them as a difficult or odd case. They are mentioned to point out how unwise it would be to study plants starting from there. Our best hope is to deal with mushrooms and truffles by employing some of the resources developed for the study of the other plants. If we develop a powerful enough set of tools, we should be able to make sense of difficult cases. Dealing with these cases may even turn out to be an indirect vindication of the overall approach to the study of plants. What is especially interesting is that Theophrastus does not even consider the option of placing mushrooms and truffles in a group of their own, distinct from both animals and plants. This theoretical option is simply not available to him. From the very start of his study Theophrastus appears to operate with the distinction between animals and plants. However, without the study of the soul offered in Aristotle's *De anima* as theoretical background, this distinction would be far from a compelling one. In fact, there would be no theoretical need to conduct separate studies of animals and plants.

<sup>82</sup> This striking silence is often registered in the secondary literature as implying, if not open disagreement, at least some distance from Aristotle. See, for example, [HARDY-TOTELIN 2016: 67](#). For an attempt to answer my question in the negative with arguments that only in part overlap with those I offer in this section, see [REPICI 2000: 200–211](#).

<sup>83</sup> Theophrastus, *HP* I 1.11.

One may still object to this conclusion by noting that Theophrastus never says that plants are *ensouled*. Theophrastus credits plants with *the nutritive power* (τὸ θρεπτικόν), but he does so without crediting them with a soul.<sup>84</sup> On this reading, Theophrastus ends up occupying a position that is not too far from the one subsequently adopted by the Stoics (among others), who claimed that plants have a nature (φύσις) but they do not have a soul (ψυχή).<sup>85</sup>

I take this objection very seriously. While I cannot rule out that Theophrastus may be able to ascribe a nutritive power to plants without ascribing them a soul, two passages offer circumstantial evidence that this is not the case. While this textual evidence is not as clear as we would like it to be, it goes some way toward addressing the concern prompted by Theophrastus's silence on the topic of the soul of plants. The first passage is from the short but difficult essay traditionally known as Theophrastus's *Metaphysics* (I note, in passing, that a better title for this text would be *On the First Principles*). There, Theophrastus lists animals, plants, and *things without a soul* (ἄψυχα) in this very order.<sup>86</sup> This is emphatically not a random list of things; rather, it is a list in which the relevant items are ordered in accordance with their distance from the first principle. It is natural to read into this list a *scala naturae* ending with inanimate things. Animals and plants are on this list as separate kinds of *ensouled* beings; as such, they are to be contrasted with *things without a soul*. The second passage is found in his writings on plants. In connection with the study of flavors, Theophrastus tells us that we should begin our investigation with those that appear in *things without a soul* (ἄψυχα) and only then continue with those found in plants and fruits.<sup>87</sup> Again, the implicit contrast is between ensouled things and things that have no soul (soulless things), with plants as one kind of living being.

I would like to end by noting that we do not have to take Theophrastus's silence as evidence that he is trying to mark his distance from Aristotle. It is open to us to read into this silence a sign that *Aristotle and Theophrastus not only share the same research program but they also work within the same*

<sup>84</sup> Theophrastus, *CP* I 12.5. I offer a full discussion of this passage in [Chapter 5, Section 3](#).

<sup>85</sup> The debate on whether plants are ensouled was very much alive not only before but also after Aristotle. Recall the view registered in Aëtius, *Placita* V 26.1–3 (= *Dox. gr.* 438.4–20):

The Stoics and the Epicureans [hold that] plants are not ensouled: some creatures partake in the impulsive and appetitive soul, others also in the rational soul, but plants move spontaneously and not on account of the soul.

For more on the context in which this testimony is embedded, see [Chapter 1, Section 1](#).

<sup>86</sup> Theophrastus, *Metaph.* 9a10–15.      <sup>87</sup> Theophrastus, *CP* VI 3.3.



*theoretical framework.* On this reading, the fundamental truth that plants are ensouled beings is a given that need not be recalled; rather, this biological truth performs for Theophrastus the function of an implicit starting point that is at work in his writings while remaining in the theoretical background.

## *Theophrastus on the Generation of Plants* (Causes of Plants I)

### 1 Introduction

In [Chapter 4](#), I argued that beyond their shared decision to study animals and plants separately, and to study them in this order, Aristotle and Theophrastus adopt a few common rules of inquiry in their investigations of animals and plants. With a concentration on *HP I*, I argued that Theophrastus develops an account of what he takes to be the paradigmatic case of plants and then uses that account as his starting point for a study of what he takes to be more difficult cases. In [Chapter 3](#), I showed that Aristotle employs a similar strategy in the context of his study of animals, and that he does so both at the pre-explanatory and the explanatory stage of inquiry.

The rationale for this shared strategy is found in a fragment from Aristotle's lost *Protrepticus*:

Prior things are always more knowable than posterior things, what is better in nature [is more knowable] than what is worse: *there is knowledge more of what is organized and determinate than of their opposites*.<sup>1</sup>

There are two ways in which things can be prior and more knowable: either by nature or relative to us.<sup>2</sup> Aristotle is concerned with what is prior and more knowable by nature. Such things are identified with those that have a higher level of internal organization. It is because these things are more organized that they are also more intelligible by nature. The idea formulated in this fragment is very general and is meant to apply to everything that can be an object of knowledge. So it is not immediately clear how this idea can be applied to the study of perishable living beings. My suggestion is that the more organized and more determinate perishable living beings

<sup>1</sup> Aristotle, *Protr.* B 33 Düring (Iamblichus *Protr.* 38.7–8 and *De comm math sc.* 81.7–11).

<sup>2</sup> For example, Aristotle, *APo* I 2, 72a1–5; *Phys.* I 1, 184a16–20; *Metaph.* VII 3, 1029a3–5; *NE* I 3, 1095a2–4.

are those that display a higher level of organic unity. In other words, Aristotle and Theophrastus begin their separate studies of animals and plants from biological systems that display a higher level of organic unity. If this suggestion is accepted, we can use the terminology offered in this fragment to make the following claims:

1. Animals display a higher level of organic unity than plants, so they are better by nature than plants; as a result, they are also more knowable by nature than plants.
2. Certain kinds of animals display a higher level of organic unity than other kinds of animals, so they are better by nature; as a result, they are also more knowable by nature than these other kinds of animals.
3. Certain kinds of plants display a higher level of organic unity than other kinds of plants, so they are better by nature; as a result, they are also more knowable by nature than these other kinds of plants.

These claims do not only establish a definite *scala naturae* among perishable living beings; they also determine an order of inquiry that we are required to follow as we engage in a systematic investigation of the phenomenon (or rather phenomena) of perishable life. We are required to begin our investigation of perishable living beings with the study of animals rather than plants, and the study of animals with the study of blooded rather than bloodless animals, with a focus on live-bearing rather than egg-laying animals, and in particular on the human animal; last but not least, we are required to begin our study of plants with the study of trees rather than less perfected forms of plant life such as shrubs, under-shrubs, and herbaceous plants.

In [Chapter 4](#), I argued that Theophrastus follows a common Peripatetic practice when he organizes the complexity of the botanical data by dividing plants into large kinds. I suggested that he embarks on the study of plants with the help of a few nominal definitions based on the visible characteristics of plants. He warns us to take those definitions with a grain of salt because of the plasticity of plants. In fact, because of their remarkable variability in appearance, plants resist any hard and fast classification based on morphology. Hence, our division into large kinds, as well as our initial definitions of those kinds, represent at most a first approximation to the complexity of the natural world. In brief, they are distinctions made in outline.<sup>3</sup> Still, by starting his investigation with a few nominal definitions and an outline of the task that lies ahead of us, Theophrastus gives us a first

<sup>3</sup> Theophrastus, *HPI* 3.5.

orientation, as well as an initial conceptual framework, to engage in an intelligent and fruitful study of the complexity of the world of plants. By doing so, he embraces a key methodological insight advanced in Aristotle's *Posterior Analytics*. According to the theory of inquiry outlined in this work, we cannot search for an explanation or a definition of *X* unless we have an initial grasp of *X*.<sup>4</sup> If I am right, the inquiry into plants is largely controlled by the theory advanced in Aristotle's *Posterior Analytics*. In this chapter, I would like to continue my search for procedures of inquiry that are shared in the early Peripatos. I will do so by turning to the investigation that Theophrastus offers in *Causes of Plants* (*CP*). I will focus on the first book, with a concentration on the explanatory strategies Theophrastus deploys in his attempt to account for the different modes of plant propagation.

A few preliminary words on the project of *CP* are in order before embarking on such a project. To begin with, the Greek manuscript tradition has transmitted us a *CP* in six books.<sup>5</sup> Since this treatise is explicitly concerned with the search of the causes of plants, it belongs to the  $\delta\iota\omicron\tau\iota$ -stage of inquiry. Taken together, *CP* I and *CP* II offer explanations of facts about plants that can be traced back to their nature. What matters is not only the specific nature of plants but also the nature of the habitat in which they live. This ecological approach is prominent in *CP* II, where we are introduced to the idea that plants have a fitness for a certain location.<sup>6</sup> In this context, the concept of a proper place becomes central. Constitutive of a proper place are causal factors such as the nature of the soil, the presence or absence of moisture, and the exposure to winds and to the sun. The discussion of how these causal factors interact with the nature of the plant includes a brief discussion of adaptation to a particular location.<sup>7</sup> What Theophrastus says at the very end of *CP* II reveals how *CP* I and *CP* II contribute to a single explanatory project:

*With respect to other properties of trees, and [in general] plants, we should try to pursue their study starting from trees, considering the essence of each of them and the nature of the region [in which each of them lives]* [ὑπὲρ δὲ τῶν ἄλλων ὄσα

<sup>4</sup> See Chapter 4, Section 4.

<sup>5</sup> I refer the reader to Chapter 4, Section 2 for how our *CP* in six books may relate to the lost Hellenistic edition of *CP* in eight books documented in the catalog of Theophrastus's writings preserved by Diogenes Laertius.

<sup>6</sup> On Theophrastus as a forerunner of ecological thought, see HUGHES 1985: 296–306 (reprinted in FORTENBAUGH-SHARPLES 1998: 67–75).

<sup>7</sup> Theophrastus, *CP* II 13.1–2. Theophrastus notes that adaptation to the surrounding environment can be observed in plants as well as in animals.

συμβαίνει τοῖς δένδροις ἢ φυτοῖς πειρατέον ἐκ τῶν δένδρων μετιέναι καὶ θεωρεῖν τὴν ἰδίαν οὐσίαν ἐκάστου λαμβάνοντος καὶ τὴν τῆς χώρας φύσιν]. In this way, the common attributes, the variations according to the different kinds, and what is convenient and proper to each [of them] become clear. But we also ought to be able to study what is similar and identical [across different plants], since many different plants do not seem [after all] to be different, just like in other domains.<sup>8</sup>

To fully appreciate what we are told in this passage, we should keep in mind one of the main results achieved in [Chapter 4](#) – namely, that our systematic study of plants begins with a study of trees. The results reached in the study of this large kind can be adopted, and indeed adapted, as we turn to less developed forms of plant life. While *CP I* is concerned with the nature of plants, *CP II* is about the impact of the habitat on plants. Human intervention becomes the object of study in *CP III* and *CP IV*. In these books, Theophrastus concerns himself with cultivation, plantation, and in general how domestication alters the nature of a plant. The complementary nature of *CP I–II* and *CP III–IV* is made explicit at the outset of *CP III*, where we are told that the study of plants consists of two complementary investigations: while the first has its starting point in nature, the second focuses on human ingenuity and contrivance.<sup>9</sup> *CP V* completes the project in two ways. *CP V 1–7* deal with anomalous phenomena whose explanation can be traced back either to the nature of the plant, even though they represent a deviation from its natural behavior, or to the effects of an art that aims at producing fruit of a special and extraordinary character (e.g., growing a grape cluster that has no stones). *CP V 8–18* complement the discussion with a treatment of diseases in plants and the causes of death. We are left with *CP VI*. This book is announced as a systematic study of natural juices and odors. By “natural juices and odors,” Theophrastus means juices and odors that can be traced back to the properties of plants. To understand why Theophrastus discusses juices and odors together, we must keep in mind how he explains their respective generation. A juice is a mixture of a dry and earthy components in a liquid. It is naturally generated when some water is filtered through dry and earthy components. When those dry and earthy components present in the juice are diffused in the transparency of air, they give rise to an odor.<sup>10</sup> In other words, juices and odors share the same dry and earthy components, which make

<sup>8</sup> Theophrastus, *CP II* 19.6.

<sup>9</sup> Theophrastus, *CP III* 1.1. The same idea is repeated in *CP II* 1.1 and *CP V* 1.1.

<sup>10</sup> Theophrastus, *CP VI* 1.1.

themselves felt to us either through water or air. *CP* VI and the essay *On Odors* are two extant pieces of a large-scale investigation of juices and odors.<sup>11</sup>

## 2 Theophrastus on the Propagation of Plants in *CP* I

At the outset of *CP* I, Theophrastus states his overall explanatory goal:

We have spoken earlier *in the historiai* [ἐν ταῖς ἱστορίαις] about the *modes of generation in plants* [τῶν φυτῶν αἱ γενέσεις], [stating] that they are more than one, how many they are, and what they are. However, since these modes of generation are not present in all plants alike, *it is appropriate [for us] to distinguish which modes occur in what kinds of plants and on account of what causes, employing principles that are appropriate to the essential nature of each of them* [οἰκείως ἔχει διελεῖν τίνες ἐκάστοις καὶ διὰ πόιᾶς αἰτίας, ἀρχαῖς χρωμένους ταῖς κατὰ τὰς ἰδίᾶς οὐσίας], for our [explanatory] accounts ought to agree directly with the stated facts.<sup>12</sup>

There is a great deal that is interesting in this passage. To begin with, Theophrastus announces a study of modes of generation. The plural is significant because plants can propagate in more than one way. It is not unusual for the same kind of plant to propagate in several ways, so part of the task that Theophrastus sets for himself in *CP* I is to explain which modes of generation occur in which kinds of plants and why. Moreover, Theophrastus refers to the results reached earlier in his ἱστορίαι. The plural is a reference to the data collected rather than to the activity of collecting them. Those data can be found in *HP* II 1–4 (domesticated trees and, more generally, domesticated plants) and *HP* III 1 (wild trees). I do not capitalize the word “ἱστορίαι” because I see no compelling reason to take this word to be a reference to the traditional title of the work. Finally, we should resist the temptation to give a merely chronological meaning to the adverb “earlier” (πρότερον). Instead, we should apply the Peripatetic insight that the scientific enterprise proceeds in stages and the collection and organization of the relevant data come before their explanation.<sup>13</sup> This methodological insight is subordinated to an even more fundamental one: a proper study of perishable living beings must be approached via separate studies of animals and plants. It is because of this second insight that the Peripatetic tradition has left us two scientific enterprises rather than one: a study of animals and a study of plants, both organized into a ὄτι- and

<sup>11</sup> I refer the reader to [Chapter 4, Section 2](#). <sup>12</sup> Theophrastus, *CP* I 1.1.

<sup>13</sup> See [Chapter 3, Section 2](#).

a διότι-stage of inquiry. At the outset of *CP*, we are about to approach the διότι-stage of the Peripatetic study of plants.

The task that lies ahead of us is looking for causal explanations – namely, explanations that single out the relevant causes (αἰτίαι). We are told that these explanations must agree with the facts. I take this statement to be equivalent to saying that our explanations must do justice to the complexity of the data collected in *HP II 1–4* and *HP III 1*. This goal can be achieved only by finding out causes that are specific to the different kinds of plants. This entails, in turn, looking for explanations starting from the essential natures – the Greek term is οὐσίαι – of the different kinds of plants. Theophrastus considers the various οὐσίαι to be explanatorily primary. In other words, the essential natures of the different kinds of plants are his starting points in the explanation of their various modes of generation. It does not take long to see that Theophrastus is endorsing *explanatory essentialism* – namely, the view that essences understood as basic, necessary, and universal features play the role of first principles in the explanation of the per se accidents (that is to say, the other necessary and universal features) of the relevant things. Explanatory essentialism is at the heart of the Peripatetic theory of scientific explanation. At this early stage of our inquiry we do not know what goes into the essence of a given plant. But we should think, for a start, about morphology – namely, the organization of the various parts of plants, including the presence or absence of a given part. In due course, however, we will discover that there is more than morphology to the essence of a plant.

After this opening statement, Theophrastus outlines three modes of generation in plants:

- (1) generation from seed
- (2) spontaneous generation
- (3) generation from a part.

This tripartition should not be taken to be exclusive. Theophrastus does not mean to say that if a plant is generated from seed, it cannot be generated spontaneously or from a part. There are plants that appear to be generated from seed as well as spontaneously. This should not trouble us, Theophrastus adds, because we observe the same phenomenon in animals. Like plants, some animals come to be from other animals as well as from the earth.<sup>14</sup> In connection with this last claim by Theophrastus, the reader will find a note in their preferred translations

<sup>14</sup> Theophrastus, *CP I 1.2*.

of *CP*, with a reference to what Aristotle says in the context of his account of spontaneous generation.<sup>15</sup> In *GA* III II, which is the official treatment of spontaneous generation, Aristotle tells us that some hard-shelled animals come to be spontaneously as well as from the spermatic fluid they emit:

the nature of some hard-shelled animals is constituted spontaneously, while others emit some power from themselves. However, these animals too often come to be from a spontaneous constitution. [*To understand this phenomenon*] we must grasp the modes of coming to be of plants [δεῖ δὴ λαβεῖν τὰς γενέσεις τῶν τῶν φυτῶν]. While some plants come to be from seed, others come to be from slips that are planted out, and still others come to be by side-shoots (e.g., the kind of onions). Now, mussels come to be in this way, since small ones keep growing by the side next to their source. Whelks, purpuras, and those creatures that are said to honeycomb emit a slimy fluid as if it were originating from a spermatic nature.<sup>16</sup> However, *none of this is to be thought to be seed, but it bears resemblance with plants in the manner stated above* [σπέρμα δ' οὐθὲν τούτων δεῖ νομίζειν ἀλλὰ κατὰ τὸν εἰρημένον τρόπον μετέχειν τῆς ὁμοιότητος τοῖς φυτοῖς]. That is why a multitude of such animals come to be once one has come to be.<sup>17</sup>

To fully appreciate the remarks made in this passage, we must keep in mind that, according to Aristotle, hard-shelled animals are creatures that occupy an intermediate position between animals and plants.<sup>18</sup> It is, therefore, not surprising to see that Aristotle tries to account for the way (or rather ways) in which these creatures reproduce by recalling the different modes in which plants propagate. He claims that some plants reproduce from seed, while others do so from a slip or by side-shoots. Moreover, he uses this last remark to explain how mussels reproduce: small ones keep growing by the side next to their original source in a way that resembles the propagation of plants by side-shoots.

In [Chapter 4](#), I argued that for Theophrastus the analogy between plants and animals is essential to get his study of plants off the ground. I added that Theophrastus adopts some of the results achieved in the study of animals not only to lay out the task ahead of him but also to speak about plants. In fact, it is difficult to imagine how Theophrastus could have proceeded in his investigation of plants without relying on those results. This passage from *GA* III II enriches our understanding of the relation between the separate studies of plants and animals envisioned in the early

<sup>15</sup> EINARSON-LINK 1976: I 6nd; AMIGUES 2012: 130n7.

<sup>16</sup> The verb κηριάζειν is formed from κηρίον (honeycomb). According to Aristotle, these animals secrete a slimy mucous substance displaying a structure like that of a honeycomb.

<sup>17</sup> Aristotle, *GA* III II, 761b23–762a2. <sup>18</sup> Aristotle, *GA* I 23, 731b8–15.



Peripatos. It suggests that the analogy between animals and plants can play an explanatory role not only as we progress from the study of animals to the study of plants but also when we are concerned with borderline cases such as that of hard-shelled animals, the propagation of which seems to bear some resemblance to the way plants propagate. In connection with this claim, it is worth stressing that these intermediate cases do not occupy a gray area between the study of animals and plants. In other words, we should not approach this text with the idea that there are three kinds of perishable creatures: animals, plants, and intermediate living beings. Rather, for both Aristotle and Theophrastus, there are only two kinds of perishable living beings, namely animals and plants, with borderline cases such as hard-shelled animals falling on the animal side of the border. In this scenario, analogy understood as an explanatory tool can work both ways – not only from animals to plants but also from plants to animals.<sup>19</sup>

Still, it remains true that, as a rule, the order of investigation is from animals to plants rather than vice versa. It is significant that in *CP* Theophrastus begins his account by saying that, just like plants, some animals come to be from other animals as well as from the earth. Something analogous happens at the outset of *HP*, where Theophrastus adopts (and adapts) the theoretical framework that Aristotle outlines for the collection and organization of the relevant zoological data. In both cases, we should refrain from reading actual cross-references in his statements. Theophrastus is not interested in referring us to a particular treatise, let alone to a particular passage in a particular treatise, by Aristotle. His references are self-consciously impersonal. They are primarily meant to activate knowledge that his reader is expected to have acquired *before* embarking on the study of plants. Furthermore, these references need not have chronological significance. Even if it is very likely that Theophrastus wrote on plants after Aristotle wrote on animals, his references to the study of animals are better understood as evidence that the study of plants follows the study of animals in the order of investigation. Following a certain order of investigation does not imply any claims as to when the treatises reporting the results reached in those investigations were written. It is this order of investigation that makes it possible for Theophrastus to appropriate what is established in the account of the generation of animals. When Theophrastus says that some animals reproduce from seed as well as spontaneously, he can reasonably expect his

<sup>19</sup> But I hasten to say that this is the exception rather than the rule. Analogy is for the most part asymmetrical. I will return to this issue in [Chapter 6, Section 5](#).

reader to be familiar with the case of the hard-shelled animals that come to be in more than one way. He can also expect his reader to see in the modes of generation of these animals an instance of the Peripatetic insight that nature proceeds in a succession of steps without gaps, to the point that in certain borderline cases it may be difficult for us to tell whether the living thing is a plant or an animal.<sup>20</sup>

### 2.1 *Plant Propagation in Outline*

The main challenge Theophrastus faces as he turns to the explanation of how plants are generated is that plants propagate in more than one way. Right from the start of *CP*, he speaks of modes of generation (plural) rather than generation (singular).<sup>21</sup> The three modes of generation outlined in the [previous section](#) are discussed separately, beginning with generation from seed. This mode of generation is discussed first because it is the most common. While short, this discussion is not without interest because Theophrastus invokes the teleological principle that nature does nothing in vain.<sup>22</sup> We have encountered the most precise formulation of this teleological principle in connection with Aristotle's explanation of animal locomotion.<sup>23</sup> In all probability, this explanatory principle originated in the context of the study of animals. However, its methodological significance goes emphatically beyond the narrow boundaries of zoology. Already in Aristotle we find the claim that this is a general principle for the study of nature rather than a special principle that holds for the study of animals. Consider, in particular, how Aristotle introduces three explanatory principles to be used in the explanation of animal locomotion (one of them is the principle that nature does nothing in vain):

We begin our investigation by positing those [principles] that we are accustomed to employing often in natural investigation *assuming that things*

<sup>20</sup> Aristotle, *HA* VII (VIII) 1, 588b4–30. Virtually the same point is repeated in *PA* IV 5, 681a10–15. More on this passage and its theoretical implications in [Chapter 1, Section 2](#).

<sup>21</sup> Aristotle does the same in the passage when he invokes the modes of generation (γενέσεις) in plants to explain how some hard-shelled animals propagate. I refer the reader to the passage quoted earlier in this section.

<sup>22</sup> Theophrastus, *CP* I 1.1: “nature does nothing in vain.” See also *CP* II 1.2, where Theophrastus says that “nature does nothing in vain and thought aims to help nature [ἡ φύσις οὐδὲν ποιεῖν ματῆν, ἢ τε διάνοια βοηθεῖν θέλει τῇ φύσει].” In this context, it is worth recalling another, closely related, teleological principle: “nature has always an impulse toward the production of the best.” For this principle, see Theophrastus, *CP* I 16.11: ἡ δὲ [φύσις] ἀεὶ πρὸς τὸ βέλτιστον ὁρμᾷ.

<sup>23</sup> [Chapter 3, Section 4](#).

occur in the same manner in all nature's works [λαβόντες τὰ τοῦτον ἔχοντα τὸν τρόπον ἐν πᾶσι τοῖς τῆς φύσεως ἔργοις].<sup>24</sup>

What we read in Theophrastus confirms that the principle that nature does nothing in vain has a more general application. It also suggests that this principle is best understood as a Peripatetic rather than Aristotelian principle of inquiry. While the principle takes a general form, it must be understood with reference to a certain nature or other. When a plant produces a seed, we must expect that the seed has the power to produce another plant of the same kind. If not, the nature of that plant would have done something in vain.<sup>25</sup>

Let us turn now to generation from a part, which is unique to plants in the sense that plants alone can be generated from one of their parts (a branch, a twig, a side-shoot, or a root). This mode of generation must be traced back to the specific nature of plants: unlike animals, plants have life everywhere. This is a refrain we hear many times in Aristotle.<sup>26</sup> It is also a view shared by Theophrastus. He mentions it right at the outset of his research to demarcate the study of plants from the study of animals.

To speak in general, as we have said, we should not assume that [the growth of plants] is in all respects the same as in the case of animals. This is why the number of their parts is indeterminate: [*a plant*] has the power to sprout everywhere because it is alive everywhere [πανταχῆ γὰρ βλαστικόν, ἅτε καὶ πανταχῆ ζῶν].<sup>27</sup>

The statement highlighted in italics may suggest that all plants are generated from a part. In fact, we should resist such a generalization since not all plants are generated from a branch, a twig, or a side-shoot. There are plants that can be generated from a twig or a side-shoot but not from a branch.

<sup>24</sup> Aristotle, *IA* 2, 704b12–14. What Aristotle tells us in this passage is fully compatible with the fact that the explanatory principles he is about to introduce find their clearest application in the study of animals. It is very likely that these principles were first discovered and formulated in the context of the study of animals and then extended to other areas of natural philosophy on the crucial assumption that “things occur in the same manner in all nature’s works.” See LEUNISSEN 2010: 119–134 and FALCON 2021a: 1–18.

<sup>25</sup> The literature on how the principle that nature does nothing in vain should be understood is very large. In addition to LENNOX 1997: 199–214 (reprinted in LENNOX 2001a: 205–223), see LEUNISSEN 2010: 115–135; HENRY 2013: 225–263; GOTTLIEB-SOBER 2017: 246–271; STAVRIANAS 2021: 165–193; and RANGOS 2021: 233–265. For the application by Theophrastus of this teleological principle to the study of plants, see WÖHRLE 1985: 84–94.

<sup>26</sup> Aristotle, *Long.* 6, 467a18–30; *Juv.* 2, 468b5–9; *PA* IV 6, 682b30–32. The first passage is discussed in Chapter 2, Section 4. For the second, see Chapter 2, Section 5.

<sup>27</sup> Theophrastus, *HP* I 1.3.

In this context, Theophrastus reiterates his commitment to explanatory essentialism: the different modes of generation ought to be traced back to the specific essences of the different kinds of plants.<sup>28</sup> This time, however, he gives us an outline of the relevant explanation: none of the plants that have a dry nature and are single stemmed admit of propagation either from a side-shoot or a twig or a branch. More to the point: those that have a single stem do not admit of propagation from a side-shoot, whereas those that have a dry nature do not admit of propagation by either a branch or a twig. The Greek text is difficult and possibly corrupt. If we accept the text printed by the most recent editor of *CP*, the next sentence adds the following thought: it is the lack of proportion in the amount of innate heat and innate moisture that explains why single-stemmed plants and plants that do not have side-shoots cannot propagate by means of a part. These plants cannot propagate in this way because of a lack of balance in the amount of connate heat and connate moisture.<sup>29</sup> The implication is that those plants that display the right amount of innate heat and innate moisture can propagate because they can preserve this right balance of heat and moisture in all their parts. This explains why some of them can grow even from a detached part (e.g., the fig tree). At the very least, we can say that the innate moisture of a plant is taken to be an essential feature of the plant to the effect that a scientific explanation of how the plant propagates should be derived from there.

I have spoken of an “outline of the relevant explanation” because Theophrastus is very clear that he has given us a general account and has delineated the main lines of his account.<sup>30</sup> I take “general” (καθόλου) and “in outline” (ἐν τύπῳ) to work together. The account offered so far does justice to the facts observed and collected in the *HP*. Furthermore, this account establishes the role of seeds in generation and acknowledges that some plants are generated spontaneously. Finally, it explains why certain plants can be generated from a part (either a side-shoot, a twig, or a branch). In sum, there is

<sup>28</sup> Theophrastus, *CP* I 1.3.

<sup>29</sup> Theophrastus, *CP* I 1.4: καὶ ταῦτα μὲν διὰ τὰς εἰρημένους αἰτίας, τὰ δὲ ἀπαράβλαστα καὶ μονοφῆ ἀσυμμετρία τινὶ τοῦ θερμοῦ καὶ ὑγροῦ. δέχεται [δὲ] τὰς ἄλλας [ἀ] δύναται τηρεῖν τὴν ὑγρότητα καὶ θερμότητα τὴν ξύμφυτον. In addition to supplying two words, Amigues (following Wimmer) prints ἀσυμμετρία instead of συμμετρία, which is the reading transmitted by the manuscript tradition. The alternative reading – printed by Benedict Einarson, who follows Theodore Gaza and Julius Scaliger – retains the reading συμμετρία but considers the words ἀπαράβλαστα and μονοφῆ to be an intrusive gloss. Here is the text printed by Einarson: καὶ ταῦτα μὲν διὰ τὰς εἰρημένους αἰτίας, τὰ δὲ [ἀπαράβλαστα] συμμετρία τινὶ τοῦ θερμοῦ καὶ ὑγροῦ [καὶ μονοφῆ] δέχεται καὶ τὰς ἄλλας [sc. γενέσεις].

<sup>30</sup> *CP* I 1.3: “let this be defined in this manner in general [καθόλου] and in outline [τύπῳ].”

nothing provisional or tentative in the explanatory work done in *CP I* 1–3. And yet a great deal of detailed information is still missing. In this sense, we have been given only a “general” (καθόλου) account. But insofar as it delineates the main lines of an explanation – that is, insofar as it is ἐν τύπῳ – this account is as complete as it can possibly be at this early stage of our inquiry.<sup>31</sup>

Theophrastus contrasts the expressions λέγειν ἐν τύπῳ and ἀκριβολογεῖσθαι.<sup>32</sup> Since ἀκριβολογεῖσθαι is equivalent to “speaking with precision,” one may be tempted to take λέγειν ἐν τύπῳ as equivalent to “speaking without precision.” Recall, however, that a general account (a καθόλου account) is as precise as it can possibly be without dealing with what is specific about the specific cases. At the level of generality at which we are now, there is nothing tentative or provisional about this account. The only way to achieve more precision is by adding details. But the relevant details become available only when we go beyond the καθόλου account to discuss what is specific about the particular cases (τὰ καθ’ ἕκαστα).<sup>33</sup>

Let us take stock: an explanation in outline, or a general account, gives a first and necessary orientation toward the final explanation. As such, it is a first and necessary stage in the δίοτι-stage of explanation. All this confirms, indeed refines, the Peripatetic insight that the scientific enterprise unfolds in stages. In addition to a ὅτι- and a δίοτι-stage of inquiry, we now see that the scientific enterprise admits of further articulation within the δίοτι-stage of inquiry. The scientific enterprise not only advances from a ὅτι- to a δίοτι-stage of inquiry but also progresses in stages within the δίοτι-stage of inquiry. As will become fully apparent in a moment, reaching the final explanation, which is based on the ultimate essence of the thing, as required by explanatory essentialism, is a complex business requiring recourse to a combination of explanatory procedures.<sup>34</sup>

## 2.2 *Plant Propagation in Detail*

The details that are missing in our outline are supplied in *CP I* 2–7. To begin with, a notable exception to the rule is discussed: the date-palm. This tree has a single stem, a dry nature, and no side-shoots; it can nevertheless

<sup>31</sup> For the use of expressions such as λέγειν (or εἰπεῖν) ἐν τύπῳ and λαμβάνειν (or λαβεῖν) ἐν τύπῳ in the early stages of Theophrastus’s study of plants, see *HP I* 1.6; *HP I* 2.2; *HP I* 3.2; *HP II* 6.12.

<sup>32</sup> Theophrastus, *HP I* 3.5; *HP I* 4.3.

<sup>33</sup> For a clear instance of speaking first in general (λέγειν καθόλου) and in common (κοινῶς) and then speaking about particular cases (λέγειν κατὰ μέρος/καθ’ ἕκαστου), see the opening statement of *HP I* 5.1.

<sup>34</sup> For a brief but helpful introduction to the stages of scientific inquiry in Aristotle (with reference to the theory of theory of science outlined in the *Posterior Analytics*), see [GOTTHELF 2012C: 371–398](#).

propagate in ways other than by seed.<sup>35</sup> The explanatory procedure adopted in this case is reminiscent of how Aristotle proceeds in his study of animals. Like Aristotle, Theophrastus deals with exceptional or difficult cases as soon as an explanation is in place. His goal is to show how they fit within the explanatory framework provided for the other cases. Theophrastus has outlined an explanation for trees that have a single stem, a dry nature, and no side-shoots. He now deals with a *prima facie* exception, and indeed a potential challenge, to his general explanation. He shows how this apparent exception to the rule can be explained once a few additional facts that are unique to the date-palm are considered. What seems to be relevant in this case is the habitat in which this kind of plant grows, which is described as rich in food and tending to promote sprouting.

Although brief, this discussion is instructive for at least two reasons. First, it shows that a plant is not studied in isolation from its habitat. Quite the opposite: the habitat – the Greek term is *χώρα* – is taken to be a primary explanatory factor as Theophrastus tries to account for what is distinctive, or even unique, about a given plant. What is taken to be explanatorily primary is traced back to the essence of the plant, so we must conclude that a reference to the habitat features in the essential nature of the plant. Admittedly, this expansive understanding of what counts as the essence of a plant is surprising. To mitigate this surprise, it is worth stressing that a similar explanatory procedure is already in place in Aristotle's study of animals. Like Theophrastus, Aristotle at times takes the habitat of the animal to be a primitive fact and a starting point for his explanations.<sup>36</sup> Second, this discussion helps us see how dealing with an exceptional case (and dealing with it immediately after outlining his general explanation) is not a digression but an important part of the main task, which is to account for the complexity of the world of plants. By showing how a difficult case can fit the outline of the explanation, Theophrastus is able to strengthen the case for this explanation.<sup>37</sup>

<sup>35</sup> Theophrastus, *CPI* 2.1–4.

<sup>36</sup> Here is one example taken from the theory of animal locomotion: egg-laying four-footed animals like lizards bend their legs obliquely and away from their body because they are hole-dwellers (*IA* 15, 713a16–25). In this case, the *explanandum* is the unique way in which a group of animals bends their legs. The explanation is given by taking the way of life – what Aristotle calls the *βίος* – as the starting point of the explanation. For a discussion of this aspect of Aristotle's explanatory strategy, I refer the reader to LENNOX 2010a: 239–258 and GELBER 2015: 267–293. For an in-depth discussion of *IA* 15, see JANSEN 2021: 266–281.

<sup>37</sup> Let us return, once more, to the explanation of animal locomotion for an instance of the same strategy in Aristotle's study of animals. Crabs appear to be a notable exception to the general rule

As soon as the discussion of a *prima facie* exception to the general explanation is in place, Theophrastus turns to a detailed account of which plants are generated from which parts. In this stretch of text Theophrastus applies the explanatory strategy already adopted in the context of his general account. He explains the specific mode of propagation, starting from what he takes to be explanatorily primary. What is taken to be explanatorily primary is traced back to the substance or essence of a plant. For example, the fig tree can propagate by a twig because its extremities are by nature tender and moist. These extremities preserve the *living principle* (ζωτική ἀρχή), which has to do with their innate moisture and heat. By contrast, propagation by a twig is rare in the case of the almond tree because of its overall dry nature. Finally, this mode of generation is outright impossible in the case of the bay tree because of a combination of two features that are specific to this plant: the dryness of its nature and the open texture of its wood. The latter feature does not help preserve the limited internal moisture present in the bay tree. By contrast, the combination of a moist nature and a close texture in a plant is ideal for its propagation by a part other than seed. The olive tree is mentioned in this context because its close texture and oily nature explains why its extremities remain tender when they are cut. Having an oily nature, the cuttings of an olive tree do not dry out quickly. However, the olive tree cannot propagate by a branch.<sup>38</sup>

As a rule, trees propagate by means of side-shoots when the roots are shallow and do not penetrate deep in the ground, or when, in their root system, there is a combination of deep and shallow roots. In addition, there must be an accumulation of moisture in the root system, which is concocted by the sun. What is set up by the sun results in a κύημα, which eventually sends out a new growth.<sup>39</sup> To understand how Theophrastus envisions this process, we must recall what Aristotle says in *GA* on the topic of κύημα. In a recent, helpful essay, Ignatio de Ribeira Martín has shown that Aristotle uses the term σπέρμα to refer to the first mixture (the first κύημα) that contains the generative contributions coming from the male and the female.<sup>40</sup> While this passage has often been regarded as a possible

that animals progress *forward*. In fact, they seem to progress *diagonally* (*IA* 14, 712b16–712b21). Aristotle explains this apparent anomaly away by pointing out that the eyes of crabs are implanted on their two sides. In other words, crabs move obliquely with respect to us but forward relative to themselves. They move forward relative to themselves because their eyes are implanted on the parts that functionally operate as the front of the animal. Upon reflection, what appeared to be a *prima facie* challenge to the general rule ends up strengthening it. For an explanation of how crabs displace themselves and what this explanation means for the general theory, see JANSEN 2021: 266–281.

<sup>38</sup> Theophrastus, *CPI* 3.1–3.

<sup>39</sup> Theophrastus, *CPI* 3.4.

<sup>40</sup> Aristotle, *GA* I 18, 724b12–19.

interpolation, De Ribeira defends its authenticity.<sup>41</sup> Far from creating a textual problem, this apparently anomalous use of σπέρμα suggests that there is a genuine Aristotelian notion of seed, and indeed of κύημα, that is common to both animals and plants regardless of their mode of reproduction.

In the theory of animal reproduction, the κύημα is the first mixture of the female and the male: that which is first set up and is ready to grow.<sup>42</sup> Moreover, depending on the mode of generation, this mixture is either an embryo, a fertilized egg,<sup>43</sup> or a grub. Like animals, plants have a κύημα, and this is their seed (σπέρμα). This conclusion is confirmed by what Aristotle says in the following passage:

In plants too these potentials are mixed, and the female and the male principles are not separate. As a result, they generate from themselves and emit not semen [γονή] but rather a κύημα – what we call seeds [σπέρματα].<sup>44</sup>

Immediately after our passage, Aristotle goes on to recall the following line from the lost poem of Empedocles: “*the tall trees lay their eggs, olives, first.*” Aristotle cites this line with approval because fertilized eggs are an instance of κύημα. In his view, fertilized eggs are analogous to seeds in plants, so there is more than a grain of truth in the Empedoclean claim that trees lay eggs. Far from taking a poetic license, Empedocles points to the existence of an important analogy in nature between plants and animals – or so Aristotle would like to read Empedocles. In a moment, we will see that Theophrastus recalls the same Empedoclean fragment in *CPI*. For the time being, what is immediately relevant is that “κύημα” is a technical term in the Peripatetic study of perishable living beings. When they speak of κύημα, Aristotle and Theophrastus mean that which is first set up and can grow. The side-shoots are an instance of κύημα because they have the power to send out a new growth. They grow in the root system of the plant whenever the right conditions are in place. Once more, the roots are to be close to the surface, and there is to be enough moisture coming together at the right time. Theophrastus goes on to say that there is nothing fixed about the place where a side-shoot appears in the root system because the

<sup>41</sup> DE RIBEIRA 2019: 87–124. For the view that the passage is not authentic, see PECK 1942: 76. Drossaart Lulofs prints the text in square brackets in his edition of Aristotle’s *GA*. In the *apparatus criticus* he indicates that he follows Peck (“*secl. Peck*”). BALME 1992: 145 defends the authenticity of the transmitted text but does not explain how this passage contributes to Aristotle’s argument.

<sup>42</sup> Aristotle, *GA* I 20, 728b32–34.

<sup>43</sup> Wind-eggs are an instance of imperfect κύημα because they can grow only up to a point. Full discussion in DE RIBEIRA 2019: 105–107.

<sup>44</sup> Aristotle, *GA* I 23, 731a1–4.



right conditions for the formation of a κύημα obtain randomly. Plants such as the pear tree and the pomegranate tree have a large root system, so they can send up shoots not only close to their trunk but also at some distance from it – wherever the right conditions are present.

For Theophrastus, the explanation of how plants propagate must be given separately – namely, by considering the different modes of propagation. Still, the complexity of this task should not be underestimated. Within each mode of propagation there is a great deal of variation. Dealing with this variation requires the application of the explanatory strategy that Theophrastus has outlined in *HP*. A perceptive reader may have already noticed that Theophrastus offers his outline of the explanation for *trees* (δένδρα). This kind of plant is the primary focus when Theophrastus begins to fill out the relevant details because the relevant articulation is present in trees in the clearest possible way. However, as Theophrastus explains the various modes of generation beyond the paradigmatic case of trees, he no longer adopts any of the large groups of plants introduced in *HP* I 1.5. Rather, he speaks of “woody and herbaceous plants.”<sup>45</sup> Theophrastus is not as forthcoming as we would like him to be about his reasons for what looks like a change in strategy. We need to bear in mind, however, that the theory of scientific inquiry outlined in Aristotle’s *Posterior Analytics* requires the investigator to give explanations at the right level of generality. Presumably, the articulation of plants into shrubs, under-shrubs, and herbaceous plants is no longer useful in the context of the explanation of plant propagation. Hence, Theophrastus adopts the following, alternative procedure: he begins his explanatory work by focusing on the case of trees and subsequently extends some of the results achieved in the study of trees to the class of woody and herbaceous plants understood as a more convenient grouping for the sake of his explanatory concerns.<sup>46</sup>

In the transition from the study of trees to that of woody and herbaceous plants, Theophrastus is quite explicit about his overall strategy:

The other trees cannot do this [*sc.* fill out the space around them with shoots] to the same extent, but this phenomenon happens in certain woody and herbaceous plants. Since we have said enough on the topic of trees, our discussion must turn to these plants. *The modes of generation in these plants*

<sup>45</sup> This is not one of the largest kinds outlined at the outset of *HP*. For a close but not identical expression, see “woody plants and vegetables” at *HP* I 6.7.

<sup>46</sup> One might worry that this procedure creates a tension with the pre-explanatory stage of inquiry, which is supposed to prepare the ground for the explanatory work. This worry can be addressed if we keep in mind that the largest kinds of plants only provide a first orientation to the subsequent study. At the very least we can say that this division is not binding for Theophrastus.

*must be studied from the same considerations as before – namely by positing that the most common mode of generation, common to all, is generation from seed. But there is more than one mode of generation also in these plants. Each of them must be distinguished in so far as they have points of contact with what has been previously discussed* [τούτων δὲ τὰς μὲν γενέσεις ἐκ τῶν αὐτῶν θεωρητέον, κοινοτάτην πᾶσι τὴν ἀπὸ σπερμάτος τιθέντας. οὐ μὴν ἀλλὰ πλείους εἰσὶ καὶ τούτων, ἧ δὲ ἕκαστα τῶν προειρημένων ἐφάπτεται, ταύτη διαίρετέον].<sup>47</sup>

As Theophrastus moves away from trees, he extends the strategy adopted for the study of trees to the study of the remaining kinds of plants. Since there are several modes of propagation beyond that which is common to all plants – generation from seed – the focus will be on what is specific about the different modes of propagation in woody and herbaceous plants. There is a great deal of variety in the way in which these kinds of plants propagate: some woody and herbaceous plants propagate from their roots, others from a side-shoot, still others from a detached extremity. Theophrastus does not repeat himself as he deals with these kinds of plants. Rather, he offers a separate explanation of the various modes of generation with a focus on what is specific, if not even unique, about each of them. By so doing, he progressively fills out the general outline by accounting for how different kinds of plants are generated.

I will not engage in a detailed study of what Theophrastus accomplishes in this stretch of text. Instead, I would like to turn to his discussion of spontaneous generation, which is mentioned as one of the modes of generation at the outset of *CP* I. Theophrastus returns to it only when he has completed his discussion of generation from a seed or by a part other than the seed. By so doing, Theophrastus adopts an explanatory strategy that reminds us of one that Aristotle employs in his study of animal generation. Recall that Aristotle begins his account of animal generation by focusing on sexual generation. For Aristotle, this is the central case of animal generation. He turns to the study of spontaneous generation only when his account of sexual generation for live-bearing, egg-laying, and grub-producing animals is in place. This means that he deals with spontaneous generation only at the very end of *GA* III. Moreover, Aristotle approaches spontaneous generation by employing the theoretical framework developed for the study of sexual generation. It is worth recalling a key methodological passage taken from the beginning of *GA*:

As for the generation of the other animals [*sc.* those that do not reproduce sexually] we must speak about each of them according to the ongoing

<sup>47</sup> Theophrastus, *CP* I 3.5–4.1.

argument, *building it from what has been said* [ἀπὸ τῶν εἰρημένων συνείροντας].<sup>48</sup>

Theophrastus employs a similar strategy in his discussion of spontaneous generation in plants. He turns to this mode of generation only after he has completed his study of the other modes of generation. He too treats this mode of generation as an eccentric phenomenon. Right from the start, as he tries to make sense of this phenomenon, Theophrastus refers to the account of spontaneous generation given for animals:

To speak in general, [spontaneous generation] occurs when the earth is thoroughly warmed and the collected mixture is altered by the sun, *as we see also in the case of animals* [καθάπερ ὁρώμεν καὶ τὰς τῶν ζώων].<sup>49</sup>

The first-person plural in the words highlighted in italics is open to more than one reading. It may be taken to mean that spontaneous generation is in plain sight, and we all can observe this phenomenon in the case of animals. I am not persuaded by this reading. While it is true that ancient Greek zoogonies were committed to the spontaneous emergence of life from earth and water, spontaneous generation was emphatically not an obvious phenomenon.<sup>50</sup> Furthermore, Theophrastus describes it as beyond the reach of our senses.<sup>51</sup> *Spontaneous generation is something we see only when we are equipped with a certain theoretical framework.* Theophrastus seems to be gesturing at this theoretical framework when he mentions the sun as the proximate moving cause and the earth as the relevant material cause. This language reminds us of what we read in *GA* III 11. This does not mean, I hasten to add, that Theophrastus is referring his reader to *GA* III 11. Nor does it mean that he is blindly transferring results achieved in one field of study (animals) to another (plants). Theophrastus remains mindful of what is specific about plants and animals, which he considers from the outset to be two separate fields of study.

In his discussion of spontaneous propagation, Theophrastus seems to be largely concerned with *restricting* the genuine cases of spontaneous generation. Theophrastus reminds us that wind or water can import unseen seeds that can then grow under the appropriate circumstances. Far from being spontaneous, this propagation is analogous to sowing seeds and planting.<sup>52</sup> He also notes that there are many cases, especially among

<sup>48</sup> Aristotle, *GA* I 1, 716a2–4. <sup>49</sup> Compare Theophrastus, *CP* I 5.2.

<sup>50</sup> For more on the ancient Greek zoogonies in connection with the view that life emerges spontaneously from earth and water, see CAMPBELL 2014: 233–247.

<sup>51</sup> For this claim, see Theophrastus, *HP* III 3.1.5. <sup>52</sup> Theophrastus, *CP* I 5.3.

herbaceous plants, in which seeds are not evident to the naked eye but they become manifest in their subsequent effects (e.g., the growth of flowers). But even in large trees seeds may be difficult to observe, even by the expert eye. In the case of the cypress, for instance, this is not the round-shaped fruit but rather the thin and unsubstantial bran-like flake that is found in it.<sup>53</sup> Finally, in addition to propagation from unnoticed seed there is also propagation from a root, which is especially evident when the plants are very close to one another as in a wood.

Theophrastus ends his review of the putative cases of spontaneous propagation with the claim that additional data are needed.<sup>54</sup> At the very least, we can say that the corpus of writings that has been transmitted to us is not meant to be his last word on the topic of plants. Theophrastus acknowledges that more work is needed both at the *ὄτι*- and the *διότι*-stage of inquiry to fully account for the complexity of the world of plants. In particular, the Greek verb *ἀνιστορήσαι* (“to make an additional inquiry”) points to the need for a fresh collection of data with a focus on the putative cases of spontaneous generation. Additional data are needed for at least two reasons. To begin with, plants are a separate domain of investigation, so we cannot rely too heavily on what we know about spontaneous generation in animals. But there is also a tendency to rely too much on the phenomenon of spontaneous generation when it comes to how plants propagate. Theophrastus is critical of this overreliance. Scholars often read into his criticism an attack on Aristotle. I do not agree with them. First, his stance appears to be quite general, and I see no reason to read into it a criticism, let alone a revision, of what Aristotle says on the topic of spontaneous generation.<sup>55</sup> Second, Aristotle is concerned with spontaneous generation in animals. There is no evidence that Aristotle thinks that we can mechanically transpose what we have learned about spontaneous generation in one field of study to another. Third, like Theophrastus, Aristotle operates with the general rule of inquiry that all investigations should be tailored to their specific domain. At the very least, he must be ready to adapt his theory of spontaneous generation to fit the case of plants. More to the point: the first, and indeed crucial, step in this direction is the one that Theophrastus calls for – namely, a fresh collection of data. In sum, there is no textual evidence for the view that Theophrastus is targeting Aristotle’s theory of spontaneous generation in this stretch of text. One possibility is that Theophrastus is reacting to the special role assigned to spontaneous generation in the

<sup>53</sup> Theophrastus, *CPI* 5.4.    <sup>54</sup> Theophrastus, *CPI* 5.5.    <sup>55</sup> *Pace* AMIGUES 2012: 126.

early zoogonic accounts, where the emergence of life is often explained via the emergence of plants from mud.<sup>56</sup>

The account of the various modes of generation does not bring the discussion of plant propagation to a conclusion. Theophrastus continues with a long and rather technical discussion of grafting.<sup>57</sup> We are not told why grafting is discussed here rather than elsewhere. An educated guess is that grafting is an instance in which craft complements, indeed completes, nature. This is an insight that goes back to Aristotle.<sup>58</sup> After grafting, the treatment of generation in plants ends with a discussion of the seed of plants.<sup>59</sup> The seed of all plants contains within itself a certain amount of nutriment, which is generated together with the principle. Presumably, the principle in question is the vital principle (ζωτική ἀρχή). In this respect, the seed is just like a fertilized egg.<sup>60</sup> We have already seen that for Aristotle the seed is analogous to a fertilized egg – namely, the first thing that is set up (κύημα) and that from which a new living being grows. Like Aristotle, Theophrastus recalls the Empedoclean line where trees are compared to egg-laying animals: “*the tall trees lay their eggs.*” Theophrastus finds more than a grain of truth in this claim. Like Aristotle, Theophrastus takes Empedocles to offer an *analogy* that allows us to move from the study of animals to the study of plants.<sup>61</sup> Unlike Aristotle, however, he finds reasons for a criticism. It is the criticism of a student of nature who is engaged in a systematic study of plants and is concerned with making a statement that is as accurate and as general as possible. For Theophrastus, Empedocles is wrong because he has arbitrarily confined himself to the case of trees:

Empedocles has not put it badly by saying “*the tall trees lay their eggs*” [ῥοτοκεῖν μακρὰ δένδρα]. The nature of seeds is like that of eggs, *but he should have spoken about all plants and not only about trees* [πλήν ἔδει περὶ πάντων εἰπεῖν καὶ μὴ μόνον τῶν δένδρων].<sup>62</sup>

Theophrastus complains that Empedocles spoke about trees rather than plants. This is a remark made from the perspective of a student of nature engaged in a systematic study of plants and concerned with making statements that are as accurate and as general as possible. But we can safely say that the noun δένδρα does not have the same meaning for Empedocles and Theophrastus. For Theophrastus, this noun refers to a certain kind of

<sup>56</sup> More on this in [Chapter 1, Section 1](#). <sup>57</sup> Theophrastus, CP I 6.1–10.

<sup>58</sup> For this claim, see Aristotle, *Phys.* II 8, 199a15–17. <sup>59</sup> Theophrastus, CP I 7.1–3.

<sup>60</sup> Theophrastus, CP I 7.1.

<sup>61</sup> But it is far from clear that Empedocles meant to offer an analogy. See [Chapter 1, Section 1](#).

<sup>62</sup> Theophrastus, CP I 7.1.

plants as defined at the outset of *HP*. His definition offers us a first outline of the kind of plant that plays a special role in the collection, organization, and explanation of the botanical data.<sup>63</sup> When, therefore, Theophrastus says that Empedocles should have extended his discussion beyond the case of trees, he means to say that Empedocles should have extended the account developed for the paradigmatic case of plants to all kinds of plants. Put differently, Theophrastus reminds his reader that the ultimate scientific goal is to give a full account of the complexity of the botanical data to be approached via an application of the account developed for the paradigmatic case (trees). Stopping at the account of trees would be falling short of delivering on that front. But there is absolutely no reason to think that Empedocles was committed to this sort of principle. He appears to be innocent with respect to the explanatory concerns motivating the Peripatetic study of perishable life. It is difficult, if not impossible, to reconstruct the original context of his fragment. In all probability, Empedocles chose the word δένδρεα for metrical reasons and used it as a *pars pro toto*.<sup>64</sup>

Although brief and selective, the foregoing discussion highlights the existence not only of a set of explanatory strategies but also of a network of concepts shared by Aristotle and Theophrastus. The application of these explanatory strategies and the employment of these concepts, remarkable as it is, is no substitute for separate studies of generation in plants and in animals. Aristotle and Theophrastus agree that there is no way to arrive at a scientific understanding of the phenomenon of generation in animals and plants except by engaging in a study of what is specific about each of them. Contrary to what one might initially think, the main challenge faced in the study of generation in plants is not that plants lack the distinction between male and female.<sup>65</sup> This absence could be easily circumvented by invoking the Aristotelian observation that the seed is the first mixture of the male and the female – namely, the first κύημα.<sup>66</sup> The main challenge is rather that plants, unlike animals, propagate in a number of ways, and that they do so as a direct consequence of what is specific to their own form of life.

<sup>63</sup> I refer the reader to [Chapter 4, Section 3](#).

<sup>64</sup> The word δένδρεα consists of one long syllable followed by two short vowels (–UU). This works well for dactylic hexameter, the meter of didactic poetry. Both δένδρον and δένδρεα (coming from the Ionic form δένδρεον) are already well-attested Homeric terms. See also [Chapter 1, Section 1](#).

<sup>65</sup> For this claim, see Aristotle, *GA* I 23, 731a1–2; *GA* II 4, 741a3–5; *GA* III 10, 759b30–31; *GA* IV 1, 763b21–25. For the claim that whenever possible it is better for the male and the female *qua* principles of generation to be separated, see *GA* II 1, 732a6–11.

<sup>66</sup> Aristotle, *GA* I 23, 731a1–5.

Both Aristotle and Theophrastus agree that plants have life everywhere, so they can grow everywhere.

It is very telling that, from the beginning to the end of his account of the generation of plants, Theophrastus consistently speaks of *modes of generation*.<sup>67</sup> It is difficult to see how, by approaching generation on the working hypothesis that this phenomenon is to be studied in common for animals and plants, we could do justice to this aspect of plant life. The Peripatetic decision to deal separately, first with animals and then with plants, not only does justice to what is specific about generation in animals and plants; it also gives us a theoretical framework to deal with propagation in plants based on the results achieved in the study of reproduction in animals. At this point, we can fully appreciate the implications of the decision Aristotle makes at the outset of the theory of animal generation offered in his *Generation of Animals* when he tells us that plants must be studied separately by themselves.<sup>68</sup>

### 3 Growth, Sprouting, and Fructification

The systematic account of the various modes of generation in plants comes to a natural end with a discussion of the nature of seed. By the end of *CP* I 7, Theophrastus is confident that he has fulfilled the promises made at the outset of the book:

The *modes of generation* [γενέσεις] – how they occur, how many they are, and what modes are proper to what kind of plants – are clear from what we have said.<sup>69</sup>

What follows in the rest of *CP* I is a systematic treatment of growth, sprouting, and fructification. It does not take long to realize that a study of these processes is a natural, indeed inevitable, continuation of the study of generation (γένεσις). To see why, it may be helpful to return to Aristotle and his theory of animal generation.

Recall that Aristotle does not stop his account of animal generation at birth but treats generation as a single continuous process from a fully developed animal to another fully developed animal of the same kind.<sup>70</sup> The Aristotelian slogan that it takes a human being to generate a human

<sup>67</sup> Aristotle adopts the same language in *GA* III II, 761b26–27.   <sup>68</sup> Aristotle, *GA* I I, 716a1.

<sup>69</sup> Theophrastus, *CP* I 7.5.

<sup>70</sup> Chapter 3, Section 4. Additional information on Aristotle's explanatory strategy in *GA* is in GOTTHELF-FALCON 2017: 15–34. Compare LEUNISSEN-GOTTHELF 2010: 325–356 (reprinted as chapter 5 in GOTTHELF 2012a: 117–141).

being fixes not only the starting point but also the end point of the study of animal generation.<sup>71</sup> The study of the generative process starts from the parents and their particular nature and is not over until the generative process is also over. However, the generative process is over only when another fully developed animal of the same kind is in place. Theophrastus adopts a similar approach. Like Aristotle, he begins his investigation of plant propagation by taking the substantial being (οὐσίᾳ) of a fully developed plant as his starting point. As a result, the generation (γένεσις) of the plant is explained starting from its οὐσίᾳ rather than vice versa. Furthermore, like Aristotle, Theophrastus takes γένεσις to include all the natural processes that lead from one fully developed plant to another fully developed plant of the same kind. This explains why sprouting, flowering, and fructification are suitable topics of discussion in the context of *CP* I. Quite tellingly, Theophrastus speaks of sprouting as “second (as opposed to first) generation [γένεσις].”<sup>72</sup>

### 3.1 Growth and Sprouting

The first topic discussed in the second part of *CP* I is growth, with a focus on the remarkable variation that plants display in their relative speed of growth.<sup>73</sup> Two phenomena call for an explanation in connection with this: (1) within the same kind of plant, a plant grows faster from a slip or a root than from a seed, and (2) across different kinds of plants, some plants grow faster than others. The explanation of the first phenomenon is offered as reasonable (εὐλόγως): all the parts of the plant are already present in a slip, so these parts only need to grow; by contrast, the seed must first send out these parts. A similar point is made with respect to propagation from the roots as it happens in the case of bulbous plants. Bulbous plants already have large roots with a strong impulse toward sprouting. Hence, it is reasonable (εὐλόγως) that these plants grow faster and more efficiently from their roots than from a seed.

The explanation of the first phenomenon does not invoke the specific nature of the plant. This is not surprising because Theophrastus is trying to account for a variation within the same kind. Since all the plants within the

<sup>71</sup> I note, in passing, that Aristotle is happy to extend this important insight to plants. See Aristotle, *PA* II 1, 646b34: “it takes a human being to generate a human being, and it takes a [certain kind of] plant to generate a [certain kind of] plant.”

<sup>72</sup> For sprouting as second generation, see *CP* I 10.1. The expression “first generation” is used again in *CP* I 12.1 and *CP* I 12.4.

<sup>73</sup> Theophrastus, *CP* I 8.1–4.



same kind share the same nature, the difference in their relative speed of growth cannot be traced back to the nature of the plant. But as soon as Theophrastus compares the rate of growth across different kinds, he turns to the specific nature of the plant, which he treats as the primary explanatory factor. At the most general level, two ingredients are invoked as primary in the explanation of different rates of growth: openness of texture and innate moisture. Plants that are more open in texture and have more innate moisture grow faster. For instance, the pomegranate tree and the fig tree are rapid growers. By contrast, the date-palm, the cypress, and the olive tree are slow growers. These plants are slow growers because they have a close texture and a dry nature. The discussion of growth ends with the observation that growth from seed not only takes longer but is also not as efficient in the case of trees.<sup>74</sup>

Sprouting is the next topic on Theophrastus's agenda.<sup>75</sup> We are told that both early and late sprouting within the same kind and across different kinds call for an explanation. In some cases, early sprouting is due to the amount of nutriment. But we also know of early sprouting due to the weakness of the plants. For instance, herbaceous plants – and more generally, annual plants – sprout early. As in the case of growth, the variation in behavior in sprouting can be traced back to the specific nature of the different kinds of plants. Abundant moisture and an open texture give rise to early sprouting, whereas a dry nature and a close texture are found among late sprouters. Clidemus's view that the relative coldness or heat has an impact on the time of sprouting is recalled. According to the latter, plants with a colder nature sprout in summer, whereas those that exhibit a hot nature do so in winter. Theophrastus does not reject this claim, but his considered position is that early or late sprouting depends on a combination of factors: the relative heat and moisture of the plant, as well as its open or close texture. The weakness of the plant, the amount of nourishment available, and other conditions that can be traced back to the environment play the role of auxiliary causes (συναίτια).<sup>76</sup> The case of evergreen plants is discussed at the end. These plants constitute a well-demarcated group whose behavior can be explained in general terms (καθόλου). All the plants that belong to this group sprout and bear fruit later than all other plants because they have a dry nature and a close texture, and they do not shed leaves. Since they do not shed their leaves, they are required to distribute nutriment to their leaves all year round. As a result, no extra nutriment is left for early sprouting.

<sup>74</sup> Theophrastus, *CP I* 9.1–3.

<sup>75</sup> Theophrastus, *CP I* 10.1–7.

<sup>76</sup> Theophrastus, *CP I* 10.3.

What follows in the text is a discussion of plants that sprout and bear fruit all year round.<sup>77</sup> Theophrastus deals with an *aporia*, which he solves in three steps. First, Theophrastus traces the phenomenon of sprouting back to an essential feature shared by all plants: all plants have life everywhere, which explains why they can sprout everywhere.<sup>78</sup> Second, he notes that each sprout is like a plant in the sense that it has the power to grow in the tree just as the plant grows in the ground. Although all sprouts have the power to grow, they do not have the same power; rather, some grow faster than others. As a result, sprouting is not a simultaneous phenomenon.<sup>79</sup> Up to this point, Theophrastus has made a reference to facts that are common to all kinds of plants. The third and final step consists in invoking a feature that is uniquely possessed by ever-sprouting plants. This feature can be traced back to their specific nature. Like evergreen plants, these plants bring nutriment to their leaves all year around; unlike evergreen plants, their supply is so rich and continuous that, in addition to retaining their leaves, they can also generate new parts. Hence, they can generate new sprouts and bear fruit all year round.<sup>80</sup>

Establishing whether growth above and below ground takes place at the same time or rather at different times comes next in the order of explanation.<sup>81</sup> After reporting the reasons of those who argue that the roots grow in autumn and winter whereas the trunk and branches grow in spring and summer, Theophrastus reviews the arguments for a simultaneous growth of the upper and lower part of the plant. This is one of the most interesting stretches of text in *CP I*. Here Theophrastus invokes ideas and concepts that are familiar from reading Aristotle. He distinguishes the initial stage of generation from later stages of the same process. While in the *first generation* one part grows before the other in a definite sequence (the roots grow before the shoot), in the *second generation* the entire bulk of the plant not only feeds but also develops simultaneously and continuously everywhere. The analogy with animals is invoked to corroborate this point: in animals, too, the heart and the

<sup>77</sup> Theophrastus, *CP I* II.1–8.

<sup>78</sup> Theophrastus, *CP I* II.4. Theophrastus says that this is a feature that belongs to the οὐσία of all plants. We have seen that this is what makes plants another kind of perishable living being different from animals.

<sup>79</sup> Theophrastus, *CP I* II.4. <sup>80</sup> Theophrastus, *CP I* II.6–7.

<sup>81</sup> It is not immediately clear why this question is not addressed in the context of the discussion of growth, but it is postponed until after the treatment of sprouting. An educated guess is that since Theophrastus refers to sprouting in his attempt to answer this question, he considers the present order of study to be the optimal one for his overall argument.

parts around the heart are generated first but then the growth of the animal happens continuously and simultaneously.<sup>82</sup> As always, there is no explicit reference in Theophrastus to any text or claim made by Aristotle. But we do know that the order in which the different body parts are generated is a major concern in Aristotle's theory of animal generation. According to the account offered in *GA* II 6, the heart is generated first in blooded animals (and whatever is analogous to the heart in bloodless animals).<sup>83</sup> Right after the heart, the blood vessels extend from the heart and the upper part of the body in outline.<sup>84</sup> We can see here a reliance on results reached in the study of animals. These results offer a first orientation as we turn from animals to plants; they are also used to develop a set of tools that can be used to speak of the generative processes in animals and plants in analogous terms.

To be sure, there is an analogy between first generation in plants and first generation in animals. In both cases we are dealing with a generative process taking place in a definite sequence of steps. The same analogy holds when we move beyond what Theophrastus calls the first generation: just like animals, plants grow simultaneously everywhere. It would be absurd, Theophrastus says, if the nutritive power responsible for forming the plant should be active in some parts but not in others, or if the bodily instrument that it uses, either *pneuma* or the fire, should not reach all the parts of the plant alike. It is worth recalling the passage in its entirety:

Since it is also absurd if *the nutritive power* [τὸ θρεπτικόν], which forms [the plant] and gives nutriment [to what is formed] should divide its activity in accordance with the various part; or again, [it is also absurd] if that which carries out this activity, which is something bodily (either *pneuma* or fire) should do it, for it is unlikely that these [bodily things] should operate in this way either. But whenever they are jointly stirred by the season, they pervade all the plants alike.<sup>85</sup>

<sup>82</sup> Theophrastus, *CP* I 12.4. The Greek τὰ περὶ τὴν καρδίαν is a generic designation for the parts around the heart. Based on what we read in Aristotle's *GA*, we can be more precise: the blood vessels that extend from the heart.

<sup>83</sup> Aristotle, *GA* II 6, 742b35–743a1. Compare what Aristotle says on generation from the center of the living body in common for animals and plants (*Juv.* 3).

<sup>84</sup> Aristotle, *GA* II 6, 743a1–3: “the blood-vessels extend from the heart, as when artists sketch out preliminary figures on the walls. The reason is that the parts are arranged around the blood-vessels because they come to be from them.”

<sup>85</sup> Theophrastus, *CP* I 12.5: ἐπεὶ καὶ ἄτοπον εἶ τὸ θρεπτικόν, ὃ δὴ διαπλάττει καὶ δίδωσι τροφάς, διαίρεται κατὰ μέρη τὴν ἐνέργειαν, ἢ πάλιν εἴ τῶν σωματικῶν τὸ ἐνεργοῦν, οἷον πνεῦμα ἢ πῦρ, οὐδὲ γὰρ ταῦτα εἰκός. ἀλλ' ὅταν ἅμα ταῖς ὥραις κινήθωσιν, ὁμοίως δι' ὅλων διήκειν τῶν φυτῶν. In

Expressions such as “τὸ θρεπτικόν,” “τὸ φανταστικόν,” and “τὸ ὀρεκτικόν” are familiar from reading Aristotle, who uses them to refer to specific powers of the soul.<sup>86</sup> For Aristotle, the nutritive capacity (τὸ θρεπτικόν) is the most common power shared by all perishable living things insofar as they are ensouled beings.<sup>87</sup> The exercise of such a power requires a bodily instrument. Aristotle makes it clear that the nutritive power employs heat as an instrument for the concoction of food.<sup>88</sup> What matters most to him in this context is to be as clear as possible on the following crucial point: this bodily instrument alone cannot explain the phenomenon of nutrition and growth. His polemical targets are all those theories that explain nutrition and growth in a purely material way with reference to fire. For Aristotle, the efficient and final cause (αἴτιον) of nutrition and growth is an incorporeal power of the soul, while fire is at most a co-cause (συναίτιον).<sup>89</sup> While fire is required for processing food, the mere presence of heat does not suffice on its own to explain the phenomena of nutrition and growth.<sup>90</sup>

In the context of his study of animals, Aristotle is more specific about the bodily instrument used by the soul. For instance, toward the end of *GA* V 8, and in the context of his criticism of Democritus and his materialist explanation of the formation of teeth, he identifies this bodily instrument with *pneuma*, which he describes as an instrument (an ὄργανον) useful for many functions in natural processes like the hammer and anvil in the art of the smith.<sup>91</sup> One may wonder whether there are other functions that *pneuma* performs in Aristotle’s zoological theory beyond contributing to the explanation of the process of generation, nutrition, and growth. Consider Aristotle’s theory of animal motion, where *pneuma* is introduced as the instrument of animal

this exceptional case, I give the full Greek text. I follow the punctuation offered by Benedict Einarson. I also follow his translation (with only minor modifications). Suzanne Amigues appears to have a different understanding of our passage since she places a full stop after πῦρ (rather than after εἰκόσ). On her reading, Theophrastus is envisioning two *alternative* scenarios. In the first scenario, the nutritive power of the plant is responsible for the simultaneous growth of all its parts. In the second scenario, either fire or *pneuma* is the bodily principle responsible for the simultaneous growth of the plant. On this reading, our passage would establish a contrast between the incorporeal and the corporeal principle of life rather than positing the need for both for an adequate explanation of the growth of the plant.

<sup>86</sup> But note that these powers are not all on a par for Aristotle. For more on this point, I refer the reader to [Chapter 2, Section 2](#).

<sup>87</sup> Aristotle, *DA* II 4, 415a23–26. <sup>88</sup> Aristotle, *DA* II 4, 416b26–29.

<sup>89</sup> Aristotle, *DA* II 4, 416a13–14. <sup>90</sup> SHIELDS 2016: 206–207.

<sup>91</sup> Aristotle, *GA* V 8, 799b9–12: “it is also likely that the operation of *pneuma* is like an instrument for many things. As some instruments are of many uses to those involved in the arts (e.g., the hammer and the anvil in the art of the smith), so too is *pneuma* in those things that are naturally constituted.”

motion.<sup>92</sup> A full discussion of how Aristotle explains a single episode of animal motion goes emphatically beyond the scope of this book.<sup>93</sup> What matters most now is that the mechanism Aristotle envisions requires, in addition to a power of the soul, also the presence of a bodily instrument. The latter is *pneuma*, which is regarded as a non-expendable moved mover that works along with an unmoved mover (the relevant power of the soul) in each single episode of animal motion.<sup>94</sup>

It is against this background that we should read what Theophrastus says when he mentions the nutritive power along with fire and *pneuma*. Theophrastus is not envisioning two competing explanations of nutrition and growth without choosing between them – namely, one that invokes an incorporeal capacity (the threptic or nutritive power of the soul) and another that invokes a corporeal cause (either fire or *pneuma*). Rather, he is integrating the incorporeal capacity and the corporeal instrument into a single explanation. The nutritive (or threptic) power works together with the bodily instrument in the explanation of how nutrition and growth take place. Theophrastus does not decide whether this bodily instrument is *pneuma* or fire. Both are regarded as plausible candidates to carry out the relevant activity. His main concern is to stress that the threptic power along with its dedicated bodily instrument (whether it is fire or *pneuma* does not really matter to him) are not likely to perform their activity by taking one part of the plant at a time. When the right time comes – presumably, when springtime comes – they are jointly stirred into activity; as a result, they pervade the plant and act upon the whole of it in like manner.

Immediately after our passage, Theophrastus adds a criticism directed at Empedocles, who reportedly argued that earth is responsible for the growth of the roots and *aither* (which is equivalent to air in Empedocles's theory) for the growth of the shoots. Theophrastus rejects this explanation and argues that the growth of the plant requires a single matter and a single cause.<sup>95</sup> While it remains true that the weather has an impact on the growth of a plant (cold weather stops the growth of the plant while good weather triggers it), the plant grows everywhere because it has the

<sup>92</sup> Aristotle, *MA* 10, 703a5–28. For the claim that *pneuma* is an instrument of animal motion, see 703a20.

<sup>93</sup> For more on this topic, see [CORCILIUȘ-GREGORIC 2013](#): 52–97.

<sup>94</sup> I note, in passing, that thinking of *pneuma* as a non-expendable moved mover in a causal chain of motion may help us give some content to the anodyne term “co-cause” (συναιτίον) that Aristotle employs in *DA* II 4.

<sup>95</sup> Theophrastus, *CP* I 12.5.

principle of life everywhere. The connection between the principle of life, principle of growth, and principle of nutrition is made in the following passage:

All that is alive nourishes itself, and what has an impulse to grow grows as well: plants, both new and old, have an impulse to grow everywhere.<sup>96</sup>

Theophrastus's considered position seems to be something like this: plants grow all year round even though their growth may be held back by cold weather. When the mild season comes, plants not only grow but also put out shoots. His explanation of this behavior is that the twigs and branches contain sources of life (ἀρχαὶ ζωτικαί). The upper part of the plant is pregnant in winter, but it is the wet and warm weather that triggers these sources or principles of life to put out the shoots.<sup>97</sup>

This observation invites a question that is based on a comparison with animals. Theophrastus wonders whether what happens in plants is analogous to the fixed times of gestation and delivery observed in animals, or whether the behavior of plants is entirely controlled by the cycles of the seasons. Considering what happens to ever-sprouting plants in favorable climates, Theophrastus refrains from accepting the analogy with animals. There does not seem to be a fixed time of gestation in plants. Theophrastus goes on to offer the following, interesting, remark: "In our present cycle of seasons, trees are emptied in summer because of sprouting and fruiting, and then they are replenished again,<sup>98</sup> so as to be able, because of this *antiperistasis*, to bring forth fruit and to sprout at the right times, having somehow a gestation both in their parts and in their whole plant."<sup>99</sup> The term *antiperistasis* is known to us from Aristotle.<sup>100</sup> Aristotle criticizes Plato for explaining breathing and projectile motion by means of *antiperistasis*.<sup>101</sup>

In the *Timaeus*, Plato explains a number of biological and physical phenomena in terms of *antiperistasis*.<sup>102</sup> In addition to breathing and projectile motion, Plato lists acoustics, water currents, the descent of thunderbolts, and the alleged attraction exercised by amber and the lodestone.<sup>103</sup> Clearly, Aristotle wants to narrow down the acceptable uses

<sup>96</sup> Theophrastus, *CP I* 12.8.    <sup>97</sup> Theophrastus, *CP I* 12.9.

<sup>98</sup> Replenished with what? Recall that it is the nutritive power, via its bodily tools (either *pneuma* or fire), that controls growth, sprouting, and fruiting. Whatever is distributed to the extremities of the plant – let us call it nutriment – is entirely used up during sprouting and fruiting. As a result, the plant remains "empty." The plant is replenished once sprouting and fruiting are finally over.

<sup>99</sup> Theophrastus, *CP I* 13.3.    <sup>100</sup> Aristotle did not coin this term. See *Phys.* VIII 10, 267a15–16.

<sup>101</sup> Aristotle, *Resp.* 6, 472b6–31 and *Phys.* IV 8, 215a14–15.

<sup>102</sup> But Plato speaks of *περίωσις* (pushing around) rather than *ἀντιπερίστασις*.

<sup>103</sup> Plato, *Tim.* 79 A–80 C.

of *antiperistasis*. Still, he invokes it to explain meteorological phenomena such as winds.<sup>104</sup> He also employs it to explain how episodes of sleep occur in animals.<sup>105</sup> While Aristotle explain the alternation of periods of sleep and waking teleologically (sleep is for the sake of the preservation of the animals), he explains single episodes of sleep in non-teleological terms.<sup>106</sup> Something analogous happens in our passage. Sprouting and fructification are surely amenable to a teleological explanation. In *CP* I, Theophrastus speaks about these processes in terms that are unmistakably teleological. For instance, he is able to say that the fruit proper, namely the seed, is for the sake of the generation and perpetuation of the plants, or that the goal common to all plants is the production of the seed, since the end is the generation of another plant of the same kind.<sup>107</sup> He is also able to say that the outer covering that surrounds and protects the seed – the pericarp – is for the sake of the seed.<sup>108</sup> At the same time, however, he explains the cyclical occurrence of these processes in non-teleological terms by invoking *antiperistasis*. We do have the conceptual resources to combine the teleological and the *antiperistatistical* descriptions into a single coherent account: certain processes explicable in terms of *antiperistasis* must obtain if a given goal is to be reached.

### 3.2 *Fructification*

The discussion of fructification begins with the observation that there is a lack of correspondence between sprouting and fruiting: while most plants sprout at times very close to one another, and in the same season, they take longer to grow their fruit. Indeed, the ripening of the fruit happens at different times in different plants. Theophrastus explains this fact with reference to the matter involved in sprouting and fruiting: the

<sup>104</sup> Aristotle, *Meteor.* II 4, 360b22–26. <sup>105</sup> Aristotle, *Somn.* 3, 458a25–28.

<sup>106</sup> See the definition of sleep that Aristotle gives at the end of the work *On Sleep*. This is not only the final but also the most precise definition of sleep: “sleep is the paralysis of the first sense-organ preventing it from operating, and it occurs on the one hand [μὲν] of necessity – for it is not possible for the animal to exist should the conditions that produce it not obtain – and on the other hand [δέ] for the preservation of the animal” (*Somn.* 3, 458a28–32). *Antiperistasis* appears to be the crucial mechanism for the explanation of how an episode of sleep occurs when the conditions that produce it obtain. More on this in [FALCON 2019](#): 516–543.

<sup>107</sup> Theophrastus, *CP* I 16.1: “fruit and seed are for the sake of [χάριν] generation and perpetuation of the trees.” Compare Theophrastus, *CP* I 16.3: “the seed is the common goal [τέλος] of all plants since the end is the generation of the like.” See Aristotle, *DA* II 4, 414a28: the goal of reproduction is “the production of another like itself.” Compare *GA* I 4, 717a21–22. Finally, *GA* I 23, 731a24–26: “there is no function or activity in the being of plants other than the coming to be of the seed.”

<sup>108</sup> Theophrastus, *CP* I 21.1: “the seed is the goal [τέλος] and what is for the sake of something else [*sc.* the pericarp] must exist before that [*sc.* the seed].”

matter employed for their fruit is purer, especially that used for the juices in the fruit. As a result, the ripening of the fruit takes not only more work but also more time. Furthermore, the great variation in the time of ripening is a function of the different nature of the fruit: a fruit that has a woody, earthy, dry, or oily nature takes longer to ripen. For instance, the almond tree flowers early but keeps its fruit for a long time because it has a woody nature. Having a woody nature, its fruit is hard to detach from the tree.<sup>109</sup>

The discussion of the different behavior in sprouting, flowering, and fruiting continues with an explanation of the differences we observe when we compare domesticated and wild trees. Wild trees sprout earlier for a combination of causes: they retain more heat than domesticated trees because their soil is not dug up and the roots are not exposed to cold weather; moreover, unlike domesticated trees, their branches are not subject to pruning and thinning, so their generative principles are more numerous and more widely distributed even though they are smaller. And yet they fail to ripen their fruit, which creates an *aporia* because they are clearly stronger than domesticated trees. The solution is given by invoking, once more, a combination of causes. To begin with, the superabundance of fruit compensates for the superior strength of wild trees compared to domesticated trees. Moreover, the denser and drier nature of the moisture present in wild trees does not favor the ripening of their fruit. Theophrastus ends his discussion of the *aporia* by stating that, in general, it is not the case that the stronger organism, whether an animal or a plant, is also the more fertile, since the power and the strength that leads to the production of fruit, or to the generation of an offspring, is of a different kind.<sup>110</sup>

In connection with this statement, the editors of Theophrastus refer to a passage in *GA* I where Aristotle notes a difference even within the same kind of animals or plants: some have much seed while others have little seed, and still others have no seed at all, not because of illness but for the opposite reason – namely, because they are too healthy and too strong.<sup>111</sup> To make sense of this remark, we must keep in mind that for Aristotle the seed is a useful residue of nutrition. If most, or even all, nutriment is used up toward building a strong body, there is very little, or even nothing, left for the seed. It is not possible to establish whether

<sup>109</sup> Theophrastus, *CP* I 14.3–4.   <sup>110</sup> Theophrastus, *CP* I 15.3–4. Compare 16.5.

<sup>111</sup> Aristotle, *GA* I 18, 725b25–726a6. Both Einarson and Amigues refer to this Aristotelian passage in their vastly different editions of Theophrastus's *CP*.



Aristotle's ideas are in the background of *CP* I. Still, there is no doubt that the nutritive and the generative power are one and the same capacity for both Aristotle and Theophrastus. If, therefore, the nutriment is used for the body, it cannot be used for reproduction and vice versa.<sup>112</sup> In *GA*, for example, this truth is invoked to explain why small birds such as the fowls lay more eggs than the crooked-taloned birds. While in the latter kinds of birds the nutriment is used up for building strong wings, long feathers, thick legs, and a bulky body, in the former the nutriment is available for laying more eggs and laying them more often. In Aristotle's own words, "what nature takes from one place it gives to another place."<sup>113</sup>

Theophrastus appears to be committed to a similar principle when he claims:

It is not the case that the strongest animals are the most fertile; it is perhaps the opposite, since the power of the nutriment is diverted to either one result or the other, which is what happens also in plants, and it happens reasonably. We ought to take the analogy in the following way: whichever of the two results the animal or the plant sets out to do, there will be a deficiency in the other, since the animal or the plant cannot reach both. This is agreed perhaps in all cases.<sup>114</sup>

Aristotle and Theophrastus agree that nature operates in an analogous way in animals and plants. In both kinds of perishable beings, there is a limited amount of nutriment that must be used for different goals. There is, however, an important disanalogy. Theophrastus discusses it because it is immediately relevant to understanding the different behavior in fructification among wild and domesticated plants. In animals, the nutriment is used either to build the body or to produce the seed; in plants, the nutriment that is diverted to the fruit goes either to the fruit proper, which is the seed, or to the outer covering that surrounds it. Aristotle and Theophrastus coined a technical name for this covering: the pericarp (literally "what surrounds the fruit").<sup>115</sup> Theophrastus notes that the ripening of the fruit proper, namely the seed, and the ripening of the outer covering are contrary to one another: a bigger and juicier pericarp entails a smaller seed, whereas a bigger seed entails a smaller, harder, and

<sup>112</sup> Aristotle, *GA* III 1, 749b34–750a10.      <sup>113</sup> Aristotle, *GA* III 1, 750a3–4.

<sup>114</sup> Theophrastus, *CPI* 16.4.

<sup>115</sup> From Aristotle we learn that the pericarp (περικάρπιον) exists for the sake of the seed as it is its shelter (*DA* II 1, 412b1–4; *Phys.* II 8, 199a25–30). Theophrastus comes close to making a similar statement in *CP* I 19.3: "the pericarp [περικάρπιον] is for the preservation of the fruit in view of reproduction."

ill-flavored pericarp.<sup>116</sup> In wild trees, the nutriment goes to the seed, which is for the reproduction of another plant, at the expense of the pericarp. But in domesticated trees, husbandry diverts the nutriment from the seed to obtain a fleshier and juicier pericarp. The fleshy and juicy part that surrounds the seed is for human consumption.<sup>117</sup>

The treatment of fructification continues with a discussion of early and late bearers. Whenever the fruit is moist and surrounded by a thin membrane, the plant is an early bearer. Theophrastus illustrates this point with the help of the mulberry, which has a naked fruit and requires little help from the sun to ripen. The fruit of vine and fig trees ripens later than the fruit of the mulberry because it has a covering, and its fluid is greater in amount and thicker.<sup>118</sup> The discussion of early and late bearers continues with a general statement followed by a discussion of the relevant cases. This is in line with the Peripatetic strategy of offering a καθόλου explanation followed by a discussion of the relevant καθ'ἕκαστα. It is only the integration of the καθόλου and the καθ'ἕκαστα that gives us proper (*sc.* scientific) knowledge. A καθόλου explanation that is not followed by a discussion of the καθ'ἕκαστα is empty; by contrast, a discussion of the καθ'ἕκαστα that is not combined with a καθόλου explanation fails to do justice to the Peripatetic requirement that a scientific explanation must be given at the proper level of generality. In other words, the general or καθόλου account not only provides a theoretical framework for the discussion of the καθ'ἕκαστα but also highlights what the latter have in common.

At the most general level, early bearers are found among plants that produce a fruit that is neither cold nor fluid, is naked or wrapped in a thin covering, and has juices that, on ripening, are watery and not thick. By contrast, late bearers are found among plants that are full of cold fluids and that produce a woody or hard fruit that has juices that, on ripening, become oily. All these features slow down the concoction of the fruit. When we look at the particular cases, we find a confirmation of the general rule. All evergreen plants bear late fruit. For instance, the fruit of the pine tree or the cypress is dry and oily. If the fruit is not oily, it is viscous as in the case of the cedar tree. In all these cases, the fruit is hard to concoct because the viscosity and oiliness of its juices hinder concoction.

<sup>116</sup> Theophrastus, *CP* I 16.1.

<sup>117</sup> For more on the relation between the pericarp and the fruit proper, see Theophrastus, *CP* I 21.1–3.

<sup>118</sup> Theophrastus, *CP* I 17.1–3. Theophrastus does not mean the seed but rather the pericarp plus the seed, which is also called fruit.

Additionally, the hard texture of the tree makes the influx of nutriment to the fruit small. Among deciduous plants, the late bearers produce a fruit that is full of cold fluids. If the fruit is hard or woody, as in the case of acorns, it takes longer to concoct.<sup>119</sup> There exist exceptions to the rules: plants that should be early bearers turn out to be late bearers. These exceptional cases ought to be explained by taking into account what is specific about their nature. The smilax is offered as an example. This plant produces naked fruit, but it is a late bearer. This has to do with the specific nature of the smilax, which is naturally cold. As a result, the smilax is not only a late sprouter but also a late bearer.<sup>120</sup>

The discussion of early and late bearers continues with the impact of the age of the plant on fruiting. As a rule, young trees fruit late because of the abundance of inner moisture and fluid. However, there are also plants that are late bearers because of their advanced age. Moreover, too much moisture is not only a cause of late fruiting but, in a few plants, is also responsible for their failure to ripen the fruit. The case of the sycamore fig, which owing to the abundance of inner moisture cannot ripen its fruit unless the plant is scratched and smeared with oil, is recalled.<sup>121</sup> A discussion of the behavior of wild trees that fail to ripen their fruit (e.g., the wild figs and the so-called mad vine) follows in the text.<sup>122</sup> Theophrastus recommends that they be treated as different kinds of plants from their domesticated counterparts.

Toward the end of *CPI*, Theophrastus returns to the relation between the pericarp and the seed. Since the pericarp is for human consumption, it has a time limit that does not apply to the fruit proper (i.e., the seed).<sup>123</sup> Moreover, in all fruiting plants, the pericarp is produced before the fruit proper (the seed). A first reason for this differing timetable is that the seed is woody and takes longer to form. A second reason is that the pericarp is for the sake of the seed and so it comes to completion before the seed. The teleological relation that Theophrastus establishes between the seed and its outer covering is not new. We have already found it in Aristotle. We have seen that Theophrastus opens *CP I* with the claim that nature does nothing in vain and the seed is for the sake of the production of another plant of the same kind.<sup>124</sup> He comes back to this topic in our chapter with the claim that the relation between the pericarp and the fruit is to be

<sup>119</sup> Theophrastus, *CPI* 17.4–7.    <sup>120</sup> Theophrastus, *CPI* 17.8.    <sup>121</sup> Theophrastus, *CPI* 17.9–10.

<sup>122</sup> Theophrastus, *CP I* 18.3–4.    <sup>123</sup> Theophrastus, *CP I* 19.1–5.

<sup>124</sup> Theophrastus, *CP I* 1 combined with *CP* 16.1.

understood teleologically. Furthermore, while the ripening of the pericarp is easier because the sun and the air contribute to it, the ripening of the seed is the sole work of the nature of the plant. To the extent that it is possible, the nature of the plant aims at giving equal development to the pericarp and the seed, but whenever one develops more, the other develops less.<sup>125</sup>

<sup>125</sup> Theophrastus, *CP I* 21.1–2.

*The Invention of Biology?*I *Bios and Biology*

“Biology” is not an ancient word. On the contrary, it gained momentum only at the beginning of the twentieth century.<sup>1</sup> This term must have sounded quite strange if, in a public lecture delivered in London in 1876, Thomas Henry Huxley (1825–95) still spoke of “biology” as a “new-fangled denomination.”<sup>2</sup> In his lecture, Huxley defends the use of this neologism precisely because there is a “great analogy, [and] a very close alliance between those two sciences of botany and zoology . . . while they are much more widely separated from all other studies.”<sup>3</sup> Needless to say, the presence of a word means in itself very little. It is possible to have a word such as “biology” without having the concept of a science of living beings.<sup>4</sup> But it is also possible to have the idea of a science of living beings without having a name to designate it. This innocent observation creates the conceptual space for the following question: *Do Aristotle and Theophrastus, his younger colleague and immediate successor at the head of the Lyceum, have such an idea?*

<sup>1</sup> The early fortune of this term is reasonably well known. In Germany, Gottfried Reinhold Treviranus (1776–1837) adopted it to describe his project of a systematic investigation of “the various forms and manifestations of life” in 1802 (*Biologie: oder Philosophie der lebenden Natur für Naturforscher und Ärzte* [Biology or Else Philosophy of the Living Nature for Naturalists and Physicians] vol. I: 4). In France, in the same year and independently from Treviranus, in the introduction to his *Hydrogéologie, ou recherches sur l’influence qu’ont les eaux sur la surface du globe terrestre*, Jean-Baptiste Lamarck (1744–1829) employed it to carve out the conceptual space for a “theory of living bodies.” Treviranus and Lamarck did not invent this term. In Germany, Michael Christoph Hanov (1695–1773), a student of Christian Wolff, used the Latin term *biologia* in the title of the third volume of his compendium of natural philosophy entitled *Philosophia naturalis sive physica dogmatica* (published in 1766). Closer in time to Treviranus, Theodor George August Roose (1771–1803) used the term “biology” in connection with the doctrine of the vital force in the foreword to his *Grundzüge von der Lehre von der Lebenskraft* (*Fundamentals of the Doctrine of the Vital Force*) (published in 1797).

<sup>2</sup> HUXLEY 1877: 267.    <sup>3</sup> HUXLEY 1877: 268.

<sup>4</sup> Ernst Mayr reminds us, rightly and wisely, that coining the word “biology” does not *ipso facto* create a science of biology (MAYR 1982: 108).

If one ought to answer this question based on the scholarly practice of using the term “biology” in connection with Aristotle’s works on animals, the answer would have to be an unqualified “yes.”<sup>5</sup> What licenses this practice is the belief that while Aristotle concentrated his attention on the study of animals, he also created the very idea of a general scientific investigation of living beings.<sup>6</sup> Widespread as it is, this practice is not universally accepted. Historians of science have warned us against the danger of assuming the presence in the past of a scientific category such as biology that only makes sense today. While the deployment of this category creates the sense of a grand tradition of which we are the ultimate heirs, it also ends up giving us a distorted description of the past. In fact, the application of this category has the unwelcome consequence of obfuscating the existence of important differences. The most obvious is this: Aristotle operates with a conception of life that is a far cry from the one implicitly at work in our contemporary use of the term “biology.” His considered view is that there is plenty of life not only in the sublunary but also in the superlunary world. I mean not just the life of the heavenly bodies but also that of their separate unmoved movers. At the same time, Aristotle has self-consciously developed the conceptual resources to focus on perishable (sublunary) life to the exclusion of imperishable (superlunary) life.<sup>7</sup> At least in this respect, therefore, the application of the category of biology to Aristotle’s philosophy does not create an intolerable distortion of the historical truth. Still, one may legitimately wonder whether the realm of perishable life as conceived by Aristotle and Theophrastus displays enough unity and cohesion to allow for a systematic study of perishable living beings as such. In this concluding chapter I would like to return to the question of how Aristotle and Theophrastus describe their explanatory project and what their description (or descriptions) may entail for the larger question of how they conceive of what they are doing in their extant works on animals and plants.<sup>8</sup>

<sup>5</sup> Here are a few examples, listed in reverse chronological order and without any pretensions of being exhaustive: CONNELL 2021; MEYER 2015; TIPTON 2012; GOTTHELF 2012a; LENNOX 2001a; KULLMANN-FÖLLINGER 1997; GOTTHELF-LENNOX 1987. All these books have the words “Aristotle” and “biology” in their titles. SHARPLES 1995 extends the use of the term “biology” to Theophrastus.

<sup>6</sup> See the motivational prelude in LENNOX 2001a: x–xix. For Lennox, Aristotle created not only the science of biology as a discrete field of investigation but also philosophy of biology understood as a reflection on the norms of inquiry to be applied in the study of living beings.

<sup>7</sup> See [Chapter 1, Section 2](#).

<sup>8</sup> This is the strategy recommended by Andrew Cunningham for a truly historical study of the intentional activity that we call “science.” See the [Introduction](#).

Let me stress, first, that Aristotle and Theophrastus have both the conceptual and linguistic resources to create an abstract term equivalent to “biology.” If they wanted to, they could have coined such a word starting from the Greek noun “βίος.” At the most general level, this term designates a way or mode of life. When in the *Nicomachean Ethics* Aristotle famously distinguishes the contemplative life from the life of pleasure and political life, he speaks of three kinds of life: three βίοι.<sup>9</sup> This use of the term “βίος” is far from being an Aristotelian invention. We find it already attested in the *Philebus*, where Plato offers an evaluative comparison entailing three different *ways of life* (βίοι). They are the life of pleasure, the life of the mind, and the life that combines the two.<sup>10</sup> Plato looks at the relative merits of these ways of life and eventually chooses the third one. All this is well known and is also relatively uncontroversial.<sup>11</sup> What is often overlooked is that Aristotle and Theophrastus do not have to borrow the word “βίος” from an ethical context. This word is already available to them in the context of their own studies of animals and plants. For Aristotle, a βίος is the *way of life* that a certain kind of animal exhibits.<sup>12</sup> In the programmatic passage at the beginning of *HA*, Aristotle announces a collection of all the differences that animals exhibit with respect to “their modes of life [βίοι], their activities, their character traits, as well as their parts.”<sup>13</sup> When we look at what immediately follows in the text, we realize that the division into land and marine animals is the most basic distinction in the manner of animal life for Aristotle. This comes as no surprise considering that the habitat is a primary factor in controlling what goes into the βίος of an animal. For instance, there is such a thing as a marine βίος, and swimming is one of the most conspicuous activities contributing to that βίος. Of course, other features are relevant to the determination of any βίος, including the marine one. Among those that Aristotle mentions, I recall the features that relate to its behavior: whether the animal is a nocturnal or diurnal creature; whether it is a solitary, gregarious, or political being.<sup>14</sup>

<sup>9</sup> Aristotle, *NE* I 5, 1095b17–19. <sup>10</sup> Plato, *Phil.* 20 E–22 B.

<sup>11</sup> More examples of the use of the ancient Greek term “βίος” can be given. In the *Apology*, Socrates says that the unexamined life (βίος) is not worth living (βιοτός) for a human being. In this case, the style or manner of life is a βίος. For a fuller discussion of the use of the words “βίος” and “ζωή” in Plato, see [NAAS 2018](#): 164–183.

<sup>12</sup> The connection between the use of the term “βίος” in Aristotle’s ethical writings and the use of the same word in the context of his works on animals is still unexplored. An educated guess is that the ethical use of the term “βίος” is the original one.

<sup>13</sup> Aristotle, *HA* I 1, 487a11–14.

<sup>14</sup> For an in-depth discussion of how Aristotle conceives of the βίος of an animal, and how he uses this scientific concept both at the pre-explanatory and the explanatory stage of his study of animals, I refer the reader to [LENNOX 2010a](#): 239–258 and [LENNOX 2010b](#): 329–355.

Interestingly enough, at the outset of *HP I*, Theophrastus tells us that not only animals but also plants have a βίος:

the differences in plants and the rest of their nature are to be understood with respect to their parts and their qualities, as well as their modes of generations and *modes of life* [βίοι]; for they do not have character traits and actions as animals do.<sup>15</sup>

Again, the habitat is at the very heart of the definition of a βίος. Like animals, plants live and grow on land, near water, or in water.<sup>16</sup> But we cannot rule out that other features are constitutive of the βίος of a plant. The details do not matter here; what matters is that “βίος” is a term of art in the Peripatetic study of animals and plants. Aristotle and Theophrastus could have used this term to create an abstract noun to designate the study of the different ways in which the different kinds of living beings (animals and plants) live. Neither one of them show any inclination whatsoever to do so.

We can fortify this conclusion by returning to the programmatic passage that opens Aristotle’s *Meteorology*. There, Aristotle has no qualms adopting the word “μετεωρολογία” when he tells us that there remains for consideration that part of natural investigation that coincides with what his predecessors called meteorology (μετεωρολογία).<sup>17</sup> But what the early Greek thinkers called meteorology is emphatically not what Aristotle means when he uses this term. Physics before Aristotle was impervious to the distinction between celestial physics and sublunary physics. By contrast, Aristotle assumes this distinction right from the start of his *Meteorology*. As a result, he is self-consciously giving a new meaning to an old term by adapting it to his own natural philosophy. To fully appreciate what is at stake, and why it is important for Aristotle to adopt (and adapt) the term “μετεωρολογία,” we must turn to the list of sublunary phenomena he plans to explain in his *Meteorology*. A reader who is not familiar with Aristotle and his explanatory strategy may wonder why the latter is reserving a single slot in his research agenda for the explanation of sublunary phenomena as diverse and disparate as (among others) comets, winds, and earthquakes. It is only in the context of his investigation that Aristotle is able to vindicate his approach by showing that the phenomena discussed in the first three books of his *Meteorology* are all explained in terms of a material cause (the dry and moist exhalations) combined with

<sup>15</sup> Theophrastus, *HP I* 1.1. For a discussion of this pivotal text, I refer the reader to [Chapter 4, Section 2](#).

<sup>16</sup> Theophrastus, *HP I* 14.3.    <sup>17</sup> Aristotle, *Meteor.* I 1, 338a25–b21.



a moving cause (the circular motion of the heavenly bodies).<sup>18</sup> Therefore, the use of the term “μετεωρολογία” gives an impression of unity to what is *prima facie* a random list of phenomena. At the very least, Aristotle should have been more forthcoming about his overall strategy. Instead, he relies on a term that his reader would interpret in a different way to introduce an investigation that makes sense only within his own natural philosophy. It is possible to restate this point by saying that meteorology as a branch of sublunary physics is an Aristotelian innovation. Furthermore, it is an innovation that crucially depends upon Aristotle’s idiosyncratic division of the natural world into a celestial and a sublunary part. It is no wonder that this innovation did not gain much momentum in antiquity after Aristotle.<sup>19</sup>

I briefly elaborated on Aristotle’s appropriation of the word “μετεωρολογία” for three main reasons. First, the history of this term shows that the ancient Greek philosophers were quite adventurous with words. They not only created new words but were also ready to appropriate existing words and change their meaning as they needed. Second, meteorology is conceived by Aristotle as a discrete discipline. In addition to being discrete, this discipline is also strongly unified. All the phenomena that are explained in the first three books of Aristotle’s *Meteorology* are explained as stemming from the same causal starting points. Finally, the existence of a name for the discipline is important because it testifies to the existence of unity within the discipline.

## 2 **Animals and Plants Rather Than Perishable Living Beings**

With this conclusion in place, we can return to what Aristotle means to say at the beginning of the *Meteorology* when he is announcing a study of “*animals and plants*.” It is not open to us to think that carving out two slots in his research program in natural philosophy (animals and plants) rather

<sup>18</sup> We can leave aside the additional question of how *Meteor.* IV relates to *Meteor.* I–III.

<sup>19</sup> A full study of the history of the term “μετεωρολογία” before and after Aristotle can be found in the old but still very useful article by Wilhelm Capelle (CAPELLE 1912: 414–448). Except for WILSON 2013, Aristotle’s *Meteorology* has not attracted a great deal of attention lately. The main thesis defended in this valuable monograph is in broad agreement with the interpretive line I sketched in the main text. According to Malcolm Wilson, Aristotle does not repudiate the old study of the μετέωρα but neither does he simply continue it. Rather, he adopts some of the conceptual resources developed in the context of the Presocratic study of nature and adapts them to a new explanatory context. The outcome is not a revival of the Presocratic project of investigation but rather a transformation of this project into a discipline at once discrete and firmly inscribed into a larger explanatory project (Aristotle’s natural philosophy).

than one (perishable living beings) is an innocent move. We have seen that speaking of animals and plants is far from obvious and uncontroversial; on the contrary, it presupposes the application of the main results reached in Aristotle's research into the soul understood as the principle of living beings.<sup>20</sup> Moreover, in the opening lines of his *Meteorology*, Aristotle promises to study animals and plants "in common and separately." It does not take much imagination to envision an alternative scenario in which a study of living beings in the form of a common study of animals and plants is the starting point of a study of perishable life. In this alternative scenario, we would still have separate studies of animals and plants, but they would be subsumed under this common study of animals and plants. But this is emphatically not how Aristotle proceeds at the outset of the *Meteorology*. Instead of starting from a picture of unity, *Aristotle lists two separate studies and leaves us to wonder how much unity we can find in them*. There must be a reason why Aristotle speaks of animals and plants rather than living beings, ensouled beings, or things that partake in life.

To reiterate a point I made in [Chapter 1](#): the beginning of the *Meteorology* is not a random list of investigations, but it is a programmatic passage in which a whole research project in natural philosophy is carefully sketched out. What matters in this sketch is not whether we can associate a specific writing (or set of writings) with each slot in this project but rather the order in which those slots are listed, and how they are organized. When we look at the passage in this way, we are compelled to take seriously not only what Aristotle says but also what he does not say. The presence or absence of a name to designate a slot in Aristotle's research agenda is highly significant, so we are perfectly entitled to ask why Aristotle did not coin a word for the investigation of animals and plants if he really thought this investigation amounted to a single, discrete discipline.

We can make progress toward understanding why Aristotle (and Theophrastus after him) did not coin a new word to refer jointly to the separate studies of animals and plants envisioned at the outset of his *Meteorology* if we reflect on the other Greek term employed for life, namely "ζωή." While "βίος" refers to a certain mode of life, ζωή means bare life, namely the activity or set of activities that are jointly constitutive of being alive.<sup>21</sup> For Plato, everything that partakes of life (ζωή) is a living being (ζῶον). Plato makes this point in the *Timaeus*, where he introduces plants

<sup>20</sup> Here I am relying on the results reached in [Chapter 1, Section 2](#).

<sup>21</sup> Compare [NAAS 2018](#): 172–176.

as another (kind of) living being (ζῷον) from the human being.<sup>22</sup> We can modify his statement to make it acceptable to Aristotle (and Theophrastus): whatever partakes of *perishable* life is either an *animal* (ζῷον) or a *plant* (φυτόν).<sup>23</sup> Interestingly enough, Aristotle and Theophrastus do not give us a definition of life, let alone of perishable life, in their extant writings. In addition, Aristotle criticizes an attempt at the definition of life that goes back to Dionysius, who is a rather obscure figure for us today.<sup>24</sup> Dionysius's definition goes something like this: life (ζωή) is a "connate movement belonging to the kind [of creature] which is nourished, accompanying it from beginning to end."<sup>25</sup> The reference to nutrition makes it clear that this is meant to be a definition of *perishable* life. Aristotle criticizes it on the ground that animals and plants are different forms of perishable life rather than a single kind of living being.<sup>26</sup> In *De anima*, where Aristotle is not concerned with life but with the soul as the source of life, he gives us a statement to the effect that life manifests itself in more than one way followed by a list of life activities.<sup>27</sup> For Aristotle, the presence of any one of them is sufficient for being alive. While these activities are not all restricted to perishable living beings, they can be jointly used to offer a disjunctive definition that recognizes that there are different kinds of perishable living beings, and so different forms of perishable life. And yet proceeding in this way is not the same as giving a definition of perishable life. A bona fide definition of perishable life is expected to capture at least one salient feature of the *definiendum*. Such a definition is found neither in Aristotle's extant works on animals nor in Theophrastus's surviving writings on plants.

The absence of a Peripatetic definition of perishable life has not deterred scholars from trying to supply one on behalf of Aristotle and Theophrastus. Most notably, Gareth Matthews has gone beyond the letter of what we are

<sup>22</sup> Plato, *Tim.* 77 A 5. For more on Plato's conception of a living being (ζῷον) in the *Timaeus*, see [Chapter 1, Section 2](#).

<sup>23</sup> The addition of the qualification "perishable" becomes important when Aristotle compares (and contrasts) animals and plants with the heavenly bodies. The exhortation to the study of life in all its manifestations and forms offered at the outset of *PA I 5* is a prime example. There, Aristotle speaks of *perishable* plants and animals and contrasts them with the heavenly bodies, which are not subject to generation and destruction (*PA I 5*, 644b22–645a3).

<sup>24</sup> Aristotle, *Top.* VI 10, 148a23–33. Oliver Primavesi ([PRIMAVESI 1992](#): 246–261) has argued that for chronological reasons this Dionysius cannot be identified with Dionysius the sophist as scholars have routinely done at least since Hermann Bonitz ([BONITZ 1870](#): 199a53–54). Primavesi suggests that our Dionysius is most likely the same person as Dionysius of Chalcedon (also known as Dionysius the dialectician), a figure connected with the Megarian school.

<sup>25</sup> Aristotle, *Top.* VI 10, 148a23–33. <sup>26</sup> Aristotle, *Top.* VI 10, 148a23–33.

<sup>27</sup> See [Chapter 1, Section 2](#).

told in Aristotle's *De anima*. His definition of life takes the form of a schema in which being alive is a species-specific phenomenon involving one or more powers that any member of the species has in virtue of having a soul and exercises over the course of its life.<sup>28</sup> Christopher Shields has criticized this interpretive strategy because the definition offered by Matthews on behalf of Aristotle would be "too biocentric." This definition would preclude Aristotle from ascribing life beyond the boundaries of perishable life.<sup>29</sup> Since there is plenty of life beyond the sublunary world, this criticism is well taken. At the same time, however, we have seen that Aristotle has developed the conceptual resources to distinguish perishable from imperishable life.<sup>30</sup> Moreover, the focus on perishable life, to the exclusion of imperishable life, is at work from the beginning of the second book of Aristotle's *De anima*. Thus, far from being arbitrary, the definition supplied by Matthews reflects the logic of the argument as it unfolds in the first part of *DA II*. And yet I find it difficult to see how this definition can generate a unified science of perishable living beings. To the extent that it invites us to proceed by pursuing what is specific about the different forms of living beings, this definition does not bridge the division of the study of perishable living beings into separate studies of animals and plants. Rather, it confirms, and indeed strengthens, this division.

At this point, one may legitimately wonder whether, instead of trying to supplement what Aristotle and Theophrastus say in their extant works on animals and plants, we should take their silence seriously. Presumably, Aristotle and Theophrastus do not give us a definition of perishable life, not because they are not able to find one but because they do not think that there is one. As a result, the option of a common study of animals and plants remains for them a project that can be pursued only in a very limited number of cases. Moreover, they pursue this project starting from the results achieved in the context of the study of animals. This is a direct consequence of the Peripatetic approach to perishable living beings I labeled "*first animals, then plants*."<sup>31</sup>

<sup>28</sup> MATTHEWS 1992: 185–193.

<sup>29</sup> SHIELDS 1999: 183. According to Shields, the definition offered by Matthews would preclude Aristotle from ascribing life to a god. As a result, Shields takes an alternative route. This route consists in finding out a core meaning of life in the idea that a living being is an intentional system engaged in end-directed activities (SHIELDS 1999: 188–192). I do not see how this second definition of life, precisely because it is *not* programmatically restricted to perishable living beings but rather has the life of a god as its central case, can serve as a starting point for a science of *perishable* life. Further discussion (and criticism) of the route taken by Shields can be found in JOHANSEN 2012: 50–51.

<sup>30</sup> See Chapter 1, Section 2.    <sup>31</sup> See Chapter 2, Sections 3 and 4.

### 3 The Nutritive Power of the Soul in Animals and Plants

One may wonder whether the nutritive capacity can help bridge the gap between animals and plants. *Why not think that this is the power that secures the sort of unity that appears to be missing in the absence of an explicit definition of perishable life?* To fully appreciate the implications of this question, we need to bear in mind that Aristotle describes the nutritive soul as the most primitive and most widely distributed power; this is the power in virtue of which all perishable living beings have a share in being alive (ζῆν).<sup>32</sup> In *Juv.* 24 (= *Resp.* 18), Aristotle says that “coming to be consists in the first participation in the natural heat associated with the nutritive soul, and life [ζωή] is the continuation in this participation.”<sup>33</sup> Finally, both Aristotle and Theophrastus not only adopt the same terminology (they both speak of a threptic power, τὸ θρεπτικόν) but also approach this power in the same way. Both make it the same as the power for growth and reproduction: while imperishable life does not entail the power for nutrition, growth, and reproduction, perishable life requires it.<sup>34</sup> Why not, therefore, give definitional priority to the nutritive soul and say that this soul is what secures unity and allows us to speak of a unified science of perishable living beings rather than separate studies of animals and plants?<sup>35</sup>

To be sure, Aristotle and Theophrastus think that *something* is shared between animals and plants; however, it is far from clear that what is shared is the very same capacity.<sup>36</sup> To understand why, we must return to the analogy between souls and rectilinear plane figures ordered in a series beginning with the triangle. We have seen that this analogy plays a pivotal role in Aristotle’s research into the soul.<sup>37</sup> When Aristotle offers this analogy, he is careful to add that a triangle exists only *potentially* in the

<sup>32</sup> Aristotle, *DA* II 4, 415a23–26. On Theophrastus on the nutritive power of the soul, see *CP* I.12.5.

<sup>33</sup> Aristotle, *Juv.* 24 (= *Resp.* 18), 479a29–30.

<sup>34</sup> For the view that the capacity for nutrition is the same as the capacity for growth and reproduction, see Aristotle, *GA* II 1, 735a17–19:

The nutritive power [τὸ θρεπτικόν] exists in all animals and plants alike, and this is the same power which enables an animal and a plant to generate another being like itself.

For Theophrastus on the nutritive power and its relation to growth, sprouting, and fruiting, see [Chapter 5, Section 3](#).

<sup>35</sup> This line of interpretation is explored in [KING 2009: 171–187](#).

<sup>36</sup> Both “power” and “capacity” are perfectly acceptable translations of δύναμις. The powers we are concerned with are capacities animals and plants have in virtue of being ensouled. Sometimes the Greek δύναμις is rendered with “faculty” or “ability.” While I refrain from using “faculty” and “ability,” I employ “power” and “capacity” interchangeably.

<sup>37</sup> See [Chapter 1, Section 2](#).

next rectilinear plane figure; likewise in the case of the capacities of the soul. Here is the relevant passage:

In the case of both [rectilinear plane] figures and ensouled beings, what is prior is always present *potentially* [δυνάμει] in what follows in a series; for instance, a triangle in a square and the nutritive capacity in the perceptual capacity.<sup>38</sup>

The addition of the qualification “potentially” is important. A square can be divided into two isosceles triangles. But each of these triangles is not a separate and self-contained figure: it exists only as a potential part of the square. In an analogous way, the nutritive capacity we find embedded in the perceptual capacity is not a separate and self-contained power. As a result, it is far from clear that we can isolate it from the larger system in which it is embedded.

The significance of this observation for Aristotle becomes obvious when we reflect on a question that looms large as soon as the soul is identified with a set of capacities rather than a single thing. I mean the question of the unity of the soul. This question can be introduced by recalling that most of the capacities studied in Aristotle’s *De anima* are basic powers of the soul – namely, powers that are separate (or separable) in account from one another.<sup>39</sup> If these powers are separate (separable) in account from one another, how do they come together so as to form single principle of perishable life (i.e., a certain kind of soul)? This question becomes even more pressing as soon as we realize that Aristotle speaks not only of a nutritive and a perceptual *power* of the soul but also of a nutritive and a perceptual *soul*. Aristotle cannot possibly entertain the thought that one and the same perishable living being has more than one soul since he thinks that the soul is the principle that grounds the unity of the living body, so we want to know how these basic powers come together in a single soul. The analogy with rectilinear plane figures is meant to help us see how to handle this delicate question. Recall that a square is a regular quadrilateral – that is, a plane figure with four equal sides and four equal angles. Such a definition makes no reference to triangles. And yet we have just seen that two right-angled isosceles triangles are potentially present in a square. We can restate this point by saying that a square is definitionally independent from a triangle. While a square can be divided into two right-angled isosceles triangles, a square is not just an aggregation of those triangles; it

<sup>38</sup> Aristotle, *DA* II 3, 414b28–32.

<sup>39</sup> See Chapter 2, Section 1. I say “most of the powers” because *phantasia* and the power to move with respect to place are notable exceptions to the rule.

is a separate rectilinear plane figure over and above them. In an analogous way, the soul is not just an aggregation of separate powers (let alone an aggregation of multiple souls), but it is a single entity entailing those powers.

Aristotle says that the nutritive power is *in* the perceptual power just as the triangle is *in* the square. But how is the relation of containment to be understood here? To begin with, this relation does not obtain in the abstract but always within a certain kind of perishable living being – either a human or a nonhuman animal. Aristotle makes this point when he says that not only in rectilinear plane figures but also *in ensouled beings* (ἐπὶ τῶν ἐμψύχων) that which is prior is always present *potentially* (δυνάμει) in that which follows.<sup>40</sup> Whenever these powers are both present, the perishable living being possessing the higher (cognitive) power potentially contains within itself the lower ones.<sup>41</sup>

Let us reflect on the implications of this approach to the powers of the soul for how we ought to think of the nutritive power. This power cooperates in animals with the perceptual capacity, which also entails the presence of the capacity to feel pleasure and pain, as well as the capacity for non-rational desire in the form of appetites. By contrast, plants do not have a share in cognition; hence, they cannot feel pleasure and pain, and they cannot have appetites.<sup>42</sup> We may or may not agree with Aristotle on this point. In fact, I suspect that a few of us may be willing to ascribe a rudimentary form of cognition to plants along the lines suggested by Plato.<sup>43</sup> But at least for Aristotle (and presumably for Theophrastus),<sup>44</sup> the *nutritive power is a different kind of capacity when it works jointly with pleasure, pain, and desire*. We can restate this point by saying that this capacity is transformed by the presence of higher – that is, cognitive – powers. The “transformation thesis” is normally discussed in connection

<sup>40</sup> Aristotle, *De anima* II 3, 414b30. <sup>41</sup> I owe this formulation to JOHANSEN 2012: 68–69.

<sup>42</sup> I believe that this is also true for Theophrastus. There is no hard evidence that Theophrastus ascribed a thicker notion of life to plants.

<sup>43</sup> While Plato does not think that plants have a share in judgment, reason, and intelligence, he ascribes them a share in pleasant and painful perceptions as well as in appetitive desires (*Tim.* 77 B 3–6). For a helpful discussion of the cognitive capacities that Plato may be willing to ascribe to plants, I refer the reader to CARPENTER 2010: 281–303 (reprinted and updated in BALDASSARRI-BLANK 2021: 35–53). For a contemporary attempt to ascribe not only pleasure and pain but also intelligence and even memory to plants, I refer the reader to MANCUSO 2017.

<sup>44</sup> Aristotle’s *De anima* plays a foundational role for the study of animals and plants. Without that work in the background, the decision to approach the study of perishable life via separate but coordinated studies would simply be unthinkable. See Chapter 1, Sections 2 and 3 (Aristotle); Chapter 4, Section 5 (Theophrastus).

with the power of reason.<sup>45</sup> Aristotle is committed to a transformative (as opposed to an additive) theory of rationality. According to him, reason is not just an additional power that humans alone have; it is also a power that transforms the lower capacities humans share with non-rational animals. For instance, the capacity for desire as well as the perceptual capacity manifest themselves differently in human and nonhuman animals precisely because humans are rational animals while nonhuman animals are not.

To be sure, we can give an account of sense-perception and desire that does not presuppose any relation to the power of reason. Aristotle offers such an account in the first part of *DA* III 7.<sup>46</sup> Since this account is common to both human and nonhuman animals, it is meant to have a zoological significance. But when reason is factored in, this power does not add to the existing ones but rather transforms them. While the transformation thesis is standardly discussed in connection with reason, it has a significance that goes beyond the study of the cognitive capacities in rational and non-rational animals. It also applies to the study of the lower (non-cognitive) capacities that animals share with plants. What we read in Aristotle's *De anima* suggests that it would be unmethodical to think that the lower capacities can be studied by taking an additive approach, and by thinking that the study of reason alone requires a transformative approach. Recall that the basic powers of the soul are ordered in a series, so they are to be studied serially. But to study them serially requires a prior decision as to whether we adopt an additive (aggregative) approach or a transformative one.

A hybrid that combines both approaches is not an option for us. If we adopt a transformative approach to the study of the powers of the soul, we must adopt it for all the powers of the soul. If we adopt such a transformative approach, the nutritive powers present in plants, animals, and human beings are not going to be one and the same power. Rather, they will differ *in essence* from one another because they are embedded in a larger system of powers in which the presence of the highest power modifies the other ones. In this scenario, we will have a nutritive power that is *essentially* different in the case of plants, nonhuman animals, and

<sup>45</sup> I borrow this expression from Geert Keil (KEIL-KREFT 2019: 7). The ultimate origins of this language are to be found in contemporary discussions of rationality (most notably in the philosophical work of John McDowell). For an introduction to two alternative models to understand how reason interacts with the other cognitive powers, namely the additive and the transformative model, I refer the reader to BOYLE 2016: 527–555.

<sup>46</sup> *DA* III 7, 431a5–14. An in-depth analysis of this stretch of text can be found in CORCILIUS 2011: 117–143.



human animals. Indirect evidence that the nutritive power is a different kind of power in animals and plants comes from the observation that the presence of this power at the outset of a generative process gives rise to different kinds of things in animals and plants. It is only in the case of human and nonhuman animals that the exercise of the nutritive powers results in the production of the specific parts of the animal and a whole organism that is equipped with the capacity to have pleasurable or painful feelings as well as appetitive desires. In this respect, an animal or human fetus is not the same as a plant even when it is living a merely vegetative life.<sup>47</sup>

This last observation forces us to rethink how we ought to take the account of the nutritive soul advanced in *DA* II 4. In this stretch of text Aristotle is not concerned with the nutritive power as is present in plants. Nor is he concerned with this power as it is present in animals. Rather, he speaks of nutritive power in a more general way. But since there is absolutely no evidence that Aristotle thinks of animals and plants as two species under one and the same genus, we cannot take this account to be equivalent to a generic account of the nutritive power as if the same nutritive power were common to animals and plants. Instead, we should consider it *an abstract account* that has to be filled in with the relevant details as we move on, and indeed forward, with our investigation. The relevant details will not be supplied in the context of Aristotle's research into the soul; rather, they will be provided only when we turn to the study of the different forms of perishable living beings – namely, when we finally engage in separate studies of animals and plants.<sup>48</sup>

<sup>47</sup> Klaus Corcilius comes to the same conclusion by exploring a different line of argument. He argues (in [CORCILIUS 2015](#): 38–49 and [2021b](#): 22–23) that in animals the nutritive soul is *teleologically subordinated* to the perceptual soul. By his lights, the relation envisioned by Aristotle is one of *teleological nesting*. It is open to us to apply either a teleological approach or a transformative one to the powers of the soul. What matters is that for Aristotle the nutritive and the perceptual powers of the soul do not work as independent modules in perishable living beings: rather, they are *operationally fused* in animals. But this also means that we no longer have the same nutritive power when this power works as an integral part of a cognitive soul.

<sup>48</sup> The nutritive power of the soul has been the object of intense scrutiny lately. This comes as no surprise if we keep in mind that the methodology adopted for the study of this power is subsequently employed for the study of the higher (cognitive) powers of the soul. On the methodology adopted in *DA* II 4, see [JOHANSEN 2012](#): 93–106 and [CORCILIUS 2021b](#): 13–34. There are special problems with the nutritive power of the soul. Most notably, it is not immediately obvious how nutrition, growth, and reproduction can be manifestations of one and the same power of the soul. For recent attempts to address this large question, I refer the reader to [JOHANSEN 2012](#): 106–115; [COATES-LENNOX 2020](#): 414–466 (abridged in [LENNOX 2021b](#): 2–20); and [GELBER 2022](#): 104–121.

#### 4 Vital Heat in Animals and Plants

In *DA* II 4 Aristotle establishes the following, general theorem: *every perishable living being possesses some [internal, natural] heat*.<sup>49</sup> Although offered in the context of the research into the soul, this theorem does not contribute to the theory of the soul but rather to the study of animals and plants. Moreover, it contributes to the study of animals and plants insofar as they are both forms of perishable living beings. For this reason, it is quite tempting to make this theorem the cornerstone of Aristotle's science of living beings. And yet Aristotle shows no inclination whatsoever to build an entire science of perishable living beings upon this truth. Instead of making this theorem the starting point of his study of perishable life, he mentions it only at the end of his account of the nutritive soul and only as a sort of afterthought.

One might object that this is just as it should be. In his *De anima* Aristotle is not concerned with perishable living beings but with the soul as a principle of perishable life. In other words, his task is not to build a science of living beings but only to provide a theoretical foundation for such a study. But when Aristotle returns to this theorem in the context of his study of animals and everything that has a share in life (his *Parva naturalia*), he does not appear to have changed his overall attitude toward this principle. Aristotle does not build his entire science of perishable living beings upon it. This conclusion is unsurprising: if Aristotle's goal were to use this theorem as a cornerstone for his entire project, he would not have relegated it to the end of his project of the *Parva naturalia*, where his primary focus remains after all on animals.<sup>50</sup>

The idiosyncratic approach I labeled "*first animals, then plants*" finds some confirmation in Aristotle's treatment of the nutritive soul. Let us recall how the theorem that all perishable living beings possess some internal heat is secured in *DA* II 4. According to Aristotle, each power of the soul is to be studied by looking at how it is discharged. Moreover, each power is discharged by engaging in a certain activity, which is in turn related to a certain object. Aristotle refers to this object as the correlative object.<sup>51</sup> The nutritive power of the soul is no exception to the rule; this power too must have a correlative object. This object is nourishment (τροφή).<sup>52</sup> The link Aristotle establishes between the nutritive power of

<sup>49</sup> Aristotle, *DA* II 4, 416b29. <sup>50</sup> See Chapter 2, Sections 3 and 4.

<sup>51</sup> Aristotle, *DA* I 1, 402b15; I 5, 411a4; II 4, 415a20; II 11, 424a11.

<sup>52</sup> *DA* II 4, 415a23. I follow the standard reading of this passage, which is now challenged in COATES-LENNOX 2020: 416–466 (the argument is abridged in LENNOX 2021b: 3–19). While it is true that the

the soul and its correlative object explains why a considerable part of *DA* II 4 is devoted to clarifying what is meant by “nourishment.” This term is intrinsically ambiguous since it can be used to refer to either *concocted* or *unconcocted nourishment*.<sup>53</sup> Concocted nourishment is the outcome of the digestive process. As such, it is nourishment that has been assimilated and is ready to be allocated to the various parts of the perishable living body. By contrast, unconcocted nourishment is equivalent to external nourishment prior to undergoing any digestive process. The theorem that all perishable living beings possess some internal, natural heat is derived from the observation that external nourishment is the starting point of the whole nutritive process. This external nourishment must become like the nourished body before it can be allocated to its different parts, so this nourishment must undergo some change in order to be assimilated by the perishable living being. The assimilation of the external nourishment to the nourished body requires concoction, which is envisioned by Aristotle as a kind of cooking. But concoction so understood entails the presence of some internal, natural heat in the perishable living body. This heat is the agent responsible for acting on the external nourishment.<sup>54</sup> While this internal, natural heat plays an indispensable role in Aristotle’s causal account of how nutrition takes place, its presence alone does not suffice for the explanation of nutrition. The action of this heat is controlled and shaped by the nutritive power of the soul. Aristotle illustrates this point with the help of the example of the hand and the rudder. Both the hand and the rudder are required for navigation to take place. The hand is a moved mover whereas the rudder is a moved thing. But both the hand and the rudder require the additional presence of an unmoved mover that controls how navigation takes place. This is the expert knowledge embodied in the pilot whose hand moves the rudder.<sup>55</sup> When we ponder

Greek τροφή can be used to refer to the activity of nutrition, I am not persuaded by the attempt to read a reference to the activity (nutrition) rather than the relevant object (nourishment) in this passage. In their joint article, Coates and Lennox go on to reject the identification of the correlative object with nourishment. By their lights, the correlative object must be prior in definition to the nutritive power if Aristotle wants to avoid any circularity in the definition of the nutritive power. At the very least, Aristotle seems to be aware of the problem of circularity since his definition of the nutritive power does not make any reference to the correlative object. According to Aristotle, this power is the power to preserve that which has it (*sc.* the perishable living being) insofar as it has it (*DA* II 4, 416b17–18).

<sup>53</sup> Aristotle, *DA* II 4, 416 b3–9.

<sup>54</sup> Aristotle, *DA* II 4, 416b28–29: “It is necessary for all nourishment to be able to be concocted, and it is heat that affects concoction, which is why each ensouled being possess [some internal, natural] heat.”

<sup>55</sup> For a recent discussion of this image, see [COATES-LENNOX 2020: 433–435](#).

this doctrinal point, we see why Aristotle argues for the necessary co-presence of the nutritive soul and some internal, natural heat. The latter is the tool by which the soul acts on the external nourishment.

And yet making the presence of heat in the living body contingent upon the need of the organism to process unconcocted nourishment is potentially problematic.<sup>56</sup> Aristotle maintains that plants do not concoct their nourishment, but they take in nourishment already concocted from the soil.<sup>57</sup> We must conclude that all the natural processes related to the preparation of nourishment in the case of plants must take place in the soil. The latter is, as it were, their stomach. At first sight, it is tempting to explain away this textual tension by arguing that the theoretical pronouncements made in the context of the research into the soul are not binding for Aristotle. In other words, it is tempting to posit that Aristotle has changed his mind or at the very least qualified his position as he has moved away from his research into the soul and turned to his study of perishable living beings. But it does not take long to find the same claim in the context of the study of animals. For instance, the presence of the internal, natural heat is explicitly linked to the need of the living organism to process external nourishment in *PA* II 3. More importantly, this claim is not restricted to animals, but it is explicitly extended to plants.<sup>58</sup>

If Aristotle has not changed his mind on this doctrinal point, we must deal with this textual tension in some other way. My proposal is that the necessary co-presence of the nutritive power of the soul and some internal, natural heat is to be explained by means of the argumentative strategy we have seen at work in the *Parva naturalia*.<sup>59</sup> In other words, this co-presence is first established for animals and then it is extended to all perishable living beings. In this scenario, the co-presence of nutritive soul and natural heat cannot be necessary on the hypothesis that the perishable living being has to be able to concoct the relevant external nourishment. We are required to find an alternative source of hypothetical necessity that works for plants. We can restate this point with the help of the following question: why do perishable living beings such as plants need natural heat if they do not need it to bring about any physical change in the nourishment drawn from the soil? Aristotle does not address this question directly. Still, it is possible to offer an answer on his behalf. While the natural heat present in the plants

<sup>56</sup> To the best of my knowledge this point has not been noted in the secondary literature on *DA* II 4.

<sup>57</sup> *PA* II 10, 655b28–656a3. This passage is discussed in [Chapter 2, Section 5](#).

<sup>58</sup> Aristotle, *PA* II 3, 650a2–8. <sup>59</sup> See [Chapter 2, Section 4](#).

does not bring about any physical change in the nourishment drawn from the soil since the latter is already concocted, this heat is required for the preservation of the basic properties of the concocted nourishment. Recall that the nourishment drawn from the soil through the roots is some sort of warm moisture that is then distributed to the rest of the plant. In this scenario, the natural heat present in the plant does not serve to concoct the external nourishment; its presence is nonetheless necessary to maintain the basic properties of the concocted nourishment as it is distributed to the periphery of the living organism (branches and leaves).<sup>60</sup>

Reflecting on the asymmetry that exists between plants and animals may contribute new arguments to a recent debate on the *per se* object of the nutritive power. The primary *per se* object of this power seems to be concocted rather than unconcocted nourishment because this is the only kind of nourishment that is immediately relevant in the case of plants.<sup>61</sup> But this identification creates a new problem: we are no longer able to define the correlative object without reference to the power of the soul and its distinctive activity. This may not affect Aristotle's ability to define the nutritive power of the soul, since this power is not defined with reference to its object. Recall that Aristotle defines the nutritive power as the power to preserve that which has it (*sc.* the perishable living body) insofar as it has it.<sup>62</sup> At this point of his argument, Aristotle has already downgraded the correlative object to the role of a necessary condition for the activity of nutrition to take place. And yet it remains true that we are no longer able to make good sense of Aristotle's original claim that the correlative object is prior in account to both the activity and the power of the soul.

## 5 Taking Stock

The main point I would like to take away from my highly selective discussion of *DA* II 4 is this: the first and most important step made in the context of the Peripatetic study of living beings is the observation that life takes many forms. In the sublunary world, it manifests itself in the form of plant and animal life (with human life as a special kind of animal life). This is implicitly acknowledged where we are told that the most natural

<sup>60</sup> I am adopting a suggestion made in [KOROBILI 2021](#): 153–167. She argues that the natural heat that is present in plants serves as a sort of receptor and accumulator of the heat drawn from the soil along with the concocted nourishment they absorb through their roots.

<sup>61</sup> I side with Johansen on this point. See [JOHANSEN 2012](#): 104–106.

<sup>62</sup> Aristotle, *DA* II 4, 416b17–18.

function of living beings is to produce another like oneself, *whether an animal, another animal, or a plant another plant* (ζῷον μὲν ζῷον, φυτὸν δὲ φυτὸν).<sup>63</sup>

When Aristotle and Theophrastus speak of animals and plants, they never assume that animals and plants constitute a single form of life. Quite the opposite: they approach the study of perishable living beings via separate studies of animals and plants. This suggests that both take animals and plants to be different kinds of perishable living beings. Whether there is unity, and how much unity there is, remains an open question at the outset of the *Meteorology*, where Aristotle outlines an ambitious research program in natural philosophy that ends with a reference to animals and plants. When we look a bit more closely at the two *corpora* of writings Aristotle and Theophrastus have left us on the topic of animals and plants, we see that the unity they are able to secure is surprisingly limited. This observation goes some way toward explaining why they felt no need to coin a term equivalent to “biology.” While they are committed to the view that nature makes no leap, they are also committed to the view that there are at least in principle two kinds of perishable living beings that ought to be studied separately. Gradualism is fully compatible with the claim that there are two kinds of perishable living beings. Furthermore, a commitment to gradualism does not entail that there is a single domain of investigation – namely, perishable living beings. There is no textual evidence that Aristotle and Theophrastus invoke gradualism to establish that perishable living beings are a single investigative domain.<sup>64</sup>

Animals and plants do not constitute a genus for Aristotle and Theophrastus. But this does not mean that they are not able to develop a science of perishable living beings. The title of this book makes it clear that, at least in my view, there is such a science even if animals and plants are not subsumed under a single genus. Aristotle and Theophrastus have not left us two disconnected, or only loosely connected, studies of animals and plants; rather, they have passed down to us two carefully coordinated investigations. They have also devised a conceptual tool they both use: analogy. Arguably, analogy is the single most important explanatory resource employed by Aristotle and Theophrastus. Analogy helps them

<sup>63</sup> Aristotle, *DA* II 4, 415a26–29.

<sup>64</sup> Pace REPICI 2000: 39, who takes Aristotle’s commitment to gradualism as her starting point for the claim that for Aristotle there is a single investigative domain (perishable living beings) rather than two (animals and plants).

track non-trivial similarities that exist between these two domains and build a science of perishable living beings in the absence of a genus.<sup>65</sup>

Let me elaborate on this point by returning to Aristotle's theory of scientific explanation with a focus on *APo* II 17, which opens with the question whether it is possible for the cause of the same attribute not to be the same – but to be different – for all its relevant subjects.<sup>66</sup> The question is formulated in very general terms, so its relevance to our discussion is not immediately obvious. But it can be rephrased in a way that makes it relevant to us. Being alive is an attribute that is predicated of relevantly different things. Animals and plants are among those things, so the question arises whether it is possible for the cause that explains why being alive belongs to both animals and plants to be different. Aristotle answers this question in two steps. He first concentrates on what he takes to be his paradigmatic case. When we explain something per se, rather than in an accidental way or by means of a sign, we come to a negative conclusion: it is not possible for the same attribute *A* to be explained by a different cause for *C* and *D*.<sup>67</sup> Rather, the relevant cause of why *A* belongs to *C* and *D* must be not only the same but also the most appropriate because it must provide an explanation at the right level of generality. We can call this cause *B*. This conclusion marks the end of the first part of Aristotle's answer. It confirms that in order to explain something in common for animals and plants, we need to establish the salient features performing the role of *B*. But we have already seen that there are very few cases where Aristotle is able to reach this result.

And yet as soon as Aristotle has reached this negative result, he goes on to consider cases where the epistemic requirements outlined above are not so stringent. Analogy is one of them.<sup>68</sup> When we employ analogy, we are no longer dealing with one and the same attribute belonging to different subjects. Rather, we are dealing with *different attributes* belonging to different subjects. And yet, with the help of analogy, we can establish some non-trivial similarities. We can say, for instance, that *A* is to *B* as *C* is to *D*. This amounts to saying that *A* holds the same place or plays the same role with respect to *B* as *C* holds or plays with respect to *D*. Aristotle does not furnish any example in *APo* II 17. But we can easily supply one on his

<sup>65</sup> A good introduction to the topic of Aristotle's theory and use of analogy can be found in [RAPP 2021: 9–37](#).

<sup>66</sup> Aristotle, *APo* II 17, 99a1–2. I would like to express my gratitude to Lucas Angioni, who first pointed out to me the importance of what Aristotle says in this difficult and generally neglected chapter for my overall argument.

<sup>67</sup> Aristotle, *APo* II 17, 99a3.      <sup>68</sup> Aristotle, *APo* II 17, 99a15–16.

behalf: the mouth is to animals as the roots are to plants. In this example we have different bodily parts playing a functionally similar role in animals and plants. To be sure, we can restate this point by saying that both the mouth in animals and the roots in plants serve as the entry points for nourishment. But by saying this we are not trying to capture a putative common part over and above the mouth in animals and the roots in plants. Rather, we are trying to achieve two distinct but related results. First, we are connecting two separate domains (animals and plants) without glossing over their differences. Analogy is especially useful in this respect because it does not reduce, let alone remove, the complexity of the natural world; rather, it gives us a way to map and so to understand it. So much for the first result. Let us now turn to the second, which is as important as the first. When we make recourse to analogy in the way suggested above, we are exploring one domain (plants) in the light of another (animals).

This second result deserves a few words of elaboration. Analogy is fully compatible with the presence of symmetrical relations. For instance, I can say that 2 is to 4 as 4 is to 8. But I can also say that 8 is to 4 as 4 is to 2. The order in which the two pairs of *relata* are introduced is not important because this analogy is based on a symmetrical relation. Analogies of this sort are not especially interesting in the context of the Peripatetic science of perishable living beings. By contrast, analogies based on asymmetrical relations do a great deal of explanatorily work. The relations are asymmetrical because one pair of *relata* is taken to be the central case. Consequently, the direction of the explanation always goes from this central case to the peripheral ones. Let us return, for a moment, to our original example. For Aristotle, the mouth in animals is the paradigmatic entry point for nourishment. Aristotle develops an idea of what it is for something to be an entry point for nourishment by studying animals. He then extends this idea to plants by establishing that the roots are the entry point for nourishment in plants. As a general rule, the direction of explanation is from animals to plants rather than vice versa.<sup>69</sup>

The last remark on the asymmetrical nature of analogy brings us back full circle to the methodological recommendation encapsulated in the catchphrase “*first about what is first.*” We are now able to better understand this recommendation. In the Peripatetic science of living beings we begin our investigation from animals, which are considered our central case, and

<sup>69</sup> I add “as a general rule” because the explanation sometimes goes in the opposite direction. We have already seen that Aristotle explains how hard-shelled animals reproduce (by his lights spontaneously) by invoking plant propagation as a model (*GA* III 11, 761b23–762a2). See [Chapter 5, Section 2](#).



then move on to the study of plants. But the same strategy is adopted within the study of animals. Suffice it to recall that, according to Aristotle, all animals have a single controlling part serving as the seat of both the nutritive and the perceptual power.<sup>70</sup> For him, this bodily part is neither generally nor specifically the same in all animals; rather, it is the same only by analogy. While in blooded animals this part is the heart, in bloodless animals it is something that is functionally analogous to the heart. We do not have a name for this part, and we do not need one. We only need to see why bloodless animals must possess this part insofar as they are animals. Analogy helps us secure this result by allowing us to transfer a causal explanation established for one group of animals (blooded animals) to another (bloodless animals).

When we reflect on how Aristotle uses analogy, we see that analogy is not just a tool to find explanations that apply across large kinds of animals. It also has heuristic value to the extent that it opens new avenues of research as Aristotle progresses in his project of a systematic study of perishable life.<sup>71</sup> On the one hand, analogy gives Aristotle a way to establish a truth that holds across various large kinds: all these kinds of animals – no matter how different they are from one another – must share something that is functionally analogous to a heart since this centralized organization of the living body is an essential feature present in all animal bodies albeit in different degrees of perfection. On the other hand, analogy gives Aristotle a first orientation in his investigation into each of these kinds of animals. It is uncontroversial, I hope, that establishing this general truth is only a first step into a full study of what is specific about each of these kinds of animals.

Analogy remains an indispensable tool also for Theophrastus. It would be difficult, if not outright impossible, for Theophrastus to engage in his systematic study of the wonderfully complex world of plants if he could not rely on the twofold assumption that animals and plants are analogous forms of perishable life, and one should use the more determinate and more organized form of life (animals) as a model in the study of the less determinate and less organized one (plants). Like Aristotle, Theophrastus adopts analogy to transfer some of the results reached in the study of one investigative domain (animals) to another (plants), as well as to make progress in the study of plants. Like Aristotle, he makes a particular large kind his starting point and central case. We have seen that, from a purely

<sup>70</sup> Chapter 2, Section 4.

<sup>71</sup> The heuristic value of analogy is discussed in LLOYD 1996c: 138–159. It is also stressed in RAPP 2021: 9–37.

strategic point of view, trees play for Theophrastus a role equivalent to the role that blooded animals play for Aristotle.

Analogy allows Aristotle and Theophrastus to treat two separate domains such as animals and plants *as if they were a single nature* (ὡσπερ μιᾶς τινος φύσεως).<sup>72</sup> This does not mean that there is in fact a single nature shared by animals and plants. To be as clear as possible: there are no essential items that animals and plants have in common. But Aristotle and Theophrastus can still engage in a study of them *as though* there were such an item. This is enough, I think, to create the conceptual space for a Peripatetic science of perishable living beings. I do not see evidence in their extant works that Aristotle and Theophrastus are able or willing to close the gap created at the outset of the *Meteorology* where two slots in Aristotle's research agenda are introduced: *animals* and *plants*. But this does not mean that they do not have the idea of a science of perishable living beings. Rather, Aristotle and Theophrastus pursue such a science by giving full attention to what is specific about each of the two kinds of perishable living beings. Analogy proves to be especially useful in this context because it does not reduce, let alone eliminate, what is specific but rather gives Aristotle and Theophrastus a way to place it in a larger explanatory context.

<sup>72</sup> Aristotle, *APo* II 14, 98a23.

*Aristotle on Plants*

There are only a handful of references to a separate study of plants in the Aristotelian corpus. A few (but not all) have been discussed in this book. I collect them here to offer a synoptic view of how Aristotle refers to the study of plants in his extant works. To give the reader an idea of what prompted these references, I provide some textual context for each of them.

Gustav Senn offered an extensive review of these references in an old but still useful article.<sup>1</sup> He reached three main conclusions. The first is that not all of them can be dismissed as later additions. On the contrary, a few are part and parcel of the fabric of the text, so they are to be regarded as authentic. While not trivial, this conclusion is not especially controversial. By contrast, his second conclusion raises a few eyebrows. According to Senn, all the cross-references to plants in the Aristotelian corpus are references to the extant works on plants by Theophrastus. Senn argues that Aristotle did not write on plants but delegated this task to Theophrastus. Last but not least, Senn saw an especially close relation between these references and *CP*.<sup>2</sup> Crucial for this third conclusion are two passages from *HA* V 1 and *GA* I 1. They are printed below as texts [A] and [B]. In both passages, Aristotle is concerned with the modes of generation in plants, with a focus on parasitic plants – that is, plants that grow on other plants. In the second passage, he explicitly mentions the mistletoe. For Senn, this can only be a reference to *CP* II 17, where Theophrastus offers an extensive discussion of the mistletoe.

<sup>1</sup> SENN 1930: 113–140.

<sup>2</sup> According to Senn, Theophrastus wrote *CP* before *HP* when he was still working under the shadow of Aristotle. By his lights, Theophrastus attempted to break free from Aristotle only in *HP*. I will not try to review the putative evidence for this suggestion. Let me only say that chronological claims of this sort do not withstand scrutiny. What Senn takes to be evidence in *HP* that Theophrastus attempted to mark a distance from Aristotle is best understood as a reminder that the study of plants cannot be fully assimilated to the study of animals. As such, these remarks are compatible with the Aristotelian requirement that scientific progress is possible only if we pay due attention to what is specific to the object of study. See [Chapter 4, Section 2](#).

Otto Regenbogen responded to Senn.<sup>3</sup> He argued that Aristotle could not be referring to *CP* II 17 in texts [A] and [B] because Aristotle and Theophrastus offer alternative accounts of how the mistletoe grows in their extant writings. While Aristotle believes that the mistletoe is generated spontaneously from some rotten part of the host plant, Theophrastus thinks that the mistletoe always grows from seed.<sup>4</sup> Moreover, *CP* II 17 contains an implicit correction of Aristotle's account of how the mistletoe is generated.<sup>5</sup> When Aristotle refers to an investigation of plants in text [A], and refers to it as an investigation that is already in place when he writes *HA* V, he can only be referring to his own lost work on plants.

What do we learn from this scholarly controversy? At the very least, that we should be very careful when we try to establish a connection between the corpora of writings written by Aristotle and Theophrastus. The putative cross-references between their works are self-consciously crafted in impersonal terms. As for the reference to the investigation of plants in text [A], we cannot be sure that this is a reference to a lost work by Aristotle. But we cannot rule it out either.<sup>6</sup>

A similar point can be made in connection with the cross-reference in text [C]. Aristotle signals that the study of flavors offered in *Sens.* 4 is to be integrated with what is said on the same topic in the part of the study of nature that deals with plants. Scholars read into this passage a reference to the discussion of flavored juices and odors transmitted as *CP* VI. In this scenario, the cross-reference to the study of plants in the Aristotelian corpus would match the impersonal reference to the study of animals found at the outset of *CP* VI, where we are told that "the nature of flavored juice and odor has been defined elsewhere."<sup>7</sup> By reading the passage in this way, we find some support for a division of labor within the early Peripatos on the topic of plants and animals. While Aristotle would have concerned himself with animals, Theophrastus would have concentrated his attention on plants. What is especially interesting is that neither Aristotle nor Theophrastus takes ownership of the study of either animals or plants.

<sup>3</sup> REGENBOGEN 1937: 469–475.

<sup>4</sup> For Theophrastus, the mistletoe grows from seed when birds eat the fruit of the mistletoe and let their droppings fall on the host plant. See Theophrastus, *CP* II 17.5.

<sup>5</sup> Suzanne Amigues agrees that Theophrastus is implicitly correcting the account of the mistletoe (AMIGUES 2012: 221).

<sup>6</sup> Robert Mayhew has recently returned to the account of the mistletoe offered in *CP* II 17 (MAYHEW 2021: 463–475). He argues that here Theophrastus is relying on data presented by Aristotle in *HA* VIII (IX). I do not think that we can establish this conclusion beyond any reasonable doubt. I offered my reasons in Chapter 4, Section 2.

<sup>7</sup> Theophrastus, *CP* VI 1.1.

Rather, they regard their works on animals and plants as separate yet coordinated contributions to a single shared research program.

This conclusion comes very close to the position I defended in this book, except that I do not see a rigid division of labor between Aristotle (animals) and Theophrastus (plants). I refer the reader to [Appendix II](#) for the evidence that Theophrastus wrote on animals. What is important here is that both *Aristotle and Theophrastus agree that animals and plants are to be studied separately*. Consider text [D], which marks the beginning of Aristotle's study of the non-uniform parts in *PA II* 10.<sup>8</sup> Aristotle argues that two parts are the most indispensable for animals: the part for taking in nourishment and the part for discharging useless residue as it is not possible to grow without nourishment. Since nutrition is common to all living beings, the part for taking in nourishment is also found in plants. But plants do not have a part for the elimination of the useless residue. Aristotle's explanation for this absence is that plants take in concocted nourishment from the soil.<sup>9</sup> But this also means that plants do not have the part dedicated to receiving and processing unconcocted nourishment (the stomach). This stretch of text is interesting because Aristotle is engaged in a unified study of perishable living beings. And yet there is not much else Aristotle is able, or willing, to say on the topic of plants and animals insofar as they are both living beings. Rather than building a bridge between the study of animals and that of plants, he ends up arguing for their separation.

Notwithstanding the fact that Aristotle envisions separate studies of animals and plants, he offers scattered remarks on the topic of plants. While these remarks do not constitute a systematic study of plants, they show that Aristotle is knowledgeable about plants. It is not my goal in this appendix to discuss all the passages where Aristotle mentions plants.<sup>10</sup> Here I call attention to the stretch of text printed in [F]. Aristotle remains persuaded that the phenomenon of plant propagation requires a separate discussion. He makes this point, explicitly and unequivocally, in text [B]. His view is that there cannot be such a thing as a common treatment of generation in animals and plants. Nonetheless, he develops scientific concepts that can be employed in the separate treatments of animals and plants. One of them is “κύημα” (imperfectly rendered here as “fetus”). It refers to the first mixture of the generative contributions coming from the male and the female. Aristotle is willing to apply this concept beyond the narrow boundaries of his theory of sexual generation. In text [F], he tells us

<sup>8</sup> I discuss this text in [Chapter 2, Section 5](#). <sup>9</sup> Compare Aristotle, *PA II* 3, 650a20–23.

<sup>10</sup> A reasoned collection of all these passages can be found in [WIMMER 1838](#).

that what we call seed in plants is the equivalent of the first mixture of the male and the female. This term is also employed in the account of plant propagation Theophrastus offers in *CP*.<sup>11</sup>

### Texts

- [A] [Certain modes of reproduction] happen to be common to animals and plants. Some plants are generated from the seed of other plants, while others are generated spontaneously when some seed-like source [of generation] is formed. Among spontaneously generated plants, some take their nourishment from the earth, while others are generated in other plants, *as we stated in the study of plants* [ὡς περ εἴρηται ἐν τῇ θεωρίᾳ τῇ περὶ φυτῶν]. Likewise with animals: some are generated from animals whose form is of the same kind, while others are generated spontaneously and not from animals of a common kind. Among the spontaneously generated animals, some are generated from rotting earth and plants, which is the case in many insects, while others [are generated] in the animals themselves out of the residues in their parts. (Aristotle, *HA* V I, 539a15–25)
- [B] Animals that are not capable of locomotion, as for instance the hard-shelled animals and those that live by growing attached [to something else], are similar in substance to plants: just as in the latter so also in these animals there is no female and male. However, they have come to be called female and male in virtue of a similarity or analogy, since they have some such small differentiation. Indeed, among plants too, there are trees in the same kind that bear fruit and trees that do not do so but contribute to the concocting in those that bear, as occurs with the fig and the caprifig. It is the same with plants, since some plants are generated from seed, while others as though by nature acting spontaneously. The latter happens either when the earth is rotting or when some parts in the plants are; for some plants are not constituted separately by themselves but are generated on other trees (e.g., the mistletoe). *But plants ought to be investigated separately by themselves* [περὶ μὲν οὖν φυτῶν αὐτὰ καθ' αὐτὰ χωρὶς ἐπισκεπτέον]. (Aristotle, *GA* I I, 715a16–716a2)
- [C] We have spoken about flavors and tastes; *the other attributes of flavors are the specific object of research in the part of the study of nature that is*

<sup>11</sup> More on this in [Chapter 5, Section 2.2](#).

*concerned with plants* [τὰ γὰρ ἄλλα πάθη τῶν χυμῶν οἰκείαν ἔχει τὴν σκέψιν ἐν τῇ φυσιολογίᾳ τῇ περὶ τῶν φυτῶν]. (Aristotle, *Sens.* 4, 442b24–26)

- [D] Let us now make, as it were, a fresh start again, beginning first from what is first. Two parts are the most necessary in all animals that are complete: that by which nourishment is taking in that by which the residue is discharged. Plants – we say that they too are alive – have no place for the useless residue because they take their nourishment concocted from the earth, and instead of this they yield seeds and fruit. A third part, present in all animals, is between these two, in which is the source of life. The nature of plants, being stationary, does not have many kinds of uniform parts. The reason is that their use of the organs is for fewer activities. *This is the reason why the visible character of plants ought to be studied separately* [διὸ θεωρητέον καθ'αὐτὰ περὶ τῆς ιδέας αὐτῶν]. (Aristotle, *PA II 10*, 655b28–656a3)
- [E] The same happens in the case of animals and plants. In plants, males live for the most part longer [than females]. Their upper body is larger than their lower body (the male is more dwarf-like than the female), and the heat is in the upper part while the cold is in the lower part. Among plants, too, those that have a large head live longer. Such are those that are not annual but are like a tree: their upper part – namely their head – are the roots, and the plants that are annual grow downward toward their fruit. *But this topic will be determined separately in the works in which plants are discussed by themselves* [ἀλλὰ περὶ μὲν τούτων καὶ καθ'αὐτὰ ἐν τοῖς περὶ φυτῶν διορισθήσεται]. For the time being, the cause of the length and shortness of life in the other animals is stated. There remains for us to study youth and old age, as well as life and death. When these topics are determined, the investigation into animals will have reached its conclusion. (Aristotle, *Long.* 6, 467a30–b9)
- [F] Thus, in all the animals that are capable of locomotion, the female is separate from the male, and one animal is female and another male, although in form they are the same (e.g., both are a human being or a horse). By contrast, these capacities are mixed in plants and the female is not separated from the male. That is why plants generate out of themselves and emit not semen but rather a fetus [κῆμα] – what we call seeds [σπέρματα]. Empedocles says this well, poetizing: “*In this way tall trees bear eggs: first olive-trees.*” The reason is that the egg is a fetus [κῆμα], and from some of it the animal is produced, while the remainder is nutriment, and the growing plant is produced

from a part of the seed, while the remainder becomes nutriment for the shoot and the first root. In a way, the same thing happens also in the animals that have the female and the male separated. When they need to generate, they become unseparated, as in plants, and their nature wants to become one. This thing is evident to sight when they unite and couple: a single animal comes to be from both. And the animals that do not emit semen remain naturally connected for a long time, until the fetus [κύημα] is being constituted, like the insects that couple; but others until one of their inserted parts send forth that which will constitute the fetus in a certain amount of time, as in the case of blooded animals. The former animals remain connected for a part of the day, while the semen in the latter animals takes several days to constitute the fetus, but they detach themselves once they have emitted this sort of thing. And animals seem just like divided plants, as if someone, when plants produce seed, were to tear them apart and separate them into the female and male that is present in them. Moreover, nature crafts all this reasonably. The reason is that there is no function or action in the being of plants other than the coming to be of the seed, so that since this comes about by means of the coupling of the female and the male, nature has arranged them with each other by mixing them. *That is why in plants the female and the male are unseparated; however, it was investigated about plants elsewhere* [διὸ ἐν τοῖς φυτοῖς ἀχώριστον τὸ θῆλυ καὶ τὸ ἄρρεν· ἀλλὰ περὶ μὲν τούτων ἐν ἑτέροις ἐπέσκεπται].<sup>12</sup> By contrast, the animal's function is not only generating (this is in fact common to all living things), but all animals participate in some form of cognition – some more, some less, and some very little indeed. (Aristotle, *GA* I 23, 730b33–731a33)

- [G] The source of the nutritive soul is [located] in the middle of the three parts,<sup>13</sup> and is evident by perceptual observation and by rational argument. Many animals, whenever either one of the two parts (the one that is called head and the one that receives the nourishment) is cut off, go on living with the part in the middle. This is clear in the case of insects such as wasps and bees. Moreover, many animals that are not insects can continue to live when cut off due

<sup>12</sup> Aristotle tends to look ahead to the study of plants as a study that follows in the order of exposition the study of animals. But here he refers to a study that is already in place. See text [A] for another such case.

<sup>13</sup> The three parts are that by which the animals receive nourishment, that by which they discharge the residues, and the part located midway between the two. Compare text [A].



to their nutritive capacity. While it is one in actuality, such a part is potentially more than one. [These animals] are formed in the same way as a plant. Plants, when they are cut off, go on living separately and become many trees from a single origin. *The reason why some plants cannot go on living when cut up, whereas other plants grow from cuttings, will be the object of another study* [δι' ἣν δ' αἰτίαν τὰ μὲν οὐ δύναται διαιρούμενα ζῆν, τὰ δ' ἀποφυτεύεται τῶν φυτῶν ἕτερος ἔσται λόγος]. (Aristotle, *Juv.* 2, 468a20–b1)

- [H] Among animals, evidently humans go bald most of all. Still, such a condition is something general. Among plants, some are evergreen while others are deciduous, and birds that hibernate shed their feathers. Such is baldness in those humans to whom such a condition occurs. Leaves are partially shed in plants, and so are feathers and hair in those animals that have them. However, when the condition occurs all at once, it is described by the name mentioned: it is called “going bald” and “falling of the leaves.” The cause of this condition is the lack of hot moisture. Among fluids, fat has it most of all. This is the reason why oily plants tend to be evergreen. *But, with regard to these plants, the cause is to be discussed elsewhere, for other causes too contribute to this condition in their case* [ἀλλὰ περὶ μὲν τούτων ἐν ἄλλοις τὸ αἴτιον λεκτέον· καὶ γὰρ ἄλλα συναίτια τούτου τοῦ πάθους αὐτοῖς]. (Aristotle, *GA V* 3, 783b8–22)

*Theophrastus on Animals*Table AII.1 *Theophrastus on animals*

1.	Περὶ ἕτεροφωνίας ζώων τῶν ὁμογενῶν α'	1.	<i>On the Diversity of Voice in Animals of the Same Kind</i> , one book
2.	Περὶ τῶν ἀθρόον φαινομένων α'	2.	<i>On [Animals] That Appear in Swarms</i> , one book <sup>1</sup>
3.	Περὶ δακέτων καὶ βλητικῶν α'	3.	<i>On [Animals] That Bite and Sting</i> , one book
4.	Περὶ τῶν ζώων ὅσα λέγεται φθονεῖν α'	4.	<i>On Animals That Are Said to Be Malicious</i> , one book
5.	Περὶ τῶν ἐν ξηρῷ διαμενόντων α'	5.	<i>On [Animals] That Live on Land</i> , one book
6.	Περὶ τῶν τὰς χροῶς μεταβαλλόντων α'	6.	<i>On [Animals] That Change Color</i> , one book
7.	Περὶ τῶν φωλευόντων α'	7.	<i>On [Animals] That Hibernate</i> , one book
8.	Περὶ ζώων α' β' γ' δ' ε' ς' ζ'	8.	<i>On Animals</i> , seven books
9.	Περὶ τῶν αὐτομάτων ζώων α'	9.	<i>On Animals Generated Spontaneously</i> , one book.
10.	Ἐπιτομῶν Ἀριστοτέλους περὶ ζώων α' β' γ' δ' ε' ς'	10.	<i>Summary of Aristotle's On Animals</i> , six books
11.	Περὶ ζώων φρονήσεως καὶ ἤθους α'	11.	<i>On the Intelligence and Characters of Animals</i> , one book
12.	Περὶ ζώων	12.	<i>On Animals</i>

The titles listed in [Table AII.1](#) are found in the catalog of books reported in Theophrastus's *Life of Theophrastus*.<sup>2</sup> An educated guess is that this catalog goes back to the pinacographical activity of Hermippus of Smyrna (third century BC). In this scenario, Hermippus drafted his catalog (πίνακες) as an appendix to his *Life of Theophrastus*.<sup>3</sup>

<sup>1</sup> I supply "animals." Robert Sharples amplifies his translation with "creatures." But this amplification ends up obfuscating the distinction between animals and plants.

<sup>2</sup> Diogenes Laertius V 42–50. Full discussion of these titles is in [REGENBOGEN 1950: 1423–1434](#) and [SHARPLES 1995: 41–48](#).

<sup>3</sup> For Hermippus and his biographical writings, the reference book is [BOLLANSÉE 1999](#). On the origin of the catalog, see [BOLLANSÉE 1999: 168–170](#) (with additional bibliographical information).

The information preserved in the catalog helps us correct the impression that Theophrastus was engaged in a study of plants to the exclusion of animals. His interest was in both kinds of perishable living beings, and his research output on the topic of animals was second only to that of Aristotle. It is not difficult to see why the subsequent tradition has transmitted his works on plants to the exclusion of his writings on animals. His writings on animals were largely concerned with difficult or remarkable cases. Of course, they are difficult or remarkable cases *for a certain theory*: the theory that can be extracted from the extant works on animals transmitted under the name of Aristotle. But this also explains why his writings on animals enjoyed limited success. They were taken to be secondary with respect to Aristotle's works on animals, and they were even considered to be expendable with respect to the zoological theory that can be extracted from those works. I will not try to correct this impression. Instead, I would like to stress that there is no need to read in Theophrastus's focus on difficult or remarkable cases an attempt to challenge, let alone reject, Aristotle's theory. His motivation to deal with these cases must be found within this theory. To the extent that they can be reconstructed, his writings betray the ambition to make sense of these difficult cases in terms of the theory. This is so even when the question of the extent to which the theory can be applied to these cases is not explicitly answered.<sup>4</sup>

Let us consider the only extant work on animals by Theophrastus, which is transmitted in the manuscript tradition with the rather misleading title *On Fish*.<sup>5</sup> This work is almost certainly identical to the fifth item on our list: *On [Animals] That Live on Land*, one book.<sup>6</sup> Theophrastus is concerned with animals that live in water but also spend time on dry land. These animals live a double life with respect to water and dry land. In Aristotle's terminology, they dualize (ἐπαμφοτερίζειν).<sup>7</sup> Theophrastus adopts Aristotle's explanation of how animals control their bodily temperature by taking in water or air to deal with a few remarkable cases. What makes these cases remarkable is that the animals appear to take in both water and air. The qualification "θαυμαστόν" (remarkable) qualifies a few

<sup>4</sup> This addition is needed since the lack of an explicit answer in the text can in principle be taken to imply a challenge.

<sup>5</sup> An edition of the Greek text is in SHARPLES 1992.

<sup>6</sup> Athenaeus (*Deipn.* VII 312 B, 317 F) quotes from this book, which he knows under the title *On [Animals] That Spend Time* (διατρωμένων and διατριβόντων instead of διαμενόντων) *on Dry Land*. The most likely title for our short essay is the one preserved in the catalog rather than the one transmitted by the manuscript tradition.

<sup>7</sup> Theophrastus adopts this technical term at the outset of the essay to signal that he is concerned with dualizers (*On Fish* 1.5–10). On dualizers, see LLOYD 1983: 44–53.

of the cases discussed by Theophrastus.<sup>8</sup> The subsequent tradition lost interest in the underpinning zoological theory but preserved a gusto for the remarkable as such; by contrast, Theophrastus was driven by a theoretical agenda he shared with Aristotle.

An interest in remarkable cases can also be inferred from the following titles: *On [Animals] That Appear in Swarms*, *On [Animals] That Change Color*, and *On Animals That Are Said to Be Malicious*. The extant information regarding the first of these three lost essays (*On [Animals] That Appear in Swarms*) is especially interesting. Photius was still able to read this short text in Byzantium in the ninth century AD, so he left a record of its contents.<sup>9</sup> Based on Photius's synopsis, Sharples suggested that Theophrastus carried out a study of spontaneous generation.<sup>10</sup> While this is quite possible, the focus of the work must have been broader. Animals that swarm include snails, frogs, snakes, and mice. These animals swarm after they have been generated sexually often due to exceptional atmospheric phenomenon such as heavy rains and sudden floods. Theophrastus's interest in the phenomenon of spontaneous generation is at any rate documented by the title *On Animals Generated Spontaneously*. This work may have fulfilled a promise Theophrastus made in the context of his study of plants.<sup>11</sup> Photius has also summarized the contents of the essays *On Animals That Change Colors* and *On Animals That Are Said to Be Malicious*.<sup>12</sup> The first was concerned with the ability of the octopus, the chameleon, and the very mysterious *tarandos*<sup>13</sup> to change color in order to take on the colors of the adjacent plants, rocks, and localities.<sup>14</sup> The second deals with our projection of human motives onto animal behavior. Put differently, the focus of this work is on animals that *are said* to be malicious but in fact are not.

The remaining titles transmitted in the catalog imply that Theophrastus had an interest in animal behavior with a special focus on hibernation, habitat, and ecology. Robert Sharples has argued that the differences in

<sup>8</sup> Here are the first three occurrences of the term in connection with the first two cases discussed: "most remarkable of all" (θαυμαστότατον) is the case of the so-called out sleeper, a fish that makes its bed on dry land every day (*On Fish* 1). "Remarkable" (θαυμαστό) are the little fish found in India that come out of the rivers onto the dry land and jump around and go back into the water again like frogs (*On Fish* 2). In the end, however, this case is "less remarkable" (ἥττον θαυμαστόν) than the case of the out sleeper.

<sup>9</sup> Photius, *Biblioth.* 278, 527b11–528a39 (= FHS&G 359A). <sup>10</sup> SHARPLES 1995: 43–44.

<sup>11</sup> Theophrastus, *CP* I 5.5. <sup>12</sup> Photius, *Biblioth.* 278, 528a40–b27 (= FHS&G 362A).

<sup>13</sup> Compare [Aristotle], *Mir.* 30, 832b8–16. The *tarandos* is described as a wild animal native to Scythia, having the size of an ox and the head of a deer. Instead of changing the color of its skin like the octopus and the chameleon, the *tarandos* reportedly changed the color of its hair.

<sup>14</sup> On this lost work, see LERODIAKONOU 2020a: 81–119.

voice discussed are those linked to local variation.<sup>15</sup> On this suggestion, the essay *On the Diversity of Voice in Animals of the Same Kind* also circulated under the title *On Differences According to Locality*.<sup>16</sup>

The entry *On Animals*, seven books, need not refer to a separate work on animals. It may well be evidence that the seven short monographs, which were written as independent and self-contained essays by Theophrastus, were subsequently assembled into a single work.<sup>17</sup>

The title *Summary of Aristotle's On Animals*, six books, is noteworthy because it contains an explicit reference to Aristotle. Apparently, this title refers to an abridgment in six books of the works on animals authored by Aristotle. At the very least, we can infer from this title that Aristotle's works on animals were clearly distinguished from what writers such as Theophrastus himself and Eudemus of Rhodes may have contributed to the study of animals. This is far from a trivial observation, especially if we bear in mind that, at least in his extant writings on plants, when Theophrastus refers to the study of animals, he never distinguishes what Aristotle has accomplished from what he may have contributed to this study. His references to the study of animals are self-consciously impersonal. I argued that this practice suggests the existence of a shared project within the Peripatos. Still this title suggests that the works that Aristotle contributed to the study of animals enjoyed a somewhat special status.<sup>18</sup>

I do not see any reason to doubt that Theophrastus compiled an abridgment of Aristotle's study of animals. We do not know the motivations that may have prompted Theophrastus to produce such a compilation. We should recall, however, that Aristophanes of Byzantium in the third century BC wrote a summary of Aristotle's works on animals. His stated goal was to make everything Aristotle wrote on animals available to the reader in one place.<sup>19</sup> While we have no reason to think that there was any special relation between the extant summary by Aristophanes and the abridgment made by Theophrastus, we can speculate that, very early on, the corpus of works on animals was felt to be too large

<sup>15</sup> This is a topic taken up by Aristotle in *HA* IV 9, 535a28–536b33 *GA* V 7, 786b7–788b3.

<sup>16</sup> Athenaeus, *Deipn.* IX 390 A: περί τῶν κατὰ τόπους διαφορῶν.

<sup>17</sup> For this hypothesis, see BOLLANSÉE 1999: 167–168. Sharples (in SHARPLES 1995: 41–42) remains skeptical.

<sup>18</sup> Aristotle's cross-references to plants are equally impersonal. See Appendix I.

<sup>19</sup> Aristophanes, *Epitome* II 1: "I will try to do this so that you need not go through Aristotle's study of animals [πραγματεῖα περί ζώων], which is spread over many books, but you could have the factual information [ἱστορία] on each animal *together in one place*" (my emphasis). More on Aristophanes and his project in FALCON 2022b: 421–442.

and too technical. As a result, a condensation and simplification of this corpus – maybe also motivated by didactic reasons – was deemed necessary.

We should not rule out that Aristophanes and Theophrastus approached Aristotle's corpus of writings on animals from different angles. Recall that Aristophanes was a grammarian interested in Homeric textual criticism, Attic comedy, and a lexicography. His goal was to produce a reference work for scholars and poets interested in scientific data for their own literary activity.<sup>20</sup> By contrast, Theophrastus was Aristotle's colleague and his most important collaborator. We can safely assume that his summary reflected the scientific concerns that motivated Aristotle's study of animals in the first place.

Finally, we cannot rule out that other titles in the catalog may have dealt with animals. It has been suggested, for instance, that the lost *On [Kinds of] Hair* may fit well with the project of *GA 5* – that is, explaining accidental features of animals in terms of material causes.<sup>21</sup>

<sup>20</sup> HATZIMICHALI 2021: 228–245 and FALCON 2022b: 421–442. Compare also HELLMANN 2006: 354–355.

<sup>21</sup> LEFEBVRE 2016b: 18.

*[Aristotle]*, On Plants

## I Problems of Authorship and Dating

A full study of the complex and fascinating history of the transmission of this text can be found in [DROSSAART LULOFS-POORTMAN 1989](#). Here are the bare bones of the story. The original Greek of this work is not extant, but this work enjoyed great success in the Aristotelian tradition since it was translated into Syriac, Arabic, Hebrew, and Latin. A Greek retroversion based on the Latin version was made in the second half of the thirteenth century AD. This retroversion is the text printed in the Bekker edition of Aristotle.<sup>1</sup> The historical and philological relevance of the extant Greek text is negligible.<sup>2</sup> Far more important is the Arabic translation made by Isâq ibn Hunayn (*ca.* 900 AD) – most likely after the lost Syriac translation. This Arabic translation was the basis for both the Latin translation produced by Alfred Sarashel (*ca.* 1200 AD) and the Hebrew translation prepared by Qalonymos ben Qalonymos (1314 AD).

The Arabic tradition ascribes our text to “Nicolaus,” who is said to have explained (i.e., commented on) the lost work on plants by Aristotle.<sup>3</sup> I have already indicated that the relation between our extant text and the lost work by Aristotle on plants is, to say the least, poorly understood.<sup>4</sup> H. J. Drossaart Lulofs, who is also the last editor of our work, believes

<sup>1</sup> [BEKKER 1831](#): 815a10–830b4.

<sup>2</sup> [DROSSAART LULOFS 1957](#): 75. Compare [DROSSAART LULOFS-POORTMAN 1989](#): “On the whole, it must be admitted that [the Greek translation] is even less reliable than Alfred’s Latin version. The ‘law’ that in each subsequent translation the text deteriorates appears to be inexorable, and the naive expectation of the Greek [translator] that he could restore a lost work of Aristotle for his compatriots was not realized” (575).

<sup>3</sup> Haġgi Khalifa (died in 1658 AD), *Lexicon bibliographicum* V, p. 16 nr. 10564: “The book on plants of Aristotle in two treatises which Nicolaus explained and Ishâq ibn Hunayn translated with correction by Tâbit ibn Qurra.” The book on plants is attributed to Nicolaus by Ibn al-Nadîm (254.1–4 Flügel) and Ibn al Qifî (336.5–12 Lippert).

<sup>4</sup> See the [Introduction](#).

that vestiges of the lost work on plants by Aristotle can still be found in our text.<sup>5</sup> He also believes that Nicolaus, the author of the work on plants, is the same person as Nicolaus of Damascus, the author of a compendium of Aristotelian philosophy. He also defends the traditional identification of Nicolaus, the author of the compendium of Aristotelian philosophy, with the advisor and friend of King Herod of Judea and Emperor Augustus, as well as preceptor of the twin children of Cleopatra and Antonius. If this identification is accepted, both our extant work on plants in two books and the compendium of Aristotelian philosophy must be dated to the end of the first century BC.

Drossaart Lulofs addresses the question of the relation between the compendium of philosophy and the work on plants. His main results can be summarized as follows: this relation remains difficult to ascertain, but it is not likely that the work on plants was originally part of the compendium.<sup>6</sup> And yet, the *modus operandi* might have to be the same in both works. In fact, the way in which Nicolaus condensed and abbreviated Aristotle's philosophy in the compendium may help us understand how Nicolaus operated in the work on plants. Arguably, the most original feature of the compendium is the attempt to complete the Aristotelian project with results reached in fields of study left untouched, or only briefly touched, by Aristotle. In those cases, Nicolaus availed himself of the results reached by Theophrastus.<sup>7</sup> In light of this, the compendium is best described as a summary of *Peripatetic* philosophy. And yet it is presented as a summary of *Aristotle's* philosophy.<sup>8</sup> Following this, it is hard to resist the following conclusion: Nicolaus considered Theophrastus a loyal pupil of Aristotle and regarded his research output as a straightforward contribution to Aristotle's philosophy.

<sup>5</sup> For more on how Drossaart Lulofs sees the complicated relation between the extant versions of this summary and the lost work on plants by Aristotle, I refer the reader to the diagram printed at the outset of the wonderful edition of the five extant versions of this summary that Drossaart Lulofs jointly produced with E. L. J. Poortman (DROSSAART LULOFS-POORTMAN 1989: xiv).

<sup>6</sup> H. J. Drossaart Lulofs describes the relation between the extant work on plants and the compendium as follows: "all things considered, the question whether *De plantis* was part of Nicolaus' *Compendium* does not admit of a definite answer, but the odds are against its being positive" (DROSSAART LULOFS-POORTMAN 1989: 20–21).

<sup>7</sup> Hidemi Takahashi (in TAKAHASHI 2002: 189–224) goes a long way toward explaining how Nicolaus operated in connection with the extant fragments from book 7. In his words, this book "was devoted to a summary presentation of those sciences left untouched by Aristotle and developed by Theophrastus (mineralogy, botany, and hydrology, along with some new elements of zoology)."

<sup>8</sup> The transmitted title of the compendium is *On the Philosophy of Aristotle*. See the evidence collected in DROSSAART LULOFS-POORTMAN 1965: 9–11.



The complicated edifice I outlined above rests on a double identification – namely, the identification of Nicolaus the author of the work on plants with Nicolaus of Damascus and the identification of Nicolaus of Damascus with the author of compendium of Aristotelian philosophy. But how solid is this foundation? Silvia Fazzo has challenged the second identification on the ground that the Aristotelian compendium betrays knowledge of a *Metaphysics* that includes the second book (*Alpha elatton*).<sup>9</sup> In brief, she does not believe that a *Metaphysics* that included this book could circulate before Alexander of Aphrodisias (end of second century to beginning of third century AD). If she is right, the author of the Aristotelian compendium should be dated after Alexander of Aphrodisias. I will not follow her argument in any detail. What matters is her conclusion: Nicolaus the author of the compendium of Aristotelian philosophy should be identified with Nicolaus of Leodicea in Syria (fourth century AD). Bernhard Herzhoff, in an article specifically concerned with the extant work on plants attributed to Aristotle, has accepted this conclusion.<sup>10</sup> He has also built on the suggestion made by Fazzo to read the activity of Nicolaus of Leodicea in connection what was attempted around the same time by Themistius. This connection has led Herzhoff to venture the following suggestion: we should abandon the patchwork hypothesis that has dominated scholarship on and around the work on plants attributed to Aristotle in favor of the alternative hypothesis that this treatise is largely based on the lost work on plants written by Aristotle. While we cannot exclude an infusion of materials from the Peripatetic tradition, and in particular from Theophrastus, we should operate on the assumption that the extant work is a condensation of the original arguments and claims made by Aristotle rather than an amalgam of Peripatetic ideas.

In the almost complete absence of independent evidence about the lost work on plants by Aristotle, it remains difficult, if not impossible, to isolate what is by Aristotle from what is not. One example will clarify this point. The work opens with a doxographical section that has no parallel in the extant writings by Aristotle. While it is quite possible that this section goes back to his lost work on plants, this cannot be confirmed in the absence of any other source of information.

<sup>9</sup> FAZZO 2008: 99–126. Further evidence for a later dating of Nicolaus the author of the compendium is offered in a joint article by Silvia Fazzo and Mauro Zonta (FAZZO-ZONTA 2008: 681–690).

<sup>10</sup> HERZHOFF 2016: 135–187.

## 2 Outline of the Contents

What follows is a review of the work on plants transmitted under the name of Aristotle. The goal is to provide the reader with an idea of its contents. A full analysis of the claims made, or a complete discussion of their putative source (or sources), goes beyond the scope of this appendix.<sup>11</sup>

The work begins with the statement that life is found in animals and plants, but it is patent and obvious in animals whereas it is hidden and not clear at all in plants (815a10–13). The text goes on to announce a preliminary inquiry into whether plants have soul, capacity for desire and pleasure, and power of discrimination (815a13–15).<sup>12</sup> The ensuing review of reputable opinions on the topic of plants has no parallel in the extant writings by Aristotle. However, it has one in the doxographical tradition.<sup>13</sup> A look at this tradition suggests that the debate on whether plants are ensouled beings remained very much alive after Aristotle both in Hellenistic and post-Hellenistic times. This may explain why Nicolaus felt the need to open his work on plants with a review of this debate. His diagnosis of the source of this disagreement is the inability of philosophers to find any intermediate between life and its privation (815a35–816a1). His solution consists in carving out the theoretical space for a kind of life that does not require cognition in the form of sense-perception or the capacity to feel pleasure and pain. None of this is terribly original.

Next, Nicolaus turns to the topic of the presence or absence of sexes in plants. This investigation is motivated by recalling Empedocles and his view that the male and the female are mixed in plants (816b30–817a3, 817a9–11). Nicolaus objects that for two things to mix, they have first to exist separately. Nicolaus replaces the Empedoclean view with the Aristotelian claim that the two sexes are not separate in plants. He explains this claim by recalling that the seed (σπέρμα) is *analogous* to the first κύημα in animals. In other words, the seed of a plant is *analogous* to the first mixture of the generative contributions coming from the male and the female principles of animal life (817a28–36). What we read in this stretch of text seems to be an intelligent reworking of what we find in *GA I* 23.<sup>14</sup>

<sup>11</sup> A more in-depth review of the contents of this work is offered in [MORAUX 1973](#): 487–514. [FERRINI 2012](#) contains a rich apparatus of endnotes helping the reader to navigate the work.

<sup>12</sup> At least at this early stage of the inquiry, we should not presuppose any specific view on how the power of discrimination may be related to the capacity to feel pleasure and pain and the capacity to desire.

<sup>13</sup> Aëtius, *Placita* V 26.1–4 (= *Dox. gr.* 440.4–20). For more on the doxographical tradition going back to Aëtius, see [Chapter 1, Section 1](#).

<sup>14</sup> The relevant passage is printed as text [F] in [Appendix 1](#). For more on the Aristotelian solution and its theoretical implications, see [Chapter 5, Section 2.2](#).

The rest of the first book is an abridgment of what Theophrastus says on the topic of plants in *HP I* and *HP II*. The original topics and their order of discussion are still detectable even though the work by Nicolaus has been considerably abbreviated by its translators to the point that it is at times hard to follow his original train of thought. A discussion of the bodily parts in plants, with a concentration on the difficulties that the investigator has to face in deciding what counts as a genuine part, is offered (818a36–b27).<sup>15</sup> The largest kinds of plants Theophrastus gives as a first orientation to the study of plants are also found in our text (819a41–b3).<sup>16</sup> An attempt at their definition is followed by a review of the way (or rather ways) in which plants differ from one another, with an emphasis on the distinction between domesticated and wild plants (819b27–39) and on the relation between plants and their habitat (819b39–820a10).<sup>17</sup> After a review of how plants differ with respect to their juices and fruit, the focus shifts to the modes of generation. The rest of the first book appears to be a condensed version of what we find in *HP II* 1–7.

The second book begins with an account of nutrition and growth in plants. The details of the discussion are difficult to follow because of the lack of the original source combined with the fact that this source has been abbreviated and condensed to an extreme point. The translation from the Greek to the Syriac and from the Syriac to the Arabic has yielded a text that is garbled in a few places.

Concoction (πέψις) appears to be the key natural process that explains how the moisture taken from the soil is assimilated by the plant. We are told that concoction requires the interaction of three powers that can be traced back respectively to earth, water, and fire (822a12–14). This interaction is most clearly at work in the production of pottery. To make pottery, we need clay, water as a kind of glue, and fire. When wet clay is baked, the moisture is dispersed, and the particles of clay cohere together (822a16–24).

The explanation of what happens when a compound of earth and water is solidified by the agency of fire is discussed at the most general level for the formation of stones and metals as well as the generation of the bodily parts of animals and plants. It is only when this common account is in place that the focus shifts to what is specific to the case of plants. What we are told at the start of the second book can be described as an attempt to give

<sup>15</sup> The original discussion is found in Theophrastus, *HP I* 1.1.   <sup>16</sup> See Theophrastus, *HP I* 1.3.

<sup>17</sup> The section on the habitat is an abridgment of Theophrastus, *HP I* 4.2–4.

a common account of the formation of organic and inorganic bodies. It reminds us of what Aristotle says in *Meteorology* IV.

What is specific about concoction in plants is described in the following terms: the dryness of the plant draws moisture from the soil; as this moisture moves up in the plant, it is also warmed up (822b1–6).<sup>18</sup> We are not told what agent is responsible for warming up the moisture drawn from the soil, but this agent can only be the innate heat of the plant that is associated with fire. Growth is understood as the outcome of a straightforward process of solidification: once heated, the moisture drawn from the soil becomes solid and is added to the body of the plant. Since plants are relatively simple living bodies, they can grow quickly. For instance, small herbaceous plants grow in a single day (822b5–6). This is not true for animals because their bodies are more articulated; in addition, their nutriment requires further processing to be assimilated by animals (822b6–8).<sup>19</sup>

What is drawn from the soil is distributed to the entire body of the plant and whatever is in excess flows out (822b18–20). The explanation of how the moisture can move from the roots up to the rest of the plants is a major concern in this stretch of text. An analogy is offered with the formation of springs and rivers in the mountains. Whenever an excess of water is forced into a narrow channel, the excess of steam rising from them seeks an exit on the surface. The reader is also referred to the *Meteorology* for a fuller discussion of this phenomenon (822b32–34).<sup>20</sup>

After a long and tortuous discussion of a few meteorological phenomena, the focus shifts to the role that the habitat plays in the growth of the plant. We are told that a plant needs two things: proper nutrition and a position suitable to its nature (824a36–39). What follows is a review of the

<sup>18</sup> At 822b1, I am following the Arabic version, which reads (in Drossaart Lulofs's translation) as follows: "within plants movement is easy because dryness, which is one of the powers of earth, draws moisture." We are not told why the dryness of the plant draws the moisture from the soil. Recall, however, that Theophrastus invokes *antiperistasis* for the explanation of why an "empty" plant draws its nutriment from the soil (see Chapter 5, Section 3).

<sup>19</sup> At least for Aristotle, animals take in *unconcocted* nutriment. As a result, their nutriment requires further work before it can be assimilated and added up to their bodies. This further work is not needed in the case of plants because they draw *concocted* moisture from the earth. The moisture in the soil is concocted by the agency of the sun and the surrounding air. See the main text for more on this point.

<sup>20</sup> This reference gives rise to an excursus on a few meteorological phenomena such as the cause of earthquakes, the formation of sand by the sea, and the formation of salt water. In addition to Aristotle's *Meteorology*, Nicolaus must have used Theophrastus's *Meteorology*. It has long been noted that the source of the explanation of the saltiness of water agrees with what we know about Theophrastus's views on the topic. See MORAUX 1973: 509 and DROSSAART LULOFS-POORTMAN 1989: 318.

effects of exceedingly cold or hot places, sandy and salty places, on the growth of the plants, as well as a discussion of plants that grow on the surface of water, or in a wet or rocky soil. The impact of the soil, the presence or absence of water, as well as the quality of the surrounding air are discussed. Reference to concoction is made a few times. This appears to be reference to a process taking place in the soil rather than within the plant; moreover, this is a process that is due to the action of the sun and the surrounding air.<sup>21</sup> Upon reflection, it becomes clear that the concoction that takes place in the soil and the one that happens in the plant work together in the explanation of how a plant grows. An educated guess is that the nutriment concocted in the soil is distributed to the entire body of the plant, where it undergoes a second concoction. This second concoction amounts to a straightforward solidification of the moisture drawn from the soil, which is added to the body of the plant.

Fruiting follows growth in the order of inquiry.<sup>22</sup> Depending on the nature of the plant, the fruit can appear before, after, or at the same time as the leaves. When the plant has a considerable amount of viscous juice, the inner heat of the plant is responsible for its concoction producing the fruit before the leaves. By contrast, when the plant has a considerable amount of moisture, the production of the fruit is delayed; as a result, leaves will appear before the fruit. When the plant has a considerable amount of both moisture and viscous juice, the fruit and the leaves may appear at the same time. But how is the growth of leaves to be explained? When the moisture is abundant and is not fully concocted by the combined agency of the inner heat and the sun, we obtain leaves rather than the fruit (827a24–33). Leaves are for the protection of the fruit from the intensity of the sun (827a33–35).<sup>23</sup>

Perhaps it is still possible to see an overall argument in the next stretch of text, which at first sight appears to be concerned with a random list of topics. Dealing with the predominantly green coloration of the surface of plants can be seen as a logical continuation on the topic of leaves. Their green color is explained as the effect of concoction on the inner moisture. The concoction in question is the one that happens in the plant, not in the soil. It is due to the action of the innate heat of the plant and the sun.<sup>24</sup> Discussing the

<sup>21</sup> References to concoction are made at 825a32, 825b20, 826a28, and 826b37.

<sup>22</sup> The same order of explanation can be observed in *CP I*. See [Chapter 5, Section 3](#).

<sup>23</sup> Compare Aristotle, *DA II I*, 412b1–2.

<sup>24</sup> This excerpt can be usefully compared with what is said in the work on colors attributed to Aristotle, where we find similar claims regarding coloration in plants. [Aristotle] *Color. 5*, 794b19–22: “the original color is green in all plants: shoots, leaves, and the fruit are green at first.” *Color. 5*, 795a12–20:

directions in which plants grow (whether upward or downward) becomes the occasion for a few additional remarks on the topic of the two concoctions that are characteristic of plants – namely, the one taking place in the soil and the one occurring in the plant. In this context, we learn that plants do not undergo a third concoction, which is limited to animals. This further concoction is needed for the articulation of the bodies of animals and the divergence in their nature (828a6–13).<sup>25</sup> The explanation of why trees shed their leaves is a natural complement to this discussion. The channels that bring the moisture to the leaves narrow down and eventually close up. As a result, the leaves do not receive nutriment and dry up (828a32–39).

The focus returns to fruiting and the factors controlling fructification in the next section. If water predominates in the plant (presumably if the inner moisture in the plant is not viscous enough), the plant hardly bears fruits for the combination of three factors: because the concoction that happens in the plant cannot solidify the inner moisture, the inner channels in which the moisture flows are too wide, and the root system is too weak.<sup>26</sup> This is true for all herbaceous plants as well as for some vegetables (828b8–14). Flowers are produced by using the finer portion of the nutriment at the start of the process of concoction and for this reason the flower comes before the fruit. The color of the fruit ranges between a deep blue and white with yellow in between (828b34–40).

The exudation of a milky juice in some trees is traced back to the nature of their inner moisture, which is concocted until it becomes viscous, like milk, which is then attracted to the extremities of the plant. All milky juices have a tendency toward coagulation, so that if the outside of the tree is cold, the milk coagulates; the outcome of that process is the formation of gum, and the ability or inability of the plant to concoct it (829a4–15).

Toward the end of the work, attention turns to the nature of the juices in the fruit, which can range between bitter or sweet. As a rule, the fruit is bitter when the process of concoction is not complete. A discussion of how the surrounding environment and the nature of the soil may impact the quality of the juices in the fruit is offered. We are told that trees grown by acidic waters tend to produce sweet fruit (829b2–10) and that trees that bear fruit for the first time tend to produce bitter fruit (829b23–25).

“in those shoots that remain unmixed with the rays of the sun the white color remains . . . in all plants the parts above the earth are green at first but beneath the earth stalks and roots are white.” In this context, green is seen as the first color between white and black.

<sup>25</sup> This confirms what we read at 822b6–8.

<sup>26</sup> Presumably, it does not draw enough concocted moisture from the soil.

When we look at our work as a whole, we see a prolegomenon to the study of plants that, at least in part, is based on Aristotle's *DA* and *GA* followed by a condensed version of the ὄτι-stage of the research on plants largely based on the data collected in Theophrastus's *HP* I and *HP* II 1–7. The inquiry should continue with an attempt to explain the phenomena at the διότι-stage of research. It is no surprise that growth and fructification emerge as the two main explananda. This is exactly how Theophrastus proceeds in *CP* I and *CP* II. And yet what we read in our text does not appear to be based on Theophrastus. It is quite possible that the second book goes back, *in toto* or in part, to the lost work on plants by Aristotle. Unfortunately, we have no way to substantiate this hypothesis.

What is specific about plants remains the focus throughout the second book, but this focus requires recalling results reached in the study of animals. It is only when those results are available that a full appreciation of plants as a distinct form of life is possible.

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