METHOD AND METAPHOR IN ARISTOTLE'S SCIENCE OF NATURE

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by

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Abstract

This dissertation is a collection of essays exploring the role of metaphor in Aristotle's scientific method. Aristotle often appeals to metaphors in his scientific practice; but in the *Posterior Analytics*, he suggests that their use is inimical to science. Why, then, does he use them in natural science? And what does his use of metaphor in science reveal about the nature of his scientific investigations? I approach these questions by investigating the epistemic status of metaphor in Aristotelian science. In the first essay, I defend an interpretation of metaphor as a type of heuristic reasoning: I claim that Aristotle uses metaphor to express conditions an explanation in natural science must meet if it is to explain regular, ordered change. These conditions specify the kinds of causes—particularly unmoved efficient causes—which the inquirer into nature is seeking. In the second essay, I look to Aristotle's use of certain *endoxa* or common beliefs as explanatory principles in science, and show that his use of these principles is similar to his use of metaphor. In the final essay, I present a historical study of the analogy of art and nature, and I suggest that by looking to how the Greeks understood the role of inquiry in the arts, we can shed some light on Aristotle's views concerning the method of inquiry he thinks the natural scientist should adopt.

Keywords

Aristotle, natural philosophy, metaphor, method, science, paradigm, imitation, art, nature, separation of sexes, heuristic, scientific method, epistemology, scientific inquiry, Plato, Hippocratic tradition

For Granny

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To Samantha: how about those mountains?

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1. Introduction

"Perhaps universal history is the history of a few metaphors."

Borges (1964), *Other Inquisitions*, 6.

A common way we talk about the world, in our everyday language and in science, is through metaphor, but the place of metaphor in science has often been subject to suspicion. In rhetoric or poetry, one might question the appropriateness of a particular metaphor when judging the success of the poem or speech. In science, however, it is the appropriateness of metaphor as such that has often been questioned. In its beginnings in the 17th Century, modern science developed with the self-conscious abandonment of figurative forms of thought, and metaphor was condemned as too obscure to have any appropriate use. Hobbes, for instance, says using metaphor in science is akin to "wandering amongst innumerable absurdities" that fail to advance our knowledge (*Leviathan*, part I, chapter 5), and calls metaphor an *ignis fatuus*—a fool's fire.[1] Since the mid-twentieth century, attitudes have changed. On the one hand, the use of metaphor has been defended as an important means to scientific discovery and education.[2] On the other hand, empirical studies have begun to look at how the use of different metaphors

[1] Literally, "foolish fire", they are phosphorescent lights, thought to be the work of malevolent spirits, which one might encounter and mistakenly follow while walking through an English bog at night. They are "foolish" because those who followed them were fooled into being led astray. Metaphorically, they came to mean any delusive guiding principle.

[2] Black (1962), *Models and Metaphors*; Ricoeur (2003), *The Rule of Metaphor*; Lakoff and Johnson (2008), *Metaphors We Live By*; Chew and Laubichler (2003), "Natural Enemies—Metaphor or Misconception? ", *Science* 301(5629), 52-53.

in scientific writing influences how we understand and react to the same data.[3] Like a false light, metaphors can lead us to see and react to things that may not be there. And while most people would no longer adopt Hobbes' proscription against metaphor in science, questions remain about the epistemic status of metaphor and about when their use in science is appropriate.

Similar questions to these were asked during the development of ancient science. For many of the early Greek philosophers, what we might call a "scientific" or "philosophical" understanding of the world was expressed through myth and metaphor. In the late fifth century, however, the dominant mode of expression changed from the *mythoi* of the poets and Presocratics, to the rational accounts or *logoi* of the Sophists, orators and philosophers. Many of these latter writers believed metaphors were inappropriate in reasoned speech and sought to avoid them altogether. As Isocrates tells us, their aim was the precise use of conventional language to describe "the facts themselves [αὐτὰς τὰς πράξεις]" (Isocrates, *Evagoras* 9.10), indicating that a distinction was beginning to be made between "poetical" and "rational" forms of discourse. Metaphor came to be identified as a particular kind of poetical discourse, while rational accounts were thought to express the way things really are. Despite the fact that his writings often make use of symbolic language, Plato is one of philosophy's first defenders of this distinction. He is routinely critical of those who claimed to demonstrate truth

[3] Thibodeau and Boroditsky (2011), "Metaphors We Think With: The Role of Metaphor in Reasoning", *PLoS ONE* 6(2).

through metaphor or who thought metaphor could constitute proper knowledge (*Meno* 99d; *Protagoras* 320c-328d; *Republic* II 376a-383a).[4]

Aristotle, by contrast, sometimes seems more sympathetic than either Isocrates or Plato to metaphor's positive role in philosophy and science. In the *Rhetoric*, he endorses metaphor as a useful rhetorical and pedagogical tool because it allows a speaker to communicate new and complex ideas easily (*Rhetoric* III 10, 1410b6 *ff.*). Yet, like both of his predecessors, he often suggests that metaphors are inappropriate in philosophy, particularly in definitions and demonstration. In the *Posterior Analytics,* he goes so far as to suggest they have no place in science at all: "if one should not argue in metaphors, it is clear that [one must neither] define using metaphors nor [define] what is said metaphorically: for necessarily one will then be arguing in metaphors" (*Posterior Analytics* II 13, 97b37-39). For Aristotle, metaphors lack the clarity required for philosophical discourse: "everything said metaphorically is unclear [ἀσαφὲς]" (*Topics* VI 2, 139b34-5), and any lack of clarity will introduce difficulties when attempting to produce sound arguments. As G.E.R. Lloyd has pointed out, "*any* recourse to *metaphora* [sc.] introduces an unclarity that is utterly inimical to the enterprise of strict demonstration—the drawing of true, incontrovertible, conclusions, by valid inference, from self-evident, indemonstrable primary premises" (Lloyd 1996, 209).

Given that Aristotle is critical of metaphor in science, it is, therefore, surprising how often he uses different metaphors in his scientific practice. In nearly all his scientific

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[4] There are difficulties, which I will not address, squaring Plato's statements at *Meno* 97e-98a2—that an *aitias logismos* is a necessary condition for knowledge—and his own *practice* of using figurative language like metaphor and allegory to express his own philosophical views.

works—both those works in which he goes about investigating natural phenomena, such as the *Meteorology* and the zoology, and in his more theoretical works like the *Physics*, *On Generation and Corruption* and *De Caelo*—he makes constant appeal to metaphor. He uses metaphor at a general level, for instance, when he compares nature to a homeowner (*On the Generation of Animals* II 6, 744b11 *ff.*), or a manual worker (*On Parts of Animals* I 5, 645a9 *ff.*), or an art (*Physics* II 2, 194a21 *ff.*). He also uses it at the level of specific phenomena, when, for example, he uses cooking as a metaphor for digestion (*Meteorology* IV 3, 381a30 *ff.*). The frequent use of such expressions might not seem problematic to a contemporary scientist, but given Aristotle's own strict requirements for scientific knowledge, their use suggests an explicit conflict between his attitude towards scientific theory and his actual practice.

Scholars who have noted this tension usually attempt to resolve it in one of two ways. Given that the use of metaphor conflicts with Aristotle's programmatic statements about science in the *Analytics*, those who see Aristotle's science as an attempt to follow the rigour of this programme conclude that these are only apparent metaphors. Instead, they claim he intends these expressions to be taken literally.[5] At the other extreme, those who think Aristotle is a pluralist when it comes to modes of demonstration, although they are willing to admit that he intends these expressions metaphorically, nevertheless conclude that metaphor has no place in a scientific theory as Aristotle presents it.[6]

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[5] Charles Kahn, for instance, claims that Aristotle uses certain expressions like "imitation", "participation", and "desiring", literally, even though they seem like metaphors when applied to non-human natural things. Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology" in Balme and Gotthelf, Eds., *Aristotle on Nature and Living Things*, 200.

[6] Lloyd (1996), *Aristotelian Explorations* suggests that Aristotle's scientific practice is at variance with his restrictions on metaphor in the *Posterior Analytics* and *Topics*.

What both conclusions share is a belief that, on his considered opinion, Aristotle thinks metaphors are at best an *ignis fatuus*. The purpose of this dissertation is to show that this belief is false. While Aristotle thinks they cannot constitute scientific *understanding*, where this would imply knowledge of the causes of some phenomenon, metaphors are important to Aristotle's method of scientific *inquiry*. Aristotle thinks metaphors are useful precisely in those contexts where we do not have scientific understanding, and they are useful because they express something true about the phenomenon we are investigating which can serve as a starting point for inquiry into its causes. Far from leading us astray, his use of metaphor suggests he thought they were an important guide to developing our understanding of the natural world.

The problem for Aristotle's science, therefore, is not to defend metaphor as a way of attaining scientific—specifically, demonstrative—understanding, but to provide reasons why metaphor can be useful for inquiry and why the relations metaphors express are not merely verbal, but grounded in the world. To put it another way, the problem is to show how to justify the use of such comparisons when we do not already have *knowledge* of the phenomena we are relating. Little has been written about Aristotle's use of metaphor in science, and what has been written is often deflationary. While I claim throughout this dissertation that he thinks metaphor can guide inquiry, André Laks suggests in his paper, "Substitution et Connaissance," that metaphor for Aristotle presupposes an acquaintance with the relations it expresses, and that results of inquiry will therefore determine our use of metaphor and not the other way around.[7] On this view, metaphor (as Aristotle understands it) is not a means of acquiring new knowledge,

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[7] Laks (1990), "Substitution Et Connaissance: Une Interprétation Unitaire (Ou Presque) De La Théorie Aristotélicienne De La Métaphore" in Furley and Nehamas, Eds., *Arisotle's Rhetoric: Philosophical Essays*.

but merely a substitution of terms: a metaphor does nothing more than substitute (one expression for) something we already know with (an expression for) something else we already know. Therefore, metaphors cannot provide us with new knowledge or insight. Furthermore, Aristotle never provides an account of how metaphor could guide scientific inquiry. This has led G.E.R. Lloyd to speculate that Aristotle has little in the way of philosophical justification for his use of metaphor, instead "making effective use of metaphor to bring out the effectiveness of metaphor itself."[8] On my reading of Aristotle's natural philosophy, one strategy in scientific inquiry is to discover and employ appropriate metaphors. The difficulty, especially because he says so little about their relationship to inquiry, is figuring out why he thinks these metaphors work.

The first essay in this dissertation, "Metaphor in Aristotle's Science," looks at two questions concerning the role of metaphor in Aristotle's science: is the use of metaphor justified in Aristotle's science? And does he use them in his investigations into natural phenomena? I answer the first question by defending the view I sketched above, namely, that Aristotle thinks of metaphor as a way to characterize natural phenomena so that the natural scientist can begin to inquire into their causes. Metaphor has, in other words, a heuristic function. Aristotle defines "metaphor" in the *Poetics* as "the application of a name [ὄνομα] that belongs to something else [ἀλλοτρίου], either from genus to species, species to genus, species to species or by analogy" (*Poetics* 21 1457b9-10). While Aristotle thinks metaphor is always unclear, if an expression is a metaphor, then he thinks one of these four relations will hold between what is referred to by the "name that belongs to something else" and what is referred to by the conventional name.

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[8] Lloyd (1996), *Aristotelian Explorations*, 222.

For example, if cooking is used as a metaphor for digestion, then since it *is* a metaphor, both cooking and digestion will either be species of the same generic process, or be related as species to genus, genus to species, or by analogy. Since some such relation holds in an Aristotelian metaphor, they consequently express some truth, however unclear, about what they refer to. It is the causal similarity they express which makes metaphors useful as heuristics. And since they are heuristic, not explanatory, Aristotle is not contradicting his own statements against the use of metaphor in definition or demonstration.

By "heuristic," I mean a set of reliable but fallible methods or rules for discovering the causes that will ultimately explain the phenomenon being investigated.[9] The method I have in mind is that of inquiring into phenomena which we do not understand by characterizing them as phenomena which we do understand. For example, by characterizing digestion as cooking, Aristotle can use the familiar efficient and material causal processes involved in cooking as a means of investigating the internal and largely hidden process of digestion. Similarly, using a different metaphor, he can appeal to the familiar relation of producing artistic imitations as a means for inquiring into the efficient causal relation between the celestial and sublunary seasonal cycles. At a preliminary stage of inquiry, metaphors such as these characterize phenomena we do not understand as phenomena we do (digestion *as* cooking, sublunary cycles *as* imitations) so that, in inquiry, we know what kinds of causes to look for. Yet, even if Aristotle could think the use of metaphor is justified in natural science, it remains an open question whether he actually uses them in this way.

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[9] The way I characterize "heuristic" is informed by Chow (2011), *Heuristics, Concepts, and Cognitive Architecture: Towards Understanding How the Mind Works*, *Philosophy*, PhD Dissertation, Chapter 2.3.

This leads to the second question: how does Aristotle use metaphor in his scientific practice? One of the dangers of using metaphors in science is that they can cease to be seen as metaphors, and begin to be understood as explanations themselves. This raises difficult problems for an historian of science, because most authors, historical or otherwise, are usually not explicit about whether they are using an expression metaphorically or not. The lack of clear criteria for determining when an author is using an expression metaphorically means it is difficult to tell when a metaphor has become a way of understanding the world instead of a way of inquiring into it. This is primarily an exegetical problem, but it is a serious one if our goal is to understand the history and development of science. By establishing a possible role for metaphor in Aristotle's science, the broader, methodological question I address in this paper is whether determining such criteria is possible.

As a way into this question, I look at one such way of understanding the world that is sometimes attributed to Aristotle: that, as David Sedley suggests, "the whole natural world is, in one way or another, pulling itself up by its own bootstraps in the interests of maximum godlikeness."[10] This is what I call the metaphor of imitation. I argue that Aristotle is aware he is using imitation metaphorically. I also try to show that the evidence Sedley and others use to support the reading that the whole natural world imitates the divine can also be seen as evidence against it. But the larger claim I establish is that we need not suppose that Aristotle is asserting some way the world is when he makes such claims; rather, he uses metaphors to investigate some way the world might

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[10] Sedley (2010), "Teleology: Aristotelian and Platonic" in Lennox and Bolton, Eds., *Being, Nature, and Life in Aristotle*, 10. Similar interpretations are given in Burnyeat (2004), "Introduction: Aristotle on the Foundations of Sublunary Physics" in de Haas and Mansfeld, Eds., *Aristotle: On Generation and Corruption, Book I: Symposium Aristotelicum* and Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology".

be, and part of his method in science involves working out the causes of phenomena that they suggest.

In the second essay, "On the Principle of Separation in Aristotle's Biology," I look at questions about how Aristotle adopted common Greek beliefs into his science, and how he understood the relationship between those beliefs and his method of explaining regular, ordered change. As with his use of metaphor, in this paper I argue that Aristotle will use popular beliefs to express the conditions an explanation must meet if it is to account for a world of regular, ordered change. I begin with Aristotle's explanation of separate males and females in the second book of *On the Generation of Animals* and use it as a case study to explore these questions. The explanation makes use of what I call "the principle of separation," and it is one of a family of normative principles that refers to the comparative value of correlative opposites. Aristotle uses these principles in several well-known teleological accounts of natural phenomena, and they all depend on characterizing things in the world in terms of relative value. There are two questions we might ask about the legitimacy of these normative principles in Aristotle's natural philosophy. First, it is hard to see how these are empirically robust first principles established inductively by observations of the natural world. Rather, they seem to reflect common Greek attitudes and prejudices, which Aristotle simply takes over unchallenged. Second, they do not seem to be methodologically sound. According to his standards for scientific explanations, appeals to what is "better" or "best" should always be said *relative* to the specific substance being explained (*Physics* II 7; *On the Gait of*

Animals 2). In light of this they seem to have too wide a scope to be explanatorily useful.[11]

Such questions have led some scholars to conclude that these principles represent an uncritical adoption of common beliefs into science.[12] G.E.R. Lloyd, for instance, argues that Aristotle "stubbornly" adhered to the common Greek belief that right is superior to left, the upper to the lower, etc., because Aristotle believed that each is naturally and essentially superior "in man, and man is the norm by which he judges the rest of the animal kingdom."[13] Against this view, I follow Leunissen who argues that such principles are not explanations, but heuristics for determining the causally relevant features that a proper explanation will pick out.[14] I diverge from Leunissen's interpretation, however, by denying that Aristotle thinks animals obtain any biological advantage from having separate sexes. Instead, the principle reflects Aristotle's understanding of efficient causation. If regular, ordered change is one of Aristotle's *explananda*, then he has reason to say it is always better (although perhaps not necessary) for an agent of such change to be unaffected when it acts.

Finally, the third essay "Art and Nature in Aristotle's Physics," looks at how Aristotle uses the analogy between art and nature to guide questions about how inquiry in natural

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[11] Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 123.

[12] Lloyd (1996), *Aristotelian Explorations*; Preus (1970), "Science and Philosophy in Aristotle's *Generation of Animals*", *Journal of the History of Biology* 3(1); Mayhew (2004), *The Female in Aristotle's Biology: Reason or Rationalization*; Witt (2005), "Form, Normativity and Gender in Aristotle a Feminist Perspective" in Freeland, Ed., *Feminist Reflections on the History of Philosophy*; Nielsen (2008), "The Private Parts of Animals: Aristotle on the Teleology of Sexual Difference", *Phronesis: A Journal for Ancient Philosophy* 53(4-5).

[13] Lloyd (1962), "Left and Right in Greek Philosophy", *The Journal of Hellenic Studies* 82, 5.

[14] Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, Chapter 4.2.

science should proceed. This paper furthers these studies by looking to how he uses the analogy between art and nature to guide his questions about how inquiry in natural science should proceed if it is to explain the regularities in the world around us. Aristotle's understanding of the analogy between art and nature is in some respects a response to Plato.[15] Where Plato saw "natural things, and nature herself" to be "secondary products from art and reason" (*Laws* 892b5-8),[16] Aristotle claims "art imitates nature" (Physics II 2, 194a21-194a27; II 8, 199a15-18; *Meteorology* IV 3, 381a30 *ff.*). Aristotle uses this phrase to argue for the unity of natural science, and for the use of metaphor and analogy from the domain of artistic production to guide inquiry into natural ones. But, how did Aristotle arrive at this anti-Platonic conclusion? And what does it suggest about his views on the relationship between art and nature?

This essay provides a historical answer to the first question, by tracing a line of influence from the Hippocratics, through Democritus and Plato, to Aristotle. I argue that based on this tradition, Aristotle's claim that "art imitates nature" is an epistemological claim about how methods of production were first discovered in the arts. And by looking at how the Greeks viewed discovery and progress in the arts, we can shed some light on Aristotle's expectations for a scientific investigation into nature, in particular his views concerning the method of inquiry he thinks the natural scientist should adopt. In

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[15] Lennox (2001), "Material and Formal Natures in Aristotle's *De Partibus Animalium*", *Aristotle's Philosophy of Biology: Studies in the Origins of Life Science*; Menn (1995), *Plato on God as Nous*; Falcon (2005), *Aristotle and the Science of Nature: Unity without Uniformity*; Johansen (2004), *Plato's Natural Philosophy: A Study of the Timaeus-Critias*. See also, Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, Chapter Five, and Henry (2013), "Optimality and Teleology in Aristotle's Natural Science", *Oxford Studies in Ancient Philosophy* 45.

[16] πρῶτα ἔργα καὶ πράξεις τέχνης ἂν γίγνοιτο, ὄντα ἐν πρώτοις, τὰ δὲ φύσει καὶ φύσις, ἣν οὐκ ὀρθῶς ἐπονομάζουσιν αὐτὸ τοῦτο, ὕστερα καὶ ἀρχόμενα ἂν ἐκ τέχνης εἴη καὶ νοῦ.

particular, I will look at how Aristotle conceives of the relation between art as science and the study of nature, and why he thinks the use of metaphor and analogy from the domain of the arts can guide inquiry into processes that occur by nature.

While Aristotle does not consider metaphor to be a form of scientific knowledge, he nevertheless thinks metaphors play an important epistemic role in inquiring into natural phenomena. In cases where the scientist has a clear grasp of one domain, he thinks the intuition of a generic or analogical relation suggested by metaphor will allow her to use explanations from that domain to formulate expectations for explanation in another. This process involves experience and intuition, and the perception of a similarity which leads to metaphor may not produce any scientifically meaningful results; but, that does not mean Aristotle thinks it is illegitimate in science. For Aristotle, metaphors are not, as they were for Hobbes, a fool's guide. Rather, working out the details of these metaphors, and critically reflecting on both their empirical and *a priori* plausibility, is a significant part of Aristotle's method of inquiry, and in no way antithetical to his scientific theory.

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2. Metaphor in Aristotle's Science*

> "Do you think it's always fresh water that falls
> each time Zeus makes it rain? Or, does the sun
> draw up the same water from down below again?"[1]
>
> Aristophanes, *Clouds*, ll.1279-1281

One of the scientific ventures that Aristotle engages in is what we might now call expounding theoretic necessities.[2] A modern example would be the gene, which was postulated as the unit of heredity well before anyone had any clear idea of what it was or how it worked. That one proved to be useful and has endured. Another example, but one whose usefulness for science is still an open question, is the idea of "the language of thought" (Fodor 1975). The point of such moments in science is to express something like the following: "there has to be something, some physical mechanism, that brings it about that x produces y, and these are the details that that mechanism must account for:...." An Aristotelian example of this is the idea of *kinēseis* which do so much work for him in his physiology of perception and also of reproduction.[3] He does not know precisely what they are, of course, but using them is perfectly legitimate science, just as it is legitimate to say, "there is something that encodes a parent's traits and passes them on to the offspring."

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* All translations are my own unless otherwise noted.

[1] πότερα νομίζεις καινὸν αἰεὶ τὸν Δία
ὕειν ὕδωρ ἑκάστοτ', ἢ τὸν ἥλιον
ἕλκειν κάτωθεν ταὐτὸ τοῦθ' ὕδωρ πάλιν;

[2] The term "theoretic necessities" and this account of their role in science were suggested to me by John Thorp.

[3] Henry (2006), "Understanding Aristotle's Reproductive Hylomorphism", *Apeiron* 39(3), 436-442

In this paper, I show that Aristotle uses metaphor as a way of deploying such theoretic necessities. Aristotle uses metaphors as a way to express conditions that an explanation of some natural phenomenon must meet if it is to be an explanation of regular, ordered change—the kind of change which Aristotle believes is observed to occur in the natural world. These conditions, in turn, characterize the phenomenon in such a way that we can begin to inquire into its causes. For Aristotle, metaphors are heuristics for investigating nature, and when they appear in his scientific practice, their role is to make explicit certain generic or analogical similarities among distinct phenomena, so that we can, at a preliminary stage of inquiry, use explanations of phenomena we understand as models to inform the causal investigations of phenomena we do not.

Aristotle defines "metaphor" in the *Poetics* as "the application of a name [ὄνομα] that belongs to something else [ἀλλοτρίου], either from genus to species, species to genus, species to species or by analogy" (*Poetics* 21 1457b9-10). While Aristotle thinks metaphor is always unclear, if an expression is a metaphor, then he thinks one of these four relations will hold between what is referred to by the "name that belongs to something else" and what is referred to by the conventional name. For example, when cooking is used as a metaphor for digestion (*Meteorology* IV 3, 381a30 *ff.*), then since it *is* a metaphor, both cooking and digestion will either be species of the same generic process, or be related as species to genus, genus to species, or by analogy. Since some such relation holds in an Aristotelian metaphor, they consequently express some truth, however unclear, about what they refer to. It is the causal similarity they express which makes metaphors useful as heuristics. By "heuristic," I mean a set of reliable but fallible methods or rules for discovering the causes that will ultimately explain the phenomenon

being investigated.[4] The method I have in mind is that of inquiring into phenomena which we do not understand by characterizing them as phenomena which we do understand: for example, by characterizing digestion as cooking, Aristotle can use the familiar efficient and material causal processes involved in cooking as a means of investigating the internal and largely hidden process of digestion.[5] Similarly, as I explore in this paper, he can use the familiar process of producing artistic imitations as a means for inquiring into the efficient causal relation between the celestial and sublunary seasonal cycles. Metaphors are, therefore, a starting point from which inquiry can proceed to investigate the causes that ultimately explain the phenomenon being investigated. At a preliminary stage of inquiry, metaphors characterize phenomena we do not understand as phenomena we do (digestion *as* cooking, sublunary cycles *as* imitations) so that we know what kinds of causes to look for when inquiring.

Scholars, however, have been puzzled by the apparent contradiction between Aristotle's use of metaphor in his scientific practice, and programmatic statements about method in the *Organon*, which suggest metaphor is inimical to good science. In the *Analytics,* for instance, he claims, "if one should not argue in metaphors, it is clear that [one must neither] define using metaphors nor [define] what is said metaphorically: for necessarily one will then be arguing in metaphors" (*Posterior Analytics* II 13, 97b37-39). And in the *Topics,* he claims that "everything said metaphorically is unclear [ἀσαφὲς]" (*Topics* VI 2, 139b34-5). The lack of clarity is particularly problematic for definition:

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[4] The way I characterize "heuristic" is informed by Chow (2011), *Heuristics, Concepts, and Cognitive Architecture: Towards Understanding How the Mind Works*, *Philosophy*, PhD Dissertation, Chapter 2.3.

[5] I discuss this example in more detail in Chapter Three.

> τῶν δὲ ὅρων δυσεπιχειρητότατοι πάντων εἰσὶν ὅσοι κέχρηνται τοιούτοις ὀνόμασιν ἃ πρῶτον μὲν ἄδηλά ἐστιν εἴτε ἁπλῶς εἴτε πολλαχῶς λέγεται, πρὸς δὲ τούτοις μηδὲ γνώριμα πότερον κυρίως ἢ κατὰ μεταφορὰν ὑπὸ τοῦ ὁρισαμένου λέγεται. διὰ μὲν γὰρ τὸ ἀσαφῆ εἶναι οὐκ ἔχει ἐπιχειρήματα· διὰ δὲ τὸ ἀγνοεῖσθαι εἰ παρὰ τὸ κατὰ μεταφορὰν λέγεσθαι τοιαῦτ' ἐστίν, οὐκ ἔχει ἐπιτίμησιν.
>
> The most difficult of all definitions are those that employ terms for which, in the first place, it is not apparent whether they are used in one way or several, and, further, it is not known whether they are used strictly [κυρίως] or metaphorically [κατὰ μεταφορὰν] by the definer. On the one hand, because they are unclear [ἀσαφῆ], one cannot argue [with the definer]; on the other hand, because one does not know whether [the definition] is unclear [ἀσαφῆ] [for any reason] besides being said metaphorically, it is impossible to criticize them. (*Topics* VIII 3, 158b8-15)

Like things said 'in many ways', a metaphor signifies two or more things simultaneously, and so its meaning is unclear. Yet, unlike terms said "strictly" or conventionally, Aristotle thinks a metaphor will be unconventional: it is intentionally chosen by the person making the comparison. Aristotle concludes that it is "impossible to criticize" the person who chose the metaphor because, in a dialectical contest, it must be assumed that the normal designation is not meant. If someone were to say, "genes are selfish," one could be excused for thinking he meant genes have conscious intentions, but it does not follow that this is what he meant.[6] So long as one is defining in metaphor, then, one will be arguing in metaphors, and these are good reasons for Aristotle to think that metaphor is inappropriate in definition and demonstration. Metaphors, as G.E.R. Lloyd points out, are ambiguous and lack the univocity required by Aristotle for

[6] The phrase is from Dawkins (1976), *The Selfish Gene*, 13-15

demonstrative knowledge.[7] His scientific practice, therefore, appears to conflict with his theory.

What, then, are we to make of the status of metaphor in Aristotle's science? If, as I argue, Aristotle uses them *heuristically*, then there is no conflict. But, there will be further questions: is there any textual evidence that suggests he thinks it is appropriate to use metaphor? What grounds their use in science? And, most importantly, how does he think they are supposed to work? If, on the other hand, one supposes Aristotle uses metaphors in scientific *explanations*, is there a way to reconcile his theory with his scientific practice? For example, suppose, as Charles Kahn or David Sedley do, that Aristotle presents imitation of or participation in the divine as the final cause of each thing in the natural world. Is Aristotle using imitation and participation to express some clear, scientifically precise meaning? Should we read these expressions literally or metaphorically? And what reasons might we give for thinking Aristotle has a clear sense of what he is trying to express when he uses them?

These latter questions, I suggest, are more important for the modern interpreter, and a common strategy, adopted by Kahn, Sedley and others (intentionally or not) is to avoid these questions and interpret the metaphor away—in other words, their strategy is to interpret these metaphors as though Aristotle meant them literally.[8] In doing so, they

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[7] Lloyd (1996), *Aristotelian Explorations*, 208

[8] I discuss the widespread case of "imitation" in the section, Paradigm and Imitation, below. It is common, as well, when interpreting Aristotle's claims that nature "fashions" or "wants" something. See, e.g. Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 61, 126, 150: "The verbs of agency ascribed to the formal natures in these principles are more than mere metaphors, or reflections of the analogy between art and nature: rather, they reflect different causal patterns underlying the generation of animals and their parts." See note 29 below specifically on imitation.

are following Aristotle's own advice in the *Topics* that one can "argue captiously [συκοφαντεῖν] against the user of a metaphorical expression as though he had used it in its literal sense" (*Topics* VI 2, 139b35-6),[9] although the aims of the modern reader are more likely to read Aristotle charitably rather than captiously. But this route has its own hazards. The interpretation risks being arbitrary; it also assumes Aristotle was committed to the thesis that metaphors have no role in science. It is this view that I want to resist. While it is certainly true that Aristotle thinks metaphors do not constitute scientific *knowledge*, the *Posterior Analytics* and the *Topics* leave open a positive role for metaphor in scientific *inquiry*. Furthermore, as we will see in the next section, Aristotle's statements about inquiry in *Eudemian Ethics* II 1 suggest he believes inquiry begins from statements that are *true but not clear,* and thus show none of the *Organon*'s concerns about using unclear preliminary definitions as a starting point. Finally, his understanding of metaphor suggests it is not merely a verbal comparison, but that good metaphors bring out real similarities in the things they compare.

To begin, I provide evidence that Aristotle's theory of inquiry is consistent with the use of metaphor as a heuristic. I then turn to Aristotle's scientific practice to show he uses metaphor in this way. As a case study, I look at Aristotle's claim that the cycles of the sublunary elements *imitate* the cycles of the heavenly bodies. I argue that "imitation" is not an explanation of the sublunary elements' cyclical pattern, but a metaphor that Aristotle uses as a heuristic to inquire into causal relationships between the heavenly and

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[9] ἐνδέχεται δὲ καὶ τὸν μεταφορὰν εἰπόντα συκοφαντεῖν ὡς κυρίως εἰρηκότα. It must be admitted that this way of describing the strategy [συκοφαντεῖν] hardly seems like an endorsement. However, Stephen Menn suggests that this was, in fact, a strategy adopted not only by Aristotle, but also by later Peripatetic commentators, like Themistius. Menn (2012), "Self-Motion and Reflection: Hermias and Proclus on the Harmony of Plato and Aristotle on the Soul" in Wilberding and Horn, Eds., *Neoplatonism and the Philosophy of Nature*, 48-49

sublunary bodies. I then compare his use of the metaphor of "imitation" to a related metaphor, that "nature is a craftsman."

2.1 Metaphor and Inquiry

Aristotle's attitude towards metaphor is ambivalent. While he thinks one should avoid arguing in metaphors because they lack the requisite univocity for valid inference (*Posterior Analytics* II 13, 97b37-39, cf. *Topics* VIII 3, 158b8-15), he also thinks they can make a new fact easier to grasp. For this reason, metaphor is useful for teaching and persuading an audience. In the *Rhetoric*, Aristotle writes that through the good use of metaphor, one can not only make learning more pleasant, but one can also make a new fact intelligible by means of some more general notion, and so "it is from metaphor that we can best get hold of something fresh" (*Rhetoric* III 10, 1410b6-13). Many well-known Aristotelian expressions are intelligible for just this reason. We understand expressions like "nature does nothing in vain" and "demiurgic nature" (ἡ δημιουργήσασα φύσις, *On the Parts of Animals* I 5, 645a9) because their literal sense is obvious. This sense might not be true, but it helps us to understand the claim Aristotle is trying to make. There is no single art that imitates nature, but (as I will suggest in chapter three) we develop tools and techniques by imitating how things occur naturally. Similarly, there is no "cosmic nature" that does nothing in vain, but it seems that the parts of animals usually exist for some function.

Aristotle defines metaphor in the *Poetics* as "the application of a name [ὄνομα] that belongs to something else [ἀλλοτρίου], either from genus to species, species to genus,

species to species or by analogy" (*Poetics* 21 1457b9-10).[10] For Aristotle, metaphor is not, as it is for us, an expression with two senses, a literal and a figurative. For Aristotle, an ἀλλοτρίος name—a "foreign" or "unconventional" one—is any name that is not used strictly (κυριῶς) or conventionally (οἰκείως).[11] A metaphor, therefore, is an unconventional use of name. So for example, if The Poet says when speaking about Achilles, "the lion leapt" (*Rhetoric* III 4, 1406b22), Aristotle does not think he is using "lion" in a conventional but figurative sense that signifies the abstract concept, "courage." Instead, he is using the name, "lion" unconventionally to designate Achilles.

According to Paul Ricoeur, whether or not metaphor has epistemological implications for Aristotle depends on what it means to say a metaphor is a "foreign" use of a name.[12] On the one hand, it suggests that, when a name is used metaphorically, it substitutes for a non-metaphorical name that one could have used (assuming that word exists) (Ricoeur 2003, 20). When, for instance, Homer claims Odysseus performed "10,000 deeds" (*Rhetoric* III 4, 1456b12)—a name for a specific large quantity—what he is doing is substituting the generic name for a large quantity, 'many', with the name for a species of large quantity '10,000.' This substitution provides no new information to the listener or reader; it is simply a rhetorical flourish. In another example, the analogy, "as the drinking cup is to Dionysus, so the shield is to Ares" (1407a18), Aristotle claims the second term can be substituted for the fourth, or the fourth for the second. The cup and

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[10] "μεταφορὰ δέ ἐστιν ὀνόματος ἀλλοτρίου ἐπιφορὰ ἢ ἀπὸ τοῦ γένους ἐπὶ εἶδος ἢ ἀπὸ τοῦ εἴδους ἐπὶ τὸ γένος ἢ ἀπὸ τοῦ εἴ- δους ἐπὶ εἶδος ἢ κατὰ τὸ ἀνάλογον.

[11] *Topics* VI 2. What I have been calling "literal" is not quite the same as what Aristotle means by "strictly." Lloyd (1996), *Aristotelian Explorations*, 207. My discussion owes much to two of Lloyd's essays in that volume, "Unity of Analogy" and "The Metaphors of *Metaphora.*" although I do not agree with his conclusions.

[12] Ricoeur (2003), *The Rule of Metaphor*, 19-22

the shield are analogical because they are both things that often accompany the god in representations. Aristotle does not think this is a successful analogy, because the substitution has unintended implications. If you say, "the shield is the drinking cup of Ares," it sounds like you are suggesting that Ares drinks from his shield.

The substitutive nature of metaphor suggests that metaphor is not a means for conveying new knowledge. As Ricoeur points out, "if the metaphorical term is really a substituted term, it carries no new information, since the absent term (if one exists) can be brought back in; and if there is no information conveyed, then metaphor has only an ornamental, decorative value" (Ricoeur, 23). Conceiving of metaphor as foreign, however, also suggests that the use of a metaphor is a deviant use of name (*ibid*., 19). It is this deviant use of a name that Ricoeur suggests has a role in acquiring new knowledge. When, for instance, we take a name that designates one domain and apply it to another, it results in a search for the appropriate generic or analogical relationship that characterizes the relationship between those two domains (*ibid*., 22-26). In other words, metaphor is a kind of "calculated error" that "has to disturb a whole network by means of an aberrant attribution" (*ibid*., 23). The normal relations we expect to obtain become disordered by the metaphor; but, it also suggests new relations among things, and the re-description of the world in terms of these relations results, according to Ricoeur, in new meaning. Aristotle claims that metaphor has "produced learning [μάθησιν] and knowledge [γνῶσιν] through the genus" (1410b14-15).[13] For Ricoeur, knowledge produced "through the genus" gives us a novel way of characterizing how we see the world.

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[13] ἐποίησεν μάθησιν καὶ γνῶσιν διὰ τοῦ γένους.

André Laks, however, has argued that Ricoeur's interpretation strays too far from the text when it suggests an independent epistemological role for metaphor.[14] For Laks, Aristotelian metaphors are only substitutive. Metaphor may have a didactic function, but it is not a heuristic. For metaphor to play a heuristic role, it would have to open up new possibilities for thought; but, according to Laks, Aristotle's view in both the *Rhetoric* and the *Poetics*, suggests the similarities are not first learned through metaphor, but through intuition or induction:

> ἔστιν δὲ μέγα μὲν τὸ ἑκάστῳ τῶν εἰρημένων πρεπόντως χρῆσθαι, καὶ διπλοῖς ὀνόμασι καὶ γλώτταις, πολὺ δὲ μέγιστον τὸ μεταφορικὸν εἶναι. μόνον γὰρ τοῦτο οὔτε παρ'ἄλλου ἔστι λαβεῖν εὐφυΐας τε σημεῖόν ἐστι· τὸ γὰρ εὖ μεταφέρειν τὸ τὸ ὅμοιον θεωρεῖν ἐστιν.
>
> It is a great thing, indeed, to make a proper use of these poetical forms, as also of compounds and strange words. But the greatest thing by far is to be a master of metaphor. It is the one thing that cannot be learnt from others; and it is also a sign of genius, since a good metaphor implies an intuitive perception of the similarity [in dissimilars]. (*Poetics* 22, 1459a4-8, tr. Bywater)

Several things are worth noting in this passage. First, Aristotle claims that being a metaphor-maker (μεταφορικόν) is not something that one can learn from anyone else. Second, he thinks being a metaphor-maker is a *sign* (σημεῖόν) of genius, and he explains this by saying someone who is able to produce good metaphors (τὸ εὖ μεταφέρειν) is someone who is able to intuitively perceive (θεωρεῖν) similarities. According to Laks, what this text suggests is that the ability to produce good metaphors presupposes that one can discover similarities by some other means, through the perception of similarities

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[14] Laks (1990), "Substitution Et Connaissance: Une Interprétation Unitaire (Ou Presque) De La Théorie Aristotélicienne De La Métaphore" in Furley and Nehamas, Eds., *Arisotle's Rhetoric: Philosophical Essays*, 283

(τὸ τὸ ὅμοιον θεωρεῖν).[15] It is perception, then, and not metaphor, that Aristotle attributes to insight. Metaphor has a didactic role, insofar as with it we can persuade or teach others; but its role, if any, in producing knowledge will be subsidiary or derivative of other forms of insight. It is, as Laks says, "*un effect* de connaissance" and so it is better to talk about its quasi-cognitive role than its cognitive one (Laks, 299). Rather than guide inquiry, metaphors occasioned by perception will be subject to philosophical scrutiny. Thus, Aristotle can criticize Empedocles' metaphor that the sea is "the sweat of the earth" as being unscientific (*Meteorology* II 3, 357a24-5), and praise "the comic poets" for making a good metaphor when they claim grey hair is "the mould of old age" (*On the Generation of Animals* V 4, 784a23 *ff.*), because, as Paul Crittenden writes, "one looks to physics for the knowledge, not metaphor."[16] It will be the philosopher's insight, in the end, that determines the appropriateness of a metaphor.

Where does this leave the role of metaphor in inquiry? Ricoeur's suggestion is elegant, but he also admits it strays from Aristotle's texts (Ricoeur, 24-5). On Laks' interpretation, metaphors are merely substitutions of one term for another, and metaphor will not play an independent role in inquiry. If, for instance, I say Odysseus performed "10,000" deeds instead of "many," I have not gained new knowledge, either of the category "quantity," or of Odysseus' deeds. But there is another feature of metaphor that Laks emphasizes, one which implies metaphor does have a role in inquiry: good metaphors are grounded in an intuitive perception of similarity. An

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[15] Laks (1990), "Substitution Et Connaissance: Une Interprétation Unitaire (Ou Presque) De La Théorie Aristotélicienne De La Métaphore", 286-289

[16] Crittenden (2011), "Philosophy and Metaphor: The Philosopher's Ambivalence", *Literature & Aesthetics* 13(1), 36

intuitive perception of a similarity tells us something about what two objects are like—they may share the same predicate because they share the same genus, or because they are related as genus to species. And Aristotle suggests that, because we perceive (θεωρεῖν) this similarity, the metaphor will express a *true* belief about that similarity. The perception of similarity is not knowledge because knowledge is knowledge of the cause, and not simply the fact (*Posterior Analytics* II 1). Therefore, the metaphors used to express the perceived similarity cannot be used in scientific definitions whose aim is such knowledge. This is what we would expect from Aristotle's statements in the *Posterior Analytics* and *Topics*. Yet, the metaphor (where metaphor is a success term, i.e., the one produced by ὁ μεταφορικός) will express a *true belief*, and Aristotle thinks that true belief is a necessary starting point for inquiry into causes, the kind of inquiry that will result in scientific knowledge.

The problem of coming to have demonstrative understanding of some phenomena is the problem of the *Meno*. How do we go about inquiring into anything if we do not yet know what that thing is? Plato's solution is that we must begin from some true proposition about whatever we are investigating; and, since we do not yet *know* anything about it, our starting point will have to be, not knowledge about the subject of our inquiry, but a true belief about it.[17] Aristotle accepts Plato's resolution to the *Meno*

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[17] In this discussion, I largely follow Stephen Menn's interpretation of Aristotle on inquiry. See Menn (2002), "Plato and the Method of Analysis", *Phronesis* 47(3) and, Menn, *The Aim and the Argument of Aristotle's Metaphysics* (in draft) Iα2, 2-4. Other discussions I have consulted include Charles (2000), *Aristotle on Meaning and Essence* and Lennox (2011), "Aristotle on the Norms of Inquiry", *HOPOS: The Journal of the International Society for the History of Philosophy of Science* 1(1). Lennox, 89, notes that Aristotle offers no account in the *Posterior Analytics* for how the scientist is to inquire into basic natural kinds. Although I do not develop such a view in this paper, if I am correct that metaphor is a legitimate starting point for inquiring into nature, it is also one way Aristotle might have pursued finding such kinds.

problem when he claims that, in inquiry, we always start from what is *true but not clear* and try to end up with what is *both true and clear*. A particularly lucid explication of this method of inquiry is in *Eudemian Ethics* II 1, where Aristotle is inquiring into moral virtue. Aristotle begins from the true belief that the moral virtue will be the best disposition of some part of the soul (1219b37-1220a13); what this means, however, is not yet clear. "Best disposition" and "some part of the soul" puts us in the ballpark, but to have knowledge of moral virtue, we must investigate "what [moral virtue] is, its parts…and through what it comes to be" (*Eudemian Ethics* II 1, 1220a14). In other words, we need to know what it is, we need to know its (formal, material and efficient) causes. He goes on:

> δεῖ δὴ ζητεῖν ὥσπερ ἐν τοῖς ἄλλοις ἔχοντές τι ζητοῦσι πάντες, ὥστε ἀεὶ διὰ τῶν ἀληθῶς μὲν λεγομένων οὐ σαφῶς δὲ πειρᾶσθαι λαβεῖν καὶ τὸ ἀληθῶς καὶ σαφῶς. νῦν γὰρ ὁμοίως ἔχομεν ὥσπερ ἂν εἰ ** καὶ ὑγίειαν, ὅτι ἡ ἀρίστη διάθεσις τοῦ σώματος, καὶ Κορίσκος ὁ τῶν ἐν τῇ ἀγορᾷ μελάντατος· τί μὲν γὰρ ἑκάτερον τούτων οὐκ ἴσμεν, πρὸς μέντοι τὸ εἰδέναι τί ἑκάτερον αὐτῆς πρὸ ἔργου τὸ οὕτως ἔχειν.
>
> We must inquire [ζητεῖν], as everyone does in other cases, by having something [to start with]; so here, by going through what is said truly but not clearly [οὐ σαφῶς], we should always try to grasp [what is said] truly and clearly [σαφῶς]. For we are now in the condition of one who describes health as the best disposition of the body, or Coriscus as the darkest man in the market-place; for what either of these is we do not know, but for knowing what either of these is, it is worthwhile to be in this condition. (*Eudemian Ethics* II 1, 1220a13-23 tr. Solomon, modified; cf. *Eudemian Ethics* I 6)

Aristotle thinks all inquiry begins from what is true but not clear and through them, aims at grasping what is true and clear. Propositions that are true but not clear, like "health is the best condition of the body" or "Coriscus is the darkest man in the market-place," are those that do not yet make clear what the subject of our investigation is. We might accept them as true, perhaps on past experience (that Coriscus is the darkest man

in the market-place), or because they are analytically true (that the excellence of anything is the best disposition of that thing); but, these propositions are not scientific definitions, because they express, not what something, e.g., health or Coriscus is, but what something is *like*. Still, we are in a better position when we have a true belief of what something is like, since this belief helps to narrow down where to look for the object of inquiry (within which range of objects, or which genus) and how to recognize it when we find it (it is the object with such-and-such predicate or predicates). "It is," therefore, "worthwhile to be in this condition" because, from a true proposition about what something is *like* we are in an adequate position to inquire into what it *is*.

Now, as I pointed out in the initial problem of this paper, Aristotle believes that "everything said metaphorically is unclear [ἀσαφὲς]" (*Topics* VI 2, 139b34-5). And we have seen that metaphors for Aristotle, while they are not scientific explanations, still express true propositions, even on Laks' substitutionalist reading. Finally, in his account of inquiry in *Eudemian Ethics* II 1, true but unclear [οὐ σαφῶς] propositions are the starting points for all inquiry. There is, therefore, a legitimate role for metaphor in Aristotelian science. The aim of any scientific investigation is knowledge of the causes of natural phenomena, the knowledge that is expressed in a scientific definition. Metaphor will not constitute such knowledge; it can, however, serve as a starting point for scientific inquiry.

In her book, *Explanation and Teleology in Aristotle's Science of Nature*, one of Mariska Leunissen's insights into Aristotelian explanation is that expressions like "nature does nothing in vain" and "nature always acts for the better" are part of Aristotle's method of discovery (Leunissen 2010, 112-135). Leunissen calls these expressions "teleological principles," and she argues that they are heuristic strategies that Aristotle uses when observation and previously established definitions do not lead to final causes. These

principles are not premises in scientific demonstrations, but hypotheses that he uses to generate inferences that will lead to a final causal explanation (*ibid*, 121). I explore Aristotle's use of teleological principles in chapter two, but it is worth noting here that teleological principles are, I think, closely related to metaphor in Aristotle's science. After all, many of his metaphors are themselves teleological principles. As Leunissen points out, teleological principles are empirical principles: they are "the result of experience, the accumulation of observations, preserved by memory," which "also always need to be checked and judged against what is actually perceived" (*ibid*.). I have also tried to show this is the case with metaphor. Metaphors are the results of intuitive perception (θεωρία) and Aristotle thinks it is the philosopher or scientist who is ultimately the judge of whether a metaphor is appropriate or not. One way to think about teleological principles, I suggest, might be as established metaphors, metaphors which are particularly useful for inquiring into the (final) causes of natural phenomena.

A problem for my view, however, would be if Aristotle used metaphor in causal explanations. I have argued that metaphor in Aristotle is an important part of his method of inquiry in science, but must, according to his own stipulations in the *Organon*, play no role in scientific explanation. There is, however, an attested use of metaphor in explanation that is pervasive among scholars of Aristotle: the metaphor of "imitation." It is almost universally considered that the final cause of sublunary things, both animate and inanimate, is the "imitation of the divine to the extent that it is possible." According to this view, Aristotle's god is a paradigm which everything else in the cosmos seeks to imitate. When we examine the textual evidence for this view, however, we will see that it is thin. There are only three places, two in the physical works and one in the *Metaphyics*, where Aristotle uses imitation to describe the relation between the sublunary and celestial bodies. And in these contexts, I defend an

interpretation in which "imitation" is not a final cause, but a metaphor that Aristotle deploys to express the theoretic necessities concerning a unique efficient causal explanation: the efficient causal influence of the heavens on the sublunary elements.

2.2 Paradigm and Imitation

In *On Generation and Corruption*, Aristotle gives an argument for the eternity of coming-to-be. This argument employs three phrases that have been interpreted both literally and metaphorically by different scholars.[18] The first, that nature always desires (ὀρέγεσθαι) the better in all things (336b27-28); the second, that the god (ὁ θεός) filled up the universe, making generation perpetual (συνεπλήρωσε τὸ ὅλον ὁ θεός, ἐνδελεχῆ ποιήσας τὴν γένεσιν) (b32); and the third, that the simple bodies like air and water imitate the circular motion of the heavens (μιμεῖται τὴν κύκλῳ φοράν) (337a3-4 and again at a7). The first looks like a common Aristotelian teleological principle. The second appears to be a rhetorical flourish: the idea of a god acting in time makes no sense in Aristotle's eternal, deistic cosmos. The status of the third metaphor is what I want to examine. There are two problems with this metaphor. First, it suggests Aristotle is mixing his metaphors. One of the metaphors, either that the god filled up the universe with being, or that the sublunary elements perpetually re-generate by imitating the heavens, is superfluous. Second, if we assume that the metaphor of a providential god is a form of popularizing or Platonizing, then it seems he is attributing to the elements a kind of conscious intentionality: the sublunary bodies aim at imitating, or emulating, celestial bodies. In this section, I argue that the heavenly bodies do not operate for the sake of the sublunary ones, nor does it work the other way around. The metaphor of

[18] See note 29 below.

imitation in this argument does not suggest participation in the eternal and divine, nor does it suggest a teleological relationship between the heavens and inanimate sublunary bodies. Instead, the metaphor of imitation designates the relation of a paradigm to its image, and Aristotle uses this relation, not as a premise in a (final cause) explanation, but as a heuristic for inquiring into the efficient causal connection between the celestial and sublunary bodies.

The argument appears in a discussion of why generation will always occur. Having admonished his predecessors for failing to explain how anything comes into existence at all (*Generation and Corruption* II 9), Aristotle gives two distinct arguments for the eternity of generation. First, he argues for an efficient cause explanation of generation. Once he has shown how the hypothesis of the sun's continuous circular movement is sufficient to guarantee that generation and corruption will never cease, he thinks we have no reason to fear the world will ever end, nor wonder whether it ever had a beginning. He then gives an argument to show why this efficient cause explanation was reasonable[19]:

> Ἀεὶ δ', ὥσπερ εἴρηται, συνεχὴς ἔσται ἡ γένεσις καὶ ἡ φθορά, καὶ οὐδέποτε ὑπολείψει δι' ἣν εἴπομεν αἰτίαν. Τοῦτο δ'εὐλόγως συμβέβηκεν · ἐπεὶ γὰρ ἐν ἅπασιν ἀεὶ τοῦ βελτίονος ὀρέγεσθαί φαμεν τὴν φύσιν, βέλτιον δὲ τὸ εἶναι ἢ τὸ μὴ εἶναι (τὸ δ' εἶναι ποσαχῶς λέγομεν ἐν ἄλλοις εἴρηται), τοῦτο δ' ἀδύνατον ἐν ἅπασιν ὑπάρχειν διὰ τὸ πόρρω τῆς ἀρχῆς ἀφίστασθαι, τῷ λειπομένῳ τρόπῳ συνεπλήρωσε τὸ ὅλον ὁ θεός, ἐνδελεχῆ ποιήσας τὴν γένεσιν· οὕτω γὰρ ἂν

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[19] "Reasonable" translates εὐλογῶς. There is some debate about what this term means. Robert Bolton has argued that it is common in dialectical premises in Aristotle's scientific works. These premises reflect common sayings or beliefs that are not meant to be part of a scientific explanation. Bolton (2009), "Two Standards for Inquiry in Aristotle's *De Caelo*" in Bowen and Wildberg, Eds., *New Perspectives on Aristotle's De Caelo* Devin Henry has suggested (personal communication) that εὐλογῶς arguments do not use dialectical premises, but *a priori* premises specific to the genus studied by the science. They are, therefore, not *endoxic* or common sayings. It makes little difference for my argument which view ends up correct, since I argue that "imitation" is not an explanation at all.

μάλιστα συνείροιτο τὸ εἶναι διὰ τὸ ἐγγύτατα εἶναι τῆς οὐσίας τὸ γίνεσθαι ἀεὶ καὶ τὴν γένεσιν.

Τούτου δ' αἴτιον, ὥσπερ εἴρηται πολλάκις, ἡ κύκλῳ φορά· μόνη γὰρ συνεχής. Διὸ καὶ τἆλλα ὅσα μεταβάλλει εἰς ἄλληλα κατὰ τὰ πάθη καὶ τὰς δυνάμεις, οἷον τὰ ἁπλᾶ σώματα, μιμεῖται τὴν κύκλῳ φοράν· ὅταν γὰρ ἐξ ὕδατος ἀὴρ γένηται καὶ ἐξ ἀέρος πῦρ καὶ πάλιν ἐκ πυρὸς ὕδωρ, κύκλῳ φαμὲν περιεληλυθέναι τὴν γένεσιν διὰ τὸ πάλιν ἀνακάμπτειν. Ὥστε καὶ ἡ εὐθεῖα φορὰ μιμουμένη τὴν κύκλῳ συνεχής ἐστιν.

Generation and perishing, as was said, will always be continuous and will never fail because of the cause we just stated. This has reasonably turned out: for since we assert that *nature desires the best in all things*, and being is better than not being (the number of senses of "being" was talked about in another work[20]), and this cannot obtain in all cases[21] because they are too far from the principle, *the god completed the whole [sc. the universe] in the manner that remained by making generation perpetual.* For in this way being would be as coherent as could be, because the closest thing to substance is that generation comes-to-be eternally, as well.

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[20] There are at least two questions we might ask about this phrase: (1) what other work is Aristotle referring to? (2) what other sense of being does he have in mind? In response to (1), Aristotle might be referring to the *Categories'* discussion of being, or *Metaphysics* Δ 7, 1017a8-b9, or both. *Metaphysics* Δ 7 duplicates some of the discussion in the *Categories*. Joachim (1922), *Aristotle. On Generation and Corruption: Text and Commentary*, 245-246 points out that various meanings of εἶναι and τὸ ὄν are found in many places, but takes Δ 7 as his standard. In response to (2), Joachim (*ibid.*) claims it is "'being' in the primary and superlative sense—the substances which is pure 'form' or sheer actuality—that Aristotle here seems to have in mind" but that the principle "being is better than not being" would equally apply, regardless whether he means being-as-truth is better than being-as-falsity, being-P than not being-P, or being-potentially than not-being-simpliciter. The problematic case is being-as-said-of-the-categories other than substance, since it seems hard to understand what it would even mean to say, "being-blue is better than not-being-blue." Whenever Aristotle says "being is better than not being" (cf. *On the Generation of Animals*. II 1, 732b39-30), he probably has in mind the Pythagorean συστοιχία, reported in, e.g., *Metaphysics* A5 986a23 *ff.* According to Aristotle, Alcmaeon of Croton suggested any pair (contrary or not) could go in one (positive) column or the other (negative) column. For more on this, see Lloyd (1966), *Polarity and Analogy: Two Types of Argumentation in Early Greek Thought*.

[21] Devin Henry suggests (personal communication) that the phrase, τοῦτο δ' ἀδύνατον ἐν ἅπασιν ὑπάρχειν, might be translated, "but not all things can possess [eternal existence]." The point seems to be, not that some things are not capable of existing at all (e.g. square triangles), but that some things are not capable of eternal existence. As we will see, this is a premise in the argument for eternal existence of species in *Generation of Animals* II 1, and the claim there seems to be a specific application of this one.

> The cause of this [sc. the approach and retreat of the sun], as was often said, is circular motion: for only [circular motion] is continuous. *That is also why whatever things change into one another according to their qualities and capacities, e.g. the simple bodies, imitate circular motion.* For whenever air comes to be out of water, and fire out of air and again water out of fire, we say the coming-to-be has come around, by bending back again. Thus, *by imitating circular motion rectilinear motion is continuous, as well*. (*On Generation and Corruption* II 10, 336b25-337a7)

The argument is meant to show why it is reasonable that generation should be eternal: continuous generation is the closest thing to continuous existence, and since being is better than the alternative, this is what occurs.[22] In an echo of the Demiurge's deliberation (*Timaeus* 30c2-31a1), or his speech to the lower gods (*Timaeus* 41b8-

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[22] Aristotle often uses teleological principles or generalizations like the ones in this argument when he explains a thing's existence or generation teleologically. Falcon (2005), *Aristotle and the Science of Nature: Unity without Uniformity*, 88, lists the following passages where they occur. I have cross-checked these with Bonitz, Meyer and Langkavel (1955), *Index Aristotelicus* and Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*. They include, "nature does nothing in vain, but always the best among the possibilities for the substance of each thing" (*On the Gait of Animals* 2); also: *De Caelo* 271a33, 291b13–14; *De Anima* 432b21, 434a31; *Parva Naturalia* 476a13; *Parts of Animals* 658a8, 661b24, 691b4–5, 694a15, 695b19–20; *Gait of Animals* 704b15, 708a9, 711a19; *Generation of Animals* 739b19, 741b4, 744a37. The claim that "nature always does the best possible thing" is found in *Physics* 260a22–3; *De Caelo* 288a2–3; *Generation and Corruption* 336b27–8; *Parva Naturalia* 469a27–8; *Parts of Animals* 658a23, 687a16–17; *Gait of Animals* 704b15, 708a9–10. There is a debate whether Aristotle uses these expressions as heuristics or as premises in demonstration. Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 119-135, provides a thorough defense for the former view. Leunissen is responding to Lennox (2001), *Aristotle's Philosophy of Biology: Studies in the Origins of Life Science*, 205-223 (chapter nine), who argued they are used as premises in demonstration. For a different view, see Henry (2013), "Optimality and Teleology in Aristotle's Natural Science", *Oxford Studies in Ancient Philosophy* 45 One textual note I want add to these: Bonitz and others following him, conflate one instance of this principle with others: the claim that nature "desires" (ὀρέγεσθαι) the best, as opposed to "does" (ποιεῖν) the best—there is only *one* occurrence of this in the corpus, not four as Bonitz suggests at 836b40. Bonitz suggests *De Caelo* II 14, 297a16 (nature has to "carry" the heavy to the middle, φέρεσθαι) ; *Physics* VIII 6, 259a11 (the better "belongs more", ὑπάρχειν μᾶλλον, in natural things); and 7, 260b23 (again, ἐν τῇ φύσει ὑπάρχειν [τὸ βέλτιον]. If anything, Bonitz should have listed *Generation of Animals* IV 10, that "nature βούλονται to be measured by the periods of the heavenly bodies", since both amount to the same relation (passive) of lacking something, as opposed to the relation (active) of making something. In the end, I am ambivalent whether these differences (e.g. between nature *doing* and nature *striving*) are all that important. Compare the clear case at NE I 1 when Aristotle is discussing human activities.

41d1), Aristotle argues that the "the god" brought this result about because, while not all things in the cosmos can exist eternally, being is better than not being, and nature desires the best in all things. He concludes by saying that the cause of continuous generation is continuous circular motion, and that the sublunary bodies, by changing into one another in an ordered and cyclical series, imitate this motion, and "by imitating circular motion rectilinear motion is continuous, as well."

A problem arises for interpreting this passage because it is unclear how the first argument about the god's reason for causing eternal generation is related to the second argument about the sublunary bodies' imitation of eternal continuous motion.[23] If you take Aristotle's explanation somewhat literally, then he seems to be claiming the regular movement of the sun is efficiently caused by a divine agent because this divine agent believes perpetual generation is better than some alternative. The god accomplishes this by causing the simple bodies to imitate continuous circular motion, and, in fact, it seems that the god is acting for the sake of fulfilling, not its own desire, but nature's desire to always have something better. One might think this explanation is un-Aristotelian. Charles Kahn has called it the "indefensible interpretation."[24] Still, it is intelligible enough and fits neatly with this text. If, however, you think this is all too Platonic, you might say Aristotle is giving one "metaphorical" account, and one literal. Aristotle uses the idea of "god acting" as a metaphor to lead into the real explanation: that all sublunary things imitate the divine as a final cause. The range of interpretations varies,

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[23] The only other passage where Aristotle unambiguously speaks of a god as acting is at *De caelo* I 4, 271a33: Ὁ δὲ θεὸς καὶ ἡ φύσις οὐδὲν μάτην ποιοῦσιν. Aristotle refers to the cycle of elements "imitating" the celestial cycles at *Meteorology* I 4, 346b36: γίγνεται δὲ κύκλος οὗτος μιμούμενος τὸν τοῦ ἡλίου κύκλον; and again at *Metaphysics* Θ8 1050b28: μιμεῖται δὲ τὰ ἄφθαρτα καὶ τὰ ἐν μεταβολῇ ὄντα, οἷον γῆ καὶ πῦρ.

[24] Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology" in Balme and Gotthelf, Eds., *Aristotle on Nature and Living Things*, 185.

but generally, one might think Aristotle is identifying "the god" and "nature," and that "the god" means "the most exemplary being," "the being that is the most what it actually is," or "the most eternal thing." "Desire," then, might suggest the tendency of natural things to move from being-potentially to being-actually, or to some actuality that is like what is most actual. "Imitation," finally, is shorthand for the process all things go through when striving to attain or be like this eternally actual thing—it is the final cause of all, whether we mean this specifically, generically or by analogy.[25] Both of these interpretations are plausible, but neither is very satisfying.

In his paper, "The Place of the Prime Mover in Aristotle's Teleology," Charles Kahn began a line of questioning concerning "cosmic teleology" in Aristotle, namely the extent to which the "Prime Mover" is a direct final cause of all things in the cosmos.[26] He wanted to show how this argument was part of Aristotle's larger project to present a "scientific substitute for the mythical Demiurge, both as immediate cause of the supreme celestial rotation, and as ultimate cause of the entire system—the οὗ ἕνεκα of nature as a whole" (Kahn 1985, 196). If, as Kahn argues, the "Prime Mover" is the supreme paradigm that everything else in the cosmos imitates, then, the metaphors of "desiring" and "imitating" are *literal* (by which Kahn means true), while the metaphor of "god acting" is simply a form of popularizing or Platonizing, and should be taken no

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[25] Broadie (1993), "Que Fait Le Premier Moteur D'aristote? Sur La Théologie Du Livre Lambda De La Métaphysique", *Revue philosophique de la France et de L'etranger* 183, 379-380 raises problems for interpreting the celestial movers' "desire" for the prime mover as a form of "imitation." If, she asks, to love the prime mover is to imitate it, and this means contemplate it: "si cette âme peut contempler le Premier Moteur, n'y a-t-il pas déjà là la meilleure forme d'imitation? Pourquoi donc faudrait-il penser que l'âme désire aussi engendrer le mouvement? Elle contemple Dieu, et Dieu, nous dit-on, se contemple lui-même; ainsi, en un sens, tous deux font la même chose."

[26] These issues are addressed in Gotthelf (2012), *Teleology, First Principles and Scientific Method in Aristotle's Biology*, chapter 2. I will not enter the debate here.

more seriously than claims about Mother Nature.[27] In fact, Kahn suggests that *all* of these metaphors, including participation, imitation, desiring, are all "literal" instances of natural things trying or striving to emulate the divine paradigm of actuality.

Kahn was trying to resist what he called "positivism in exegesis," by which he meant interpretations that assumed the Prime Mover had no influence on anything in the cosmos beyond the sphere of the fixed stars. Thus, it seems he was eager to show, by the force of combined textual evidence, that such a positivist view was implausible. While he agrees with his positivist interlocutors that Aristotle gives a sufficient mechanical account of the seasonal variations on earth, what this account lacks is an explanation of why these mechanical processes were good. He writes, "the explanatory force" of these metaphors is that their literal sense "lies in the notion of a universal tendency towards positive being, realized form, and unceasing activity" (Kahn, 200). And if one agrees that the only consistent view of divinity in Aristotle is as a paradigm for imitation, then the "unceasing activity" of the Prime Mover will be the goal towards which all things, animate or inanimate, strive.

The difficulty, as Kahn points out, is that we cannot assume Aristotle's commitments are consistent before we know what his doctrines are. So, we need to look at the big picture of Aristotle's system, and then attempt to interpret the expressions we find so

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[27] Before Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology", Joachim (1922), *Aristotle's on Generation and Corruption*, *ad loc* in his commentary and Peck (1963), *Aristotle. Generation of Animals*, *ad loc* in his *Generation of Animals* commentary (*Generation of Animals* II 1, 732a2 *ff.*) assume that Aristotle does not literally mean "god" is an efficient cause of anything other than the heavens, but take 'the god' to be in some sense the "final cause" of everything. Neither defend this view. Balme (1972), *Aristotle. De Partibus Animalium I and De Generatíone Animalium I (with Passages from Ii. 1-3)*, 155, however, suggests in his commentary on the *Generation of Animals* II 1 parallel that "divine" means final cause in a generalized sense, and not the first unmoved mover.

that they fit with the big picture of that system. In Kahn's picture, the expressions "desiring" (ὀρεγεσθαι), "striving" (ἐφίεσθαι), "wanting" (βούλεσθαι), "participating" (μετέχειν) and "imitating" (μιμεῖστθαι) often occur when Aristotle talks about divinity, and so he thinks they are all expressing the same kind of relation with the divine, a final causal relation. The problem with Kahn's approach is that it assumes (although not explicitly) Aristotle does not use these expressions metaphorically. Instead, he interprets the metaphors *literally*, which they must be if Aristotle is using them in scientific explanations. They seem like metaphors to us, but Aristotle did not intend them this way. The approach is not altogether unreasonable. When Aristotle says "nature does what is best" or "does nothing in vain," we need not interpret "doing" or "in vain" as substitutions for another possible expression. Aristotle could mean these expressions literally, without intending it to mean, for instance, that nature is a conscious agent. Similarly, in the case of "imitation," Aristotle could mean that the sublunary bodies *literally* imitate the heavens, without this implying that they do so consciously. We could, following Kahn, characterize this approach in the following way: we must aim to interpret these expressions consistently along with Aristotle's other philosophical commitments.

While Kahn's method will yield some results, it raises a an exegetical problem specifically when dealing with expressions that seem metaphorical: how can we tell a metaphorical expression from a literal one, except by checking whether the literal meaning contradicts the commitments we attribute to an author independently of them? As I have shown in the previous section, Aristotle thinks, or could have thought, metaphors are legitimate in science, and to take Kahn's approach would be question-beginning. I propose, then, to bracket those philosophical commitments attributed to Aristotle which the strict sense of the expression might contradict, figure out what work the expression is doing in a given argument, and compare this to similar arguments that use similar expressions.

We must consider the literal sense of the expressions first, and then explore the similarities and differences between "imitation" and other, related expressions like "participate" or "desire."

I first want to look at what Aristotle thinks imitation means, and then try to see how it is related to two other expressions that have similar meanings: participation and resemblance. Many scholars besides Kahn have argued that imitation and participation are equivalent concepts in Aristotle, and that imitation and participation in the divine is the final cause of all natural things.[28] This interpretation, however, assumes Aristotle is thinking of imitation as *emulation*: the elements strive to emulate or be like the divine. Yet, imitation has two senses: it can mean something like emulate, but it is also used in the arts to describe the relation, like in artistic contexts, of a model to its image. And both senses share the common relation of a paradigm (παράδειγμα) and its image (εἰκών), but we need to tease apart these two senses to figure out which Aristotle is applying in *Generation and Corruption* II 10. If he is claiming that the sublunary cycles imitate the celestial cycles in this latter, paradigmatic sense, as a copy resembles its model, then it is unclear whether Aristotle is using imitation of the divine as the final cause of the sublunary cycles.

2.3 Imitation

"Imitation" is an ambiguous term.[29] One of the difficulties of interpreting it in Aristotle's natural philosophy arises because its use is quite rare.[30] It occurs only nine

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[28] See note 29 below.

[29] Some of the most influential glosses on the verb μιμέσθαι, "to imitate," and their main proponents are: (a) *to strive for god-like actuality* (Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology", 205; Bodéüs (2000), *Aristotle and the Theology of the Living Immortals*, 162; Sedley (2007), *Creationism and Its*

times in his physical writings and four times in the *Metaphysics*, and most of those are reports. The reports, however, are a good starting point, since by looking at how Aristotle thought the term was used inappropriately, we might get a better sense of what he thinks it means. In *Metaphysics* A 6, he reports "the Pythagoreans say things exist by imitation of the numbers, but Plato says they exist by participation, changing the name.[31] But in the middle [of their search,] *they gave up inquiring* [ἀφεῖσαν ἐν κοινῷ ζητεῖν] what the participation or the imitation of the Forms could be" (987b11-14. tr. Ross).[32] Implicit in Aristotle's report is the claim that, had they continued inquiring, they might have been able to find an answer, although Aristotle thinks the answer would

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Critics in Antiquity, Chapter 6.1); (b) *to resemble* (Johnson (2005), *Aristotle on Teleology* and Charles (2012), "Teleological Causation" in Shields, Ed., *The Oxford Handbook of Aristotle*; (c) *to strive for eternal species-specific actuality* (Gotthelf (2012), *Teleology, First Principles and Scientific Method in Aristotle's Biology* and Lennox (2001), *Aristotle's Philosophy of Biology*); (d) *to approximate* (Richardson Lear (2004), *Happy Lives and the Highest Good: An Essay on Aristotle's Nicomachean Ethics*, 72-92); (e) *to participate* (nearly everyone on this list; the exceptions may be Johnson and Charles); (f) *to be active or actual* (Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology", 205 Lang (2007), *The Order of Nature in Aristotle's Physics: Place and the Elements*.

Sedley claims the elements imitate god-like actuality and that "in some attenuated way even the four elementary bodies strive for everlasting actuality." Sedley (2007), *Creationism and Its Critics in Antiquity*, 170-173 Johnson (2005), *Aristotle on Teleology* David Charles suggests "imitation" means something like "resemblance;" Johnson's view is similar, and claims the elements receive an "attenuated benefit" from this imitation. Charles (2012), "Teleological Causation", Johnson (2005), *Aristotle on Teleology*. Gotthelf tentatively suggests that "the thrust" of the passage is to assimilate generation to self-preservation although he does not look to the passage in detail. Gotthelf (2012), *Teleology, First Principles and Scientific Method in Aristotle's Biology*, 8-9n13, 59;Lang (2007), *The Order of Nature in Aristotle's Physics: Place and the Elements*, 250-251 suggests the elements imitate the heavens insofar as they cannot fail to be moved (to move?) to their proper places so long as nothing prevents them, whereas the heavens have no such potency but are necessarily active.

[30] TLG reports that the phrase occurs 84 times in the Corpus. By far, the majority of occurrences are in the *Rhetoric*, *Poetics* and the ethical works.

[31] For a discussion of this passage, see Furley (1989), *Cosmic Problems: Essays on Greek and Roman Philosophy of Nature*

[32] οἱ μὲν γὰρ Πυθαγόρειοι μιμήσει τὰ ὄντα φασὶν εἶναι τῶν ἀριθμῶν, Πλάτων δὲ μεθέξει, τοὔνομα μεταβαλών. τὴν μέντοι γε μέθεξιν ἢ τὴν μίμησιν ἥτις ἂν εἴη τῶν εἰδῶν ἀφεῖσαν ἐν κοινῷ ζητεῖν.

have been a negative one: he concludes, having pursued the metaphor, that the concepts of participation and imitation are not sufficient to express the relations the Platonists and Pythagoreans were after.

While he does not criticize the Pythagorean use of "imitation" explicitly, he criticizes the related notion of participation in *Metaphysics* A 9:

> ἀλλὰ μὴν οὐδ' ἐκ τῶν εἰδῶν ἐστὶ τἆλλα κατ' οὐθένα τρόπον τῶν εἰωθότων λέγεσθαι. τὸ δὲ λέγειν παραδείγματα αὐτὰ εἶναι καὶ μετέχειν αὐτῶν τἆλλα κενολογεῖν ἐστὶ καὶ μεταφορὰς λέγειν ποιητικάς. τί γάρ ἐστι τὸ ἐργαζόμενον πρὸς τὰς ἰδέας ἀποβλέπον; ἐνδέχεταί τε καὶ εἶναι καὶ γίγνεσθαι ὅμοιον ὁτιοῦν καὶ μὴ εἰκαζόμενον πρὸς ἐκεῖνο, ὥστε καὶ ὄντος Σωκράτους καὶ μὴ ὄντος γένοιτ' ἂν οἷος Σωκράτης· ὁμοίως δὲ δῆλον ὅτι κἂν εἰ ἦν ὁ Σωκράτης ἀΐδιος.
>
> But further none of the other [sc. perceptible] things can be out of the Forms according to any of the usual senses of "out of." And to say [the Forms] are patterns [παραδείγματα] and the other things share [μετέχειν] in them is to speak vacuously and to talk in poetical metaphors [μεταφορὰς λέγειν ποιητικάς]. For what is it that does the work, looking to the Ideas? And anything can either be, or become, like another without being an image [εἰκαζόμενον] of it, so that whether Socrates exists or does not, someone might come to be like Socrates; and evidently this might be so even if Socrates were eternal. (*Metaphysics* A9, 991a19-26 tr. Ross, modified)

In this passage, Aristotle raises three criticisms related to the use of "participation" as a way of characterizing the relation between Forms and perceptible things. First, he objects that perceptible things are not composed of Forms. Second, specifically against the claim that Forms are patterns [παραδείγματα] and perceptible things their images, he objects that such language is "empty talk" and "poetical metaphor" since this relation suggests something works to make an image based on a pattern, and Aristotle implies Plato has not adequately specified what it is that looks to the Forms. Third, he objects that the eternity of the Forms does not entail that they are patterns, but at best that they are like perceptible things. I want to look at these three objections, with the aim of

trying to clarify Aristotle's reasons for objecting to "participation" as a metaphor that expresses the relation of a "paradigm" to its "image."

One question this passage raises is why Aristotle would make the second objection, namely that Plato has not specified what it is that looks to the Forms as patterns. Plato spends a good deal of time in the *Timaeus* characterizing just such an efficient cause, and the Demiurge seems at least to offer a preliminary account of what such an efficient cause must be like. Ross suggests, with hesitation, that the reason Aristotle calls "participation" a "poetical metaphor" is precisely because Aristotle thinks the account of the Demiurge and its activity in the *Timaeus* is merely figurative.[33] However, I do not think the *Timaeus* is helpful context for understanding why Aristotle thinks the "participation" is a poetical metaphor. First, the reference to "poetical metaphor" does not imply a criticism of the *Timaeus*, but the kind of metaphor Plato has chosen to use. Second, a much closer parallel text is found in the *Parmenides*, where Plato uses the metaphor of a "pattern and image" to define "participation." I want to examine each of these claims in turn.

Aristotle's use of the phrase "poetical metaphor" is not obviously a reference to *Timaeus*. This is clear from another context in which Aristotle talks of "poetical metaphor," *Meteorology* II 3, 357a24-27. There, Aristotle objects to Empedocles' explanation of the saltiness of the sea—that it is the sweat of the earth—because, while it may be sufficient for the purposes of a poem [πρὸς ποίησιν μὲν γὰρ οὕτως εἰπὼν ἴσως εἴρηκεν ἱκανῶς (ἡ γὰρ μεταφορὰ ποιητικόν), a26-7], for the purposes of the knowledge of nature it is not [πρὸς

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[33] Ross (1924), *Aristotle's Metaphysics*, Vol. 1, 198-199.

δὲ τὸ γνῶναι τὴν φύσιν οὐχ ἱκανῶς, a27]. But the reason it is insufficient for knowledge of nature is not because it is a metaphor, although Aristotle does think metaphors are part of poetry. The reason it is insufficient, which he immediately goes on to state at a27-28, is that the saltiness of sweat is not understood, either: "οὐδὲ γὰρ ἐνταῦθα δῆλον πῶς ἐκ γλυκέος τοῦ πόματος ἁλμυρὸς γίγνεται ὁ ἱδρώς...." Thus, there is no reason to think that the claim "sea is the sweat of the earth" could not provide a way of understanding why the sea is salty; however, this would require that Empedocles already has an explanation of why *sweat* is salty. But since he understands neither, Aristotle says it is absurd to suppose anything clear has been said (γελοῖον [...] οἴεταί τι σαφὲς εἰρηκέναι, a24-25) by describing one in terms of the other.[34] Aristotle's second criticism of participation in *Metaphysics* A9 follows the same pattern, although the particular criticism is different. He calls participation a poetical metaphor, but he explicitly states what it is about the metaphor that is problematic: if Forms are *patterns* and perceptible things *images of them,* participation it is not a sufficient characterization of this relation, because this relation requires an efficient cause. The claim Aristotle is making is not that the *Timaues* is merely poetic or figurative, but that "participation" is insufficient to characterize the relation Plato wants to get at.

Second, from the way Aristotle characterizes Plato's position and the criticism he raises, it is clear that his target is the *Parmenides.* There, Plato characterizes the Forms as "patterns [παραδείγματα] set in nature," and says perceptible things "resemble them and

[34] I only note that Aristotle is not here claiming metaphor is inappropriate in science *simpliciter*, but that this metaphor is sufficient for a poem, but not for knowledge of nature, because it does not state the reason why the sea is salty, but only states that both sweat and the sea are salty.

are likenesses" (*Parmenides* 132d1-3).[35] Plato, in fact, *defines* "participation" in the Forms as certain way of being-an-image [ἡ μέθεξις αὔτη τοῖς ἄλλοις γίγνεσθαι τῶν εἰδῶν οὐκ ἄλλη τις ἢ εἰκασθῆναι αὐτοῖς], and in criticizing Plato, Aristotle is applying the restriction on definition from *Posterior Analytics*: "if one should not argue in metaphors, it is clear that [one must neither] define using metaphors nor [define] what is said metaphorically: for necessarily one will then be arguing in metaphors" (*Posterior Analytics* II 13, 97b37-39).[36] Aristotle's point is that Plato is mixing metaphors: he is trying to define "participation," using another metaphor of "pattern" and "image." Aristotle, in his criticism, is trying to tease these metaphors apart by showing that an image and its model do not share predicates the same way participants and things participated in do. His first objection attempts to show that an image is not *like* its model because it is something that is *made out* of its model. A statue, for instance, is not like the model it represents because the model, or some part of the model, is a part of the statue. By contrast, material things are like what they are composed of precisely because the material they are composed of exists in them as constituents. Clay, for instance, is like water because clay literally "shares in"—is composed of—water and earth. The second objection Aristotle raises suggests that, for an image or likeness to resemble its model, there must be something that, looking to the model, acts in order to bring the image about. There must, in other words, be a sculptor in addition to the paradigm and

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[35] τὰ μὲν εἴδη ταῦτα ὥσπερ παραδείγματα ἑστάναι ἐν τῇ φύσει, τὰ δὲ ἄλλα τούτοις ἐοικέναι καὶ εἶναι ὁμοιώματα, καὶ ἡ μέθεξις αὔτη τοῖς ἄλλοις γίγνεσθαι τῶν εἰδῶν οὐκ ἄλλη τις ἢ εἰκασθῆναι αὐτοῖς.

[36] Alexander of Aphrodisias makes a similar point is his commentary: "For they say that the Ideas are models, and that the things here below participate in them; now to speak in this way, he [sc. Aristotle] says, is to use empty words and to speak in metaphors, as do the poets; for those who use "participation" in the case of the Ideas do not indicate any of those things in which the participant participates" (*in Metaphyisca* A, 101.18-22, tr. Dooley). Alexander claims, without argument, that the metaphor of a "model" and its "image" comes from painting (101.6).

its image. To make the point even clearer, he raises his third objection, that any two things can resemble one another, even an eternal and a perishable thing, without this implying that one (the eternal one) is a model and the other an image. In other words, two things may resemble one another, but this does not imply one is prior, or has the predicate in virtue of which they are similar in a primary way, as it would have to if the relation were of a paradigm to its image.[37] Even if, for two things that resemble one another, one were eternal and the other finite, Aristotle argues that would not be sufficient grounds for claiming one is a model and the other its image. For something to be an imitation, it has to be *made* in the image of something else.

Aristotle's argument against Plato suggests two things: first, it suggests he is aware participation and imitation are metaphors; and second, it suggests he thinks the contexts in which these metaphors are appropriate are different. Participation and imitation express different reasons why two or more things are similar. Participation suggests two things are similar because they share the same type of matter, while imitation suggests two things share the same form. [38] They also differ in the way they characterize the Platonic Forms as causes to particulars. Participation suggests they are causes as matter; imitation suggests they are causes as form. Plato, as Aristotle reads him, does not literally think Forms are causes as matter or causes as paradigms, but Aristotle is not certain Plato has any other way of understanding them. Plato seems to be trying to conceive of

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[37] Compare *Phaedo* 74d9-e2: "Whenever someone, on seeing something, realizes that that which he now sees wants to be like some other reality but falls short and cannot be like that other since it is inferior, do we agree that the one who thinks this must have prior knowledge of that to which he says it is like, but deficiently so?"

ὅταν τίς τι ἰδὼν ἐννοήσῃ ὅτι βούλεται μὲν τοῦτο ὃ νῦν ἐγὼ ὁρῶ εἶναι οἷον ἄλλο τι τῶν ὄντων, ἐνδεῖ δὲ καὶ οὐ δύναται τοιοῦτον εἶναι [ἴσον] οἷον ἐκεῖνο, ἀλλ' ἔστιν φαυλότερον, ἀναγκαῖόν που τὸν τοῦτο ἐννοοῦντα τυχεῖν προειδότα ἐκεῖνο ᾧ φησιν αὐτὸ προσεοικέναι μέν, ἐνδεεστέρως δὲ ἔχειν;

[38] Also, Jaeger (1957), *Paideia: The Ideals of Greek Culture*, 259.

some relation such that Forms resemble particulars but are still somehow prior to them or separate from them. From Aristotle's point of view, he is using two incompatible ways of understanding that relation.

Not only is this a good example of why Aristotle thinks defining in metaphors is problematic, it also means that Aristotle does not think imitation and participation are the same relation. Both relations suggest similarity, but a cause and what it causes need not be similar in the same way. Unlike participation, imitation, as Aristotle understands it, entails a relation between two things, a paradigm (παράδειγμα) and its image (εἰκών) or imitation (μίμησις). Furthermore, the existence of the image requires something that produces it [τὸ ἐργαζόμενον] by looking to the paradigm. Participation does not. Furthermore, similarity does not entail imitation. Imitation suggests something comes to have a predicate that it did not previously have, and so the paradigm has the predicate they share in a stronger way, at least initially. In other words, the paradigm is a cause to its image of the fact that they resemble one another.

I want to call this sense of imitation the *strict* sense. By 'strict sense', I do not mean this sense is historically earlier than another, or that Aristotle recognizes this sense as strict.[39] I just mean the more of these features something has, the more likely Aristotle is to call it an imitation. Imitation expresses a relation between a paradigm and its image. The paradigm and its image are similar, and they are similar because the paradigm is the formal cause of its image. Finally, some agent produces the image by looking to the

[39] For pre-Platonic use of "imitation", see Else (1958), "'Imitation' in the Fifth Century", *Classical Philology* 53(2)

paradigm. There are, I think, two senses of "imitation" that meet these criteria that are found elsewhere in Aristotle, what I will call (a) the *emulative*, and (b) the *paradigmatic*:

(a) In the ***emulative*** sense, "imitation" suggests an agent tries to make itself like a model by trying to assimilate herself to it: one causes oneself to share in some predicate that the model has in either a stronger or more complete way than the one who is emulating it. This sense is common in Aristotle's moral and political writings. Aristotle thinks emulation provides not only a foundation for moral development, through imitating or acquiring the habits of good models,[40] he also sees it as an important part of the development of a city, through the imitation of good constitutions.[41] In the *Poetics*, he grounds human facility with imitation in human nature itself, and argues that poetry developed from our natural tendency to imitate each other's actions.[42] This sense is also teleological, since the goal is to be like the model, and being like the model will be beneficial to the one imitating.

(b) In the ***paradigmatic*** sense, "imitation" suggests an agent tries to make something *else* similar to a model by making it like the model. This sense is used especially in the plastic arts. [43] The artist makes something like something else, as the sculptor makes

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[40] Burnyeat (1980), "Aristotle on Learning to Be Good" in Rorty, Ed., *Essays on Aristotle's Ethics*, 73-74; Curzer (2002), "Aristotle's Painful Path to Virtue", *Journal of the History of Philosophy* 40(2)

[41] On imitating constitutions: Aristotle thinks the constitutions of Carthage and Tarentum are good ones to imitate *Politics* VI 5, 1320b5 *f.* He defends the mimetic arts, especially music of the appropriate character, in *Politics* VIII 5, 1339a13 *ff.*

[42] *Poetics* 4, 1448b5-6

[43] There is a historical question about which sense developed first, that from the plastic arts (representation) or the sense in the dramatic arts (what we are likely to call 'imitation'). A good discussion of these issues is in Else (1958), "'Imitation' in the Fifth Century". He argues that the term developed in the fifth century, and is derived from the (already existing) term for a mime or actor, ὁ μῖμος. "To imitate" is to do what a μῖμος does.

> the marble like the model. Aristotle includes among these arts those like writing, sculpting and poetry (*Rhetoric* I 11, 1371b6, cf. *Poetics* 1 1447a16).[44]

If Aristotle thinks imitation is a *final cause explanation* of why the sublunary elements have similar cycles to the heavens, then it will be because he thinks they imitate in one of these two senses.

2.3.1 Imitation and Participation

On the standard view of *Generation and Corruption* II 10, "the imitation of the divine"—however this is understood[45]—is assumed to be the final cause that explains why the sublunary bodies undergo cycles; furthermore, it is said that this expression is equivalent to another claim, from *De Anima*, that the final cause of living things is "to participate in the eternal and divine to the extent that it is possible" (*De anima* II 4, 416b5 *ff.*). This requires understanding "imitation" in its emulative sense—the elements, like animals, do what they do in order to be as much like the divine as possible. As Sedley puts it, "the whole natural world is, in one way or another, pulling itself up by its own bootstraps in the interests of maximum godlikeness."[46] I want, then, to turn to

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[44] Theatre presents an interesting case. Aristotle will say in *Poetics* 2 1448a19 ff, "the imitators imitate actions [sc. of good and bad people]" (μιμοῦνται οἱ μιμούμενοι πράττοντας). This might sound more like the case of the student imitating the teacher (*Nicomachean Ethics* III 12, 1119b13-18) or like someone aspiring to be virtuous by imitating the actions of the virtuous person. However, the actors are μιμούμενος and thus also μίμησεις – they emulate, but they are not *really* trying to assume the virtuous or vicious characters of those they imitate. An actor (except perhaps a very serious method actor) does not want to acquire a certain moral character, but merely outward signs of such character. Burnyeat (2004), "Introduction: Aristotle on the Foundations of Sublunary Physics" in de Haas and Mansfeld, Eds., *Aristotle: On Generation and Corruption, Book I: Symposium Aristotelicum*.

[45] See note 29 above.

[46] Sedley (2010), "Teleology: Aristotelian and Platonic" in Lennox and Bolton, Eds., *Being, Nature, and Life in Aristotle*, 10. Sedley also claims "The highest human aspiration, philosophical contemplation, is the most

those texts where Aristotle claims the sublunary bodies imitate the celestial bodies, to see if they can shed light on which sense – emulative or paradigmatic – is at play in *Generation and Corruption* II 10.

There are only two texts, other than *On Generation and Corruption* II 10, where Aristotle describes the movements of the sublunary bodies or their motions as imitating the celestial bodies or their movements. In *Metaphysics* Θ 8, Aristotle claims:

> μιμεῖται δὲ τὰ ἄφθαρτα καὶ τὰ ἐν μεταβολῇ ὄντα, οἷον γῆ καὶ πῦρ. καὶ γὰρ ταῦτα ἀεὶ ἐνεργεῖ. καθ' αὑτὰ γὰρ καὶ ἐν αὑτοῖς ἔχει τὴν κίνησιν.
>
> The imperishable things are also imitated by the things involved with change, for example earth and fire. For these are also always active. For they have motion *per se* and in themselves. (*Metaphysics* Θ 8, 1050b28-30, tr. Ross, modified)

This is an enigmatic passage, and it is not clear whether Aristotle is using the emulative or paradigmatic sense of imitation. The problem, as Ross notes, is that it is unclear whether "they have motion *per se* and in themselves" refers to the natural movement of fire up and earth down, or to the constant tendency of the elements to change into one another. If the former, then Aristotle is asserting that the elements imitate eternal

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direct imitation of god's own activity (EN 10.7.1177b26–1178a8; 10.8.1178b7–32). Procreation, in humans, lower animals and plants is, as it had been for Plato, a bid for immortality by proxy, another way of imitating god's eternal actuality, namely by perpetuating both oneself and one's species (de An. 2.4.415a26–b7; Pol. 1.2.1252a28–30; GA 2.1.731b24–732a1; Metaph.8.1050b28–30).10 Even below the level of plant life, the world's natural cycles, such as the weather cycle whereby the four elementary bodies undergo endlessly repeated intertransformations, are imitations of god's eternal actuality (Mete. 1.9.346b35–347a10; *On Generation and Corruption* 2.10.336b34–337a7)." Sedley (2010), "Teleology: Aristotelian and Platonic", 8 Sedley's is one of the most extreme defenses of global teleology, but the view that all of these arguments concern a striving for god-like actuality is not. So, also Myles Burnyeat: "In the sublunary world two types of cycle are said to imitate the divine, eternally circling heavens. One is the eternal cycle of elemental transformation (*On Generation and Corruption* II. 10. 336b25–337a15, Metaph. Θ8. 1050b28–30), the other the eternally continuing life cycles of the biological species (de An. II. 4. 415a26–b7, GA II. 1. 731b24–732a11)." Burnyeat (2004), "Introduction: Aristotle on the Foundations of Sublunary Physics", 23-24. See also note 29 above.

substance either by engaging in locomotion, i.e., by moving to their natural place. If the latter, then they imitate the heavens by being reciprocally transformed into one another. This latter sense suggests at most Aristotle is using "imitation" in its paradigmatic sense—the transformations of the sublunary bodies resemble the movements of the imperishable. On the former reading, however, the elements' eternal activity is meant to explain why their eternal activity can be called "imitation;" yet, on this reading, it is unclear whether that implies they imitate the heavens in the emulative or paradigmatic sense. The text is indeterminate.[47]

The other text is in *Meteorologica* I 9:

> ἡ μὲν οὖν ὡς κινοῦσα καὶ κυρία καὶ πρώτη τῶν ἀρχῶν ὁ κύκλος ἐστίν, ἐν ᾧ φανερῶς ἡ τοῦ ἡλίου φορὰ διακρίνουσα καὶ συγκρίνουσα τῷ γίγνεσθαι πλησίον ἢ πορρώτερον αἰτία τῆς γενέσεως καὶ τῆς φθορᾶς ἐστι[...] Γίγνεται δὲ κύκλος οὗτος μιμούμενος τὸν τοῦ ἡλίου κύκλον· ἅμα γὰρ ἐκεῖνος εἰς τὰ πλάγια μεταβάλλει καὶ οὗτος ἄνω καὶ κάτω.
>
> The [cause] as mover, chief and first of the principles [sc. of the region common to air and water] is the circle [sc. of the sun], for the sun as it approaches or recedes, obviously causes dissipation and condensation and so gives rise to generation and destruction[...]. So this cycle occurs, imitating the circle of the sun [μιμούμενος τὸν τοῦ ἡλίου κύκλον]; for at the same time as [the sun] moves to this side or that [εἰς τὰ πλάγια, sc. perpendicular to the plane of the celestial equator], the moisture in this process rises or falls. (*Meteorology* I 9, 346b20-36, tr. Webster, modified)

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[47] In his commentary on *Metaphysics* Θ8 1050b28-30, Ross states it is doubtful whether "they have their movement of themselves and in themselves" refers to natural movement of fire up and earth down, or to the constant tendency of the elements to change into one another. Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology", 168 thinks the passage only refers to locomotion, since transmutation is not something that belongs to the elements *per se* and in themselves. Instead, the elements movement up or down is an eternal fact because it is an expression of their eternal natures. In following their own natures, they follow their superiors. Johnson (2005), *Aristotle on Teleology*, 148 claims the notion of "imitate" is explicitly visual, and that "imitate" simply means "resemblance." While my sympathies to some extent lie with Johnson, I do not think "resemble" can be a gloss on "imitate."

This text largely agrees with the description in *Generation and Corruption* II 10. The sublunary bodies are caused by the sun to dissipate and condense in a cycle which results in generation and perishing. In this case, however, it is clearly the paradigmatic sense that is at play: the sun is the efficient cause of the resemblance between the celestial and sublunary cycles. The paradigm itself is left unstated, but it is not the elements that are moving themselves to be like the heavens.

Kahn, however, argues that this is compatible with the emulative sense of imitation. According to Kahn, *Metaphysics* Θ 8 refers only to locomotion, since locomotion belongs to the nature of the elements, while transmutation does not.[48] By following their natures, the elements follow their superiors. A portion of air may have been caused by the heat from the sun; but, once the air is created, it actualizes its own goal to reach its natural place. The meaning of the "perishables imitate the imperishables" would be that the elements, in continuously actualizing their potential to be in their natural place, "imitate" or "participate" in the divine by being always actual, as animals participate in the divine by always actualizing their natural functions. Imitation, which in this sense means becoming actual, would then be a metaphorical way of describing the fact that the elements have actuality as their final cause, and their actuality resembles the eternal actuality of the heavens. This, in turn, sounds very similar to Aristotle's claim in *De anima* that animals participate in the eternal and divine by actualizing their own characteristic activity:

> ἧς ἐστὶν ἔργα γεννῆσαι καὶ τροφῇ χρῆσθαι· φυσικώτατον γὰρ τῶν ἔργων τοῖς ζῶσιν, ὅσα τέλεια καὶ μὴ πηρώματα ἢ τὴν γένεσιν αὐτομάτην ἔχει, τὸ ποιῆσαι ἕτερον οἷον αὐτό, ζῷον μὲν ζῷον φυτὸν δὲ φυτόν, ἵνα τοῦ ἀεὶ καὶ τοῦ θείου

[48] Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology", 168

> μετέχωσιν ᾗ δύνανται· πάντα γὰρ ἐκείνου ὀρέγεται, καὶ ἐκείνου ἕνεκα πράττει ὅσα πράττει κατὰ φύσιν.
>
> The functions of [the nutritive soul] are reproduction and the use of food. For, the most natural function of any living thing that has reached maturity, is unmutilated, and which has not come to be spontaneously is the production of another like itself, an animal [producing] an animal, a plant a plant, in order that, as far as its nature allows, it may participate [μετέχωσιν] in the eternal and divine. For all desire this, and they do whatever they do by nature for the sake of this. (*De Anima* II 4, 415b3-8 tr. Smith, modified)

The similarity between *Metaphysics* Θ 8 and *De Anima* II 4, noted by Kahn, Sedley, Burnyeat and others, is that in both passages Aristotle claims the actualization of a thing's nature is its final cause.[49] The elements, on this reading, actualize their potential to be in a certain place in order to imitate the imperishables. And animals actualize their potential to generate offspring in order to participate in the eternal and divine. The interpretation gives a consistent reading of Aristotelian passages, and suggests the literal or explanatory meaning behind both imitation and participation is the universal striving for actuality. But, any interpretation that suggests the *De Anima* notion of participation is equivalent to the notion of imitation in *Generation and Corruption* and *Metaphysics* Θ 8 will have to account for the following:

> First, it will have to explain why Aristotle has mixed his metaphors as much as Plato in the *Parmenides*. This would be surprising. Any interpretation that suggests these notions are (more or less) the same will have to give an account of why Aristotle might not see them as inconsistent in his case, where he did for Plato.

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[49] See note 41 above.

Second, it would require textual evidence that Aristotle thinks "imitation" and "participation" can mean the same thing. I have found almost nothing in the extant Corpus to support this identification. Instead, within the physical treatises as well as the *Metaphysics*, the metaphor of "imitating the heavenly cycles" is only used with reference to the sublunary bodies, and never to animals. The only passages in which he does so are *On Generation and Corruption* II 10; *Meteorology* I 9; and, *Metaphysics* Θ 8.[50] When he talks about "participation," only once does it refer to the cycle of the elements. In *Meteorology* II 3, he says that the dry exhalation is mixed with the wet exhalation and necessarily returns to earth with the rain, and "this will always occur according to a certain order, as much of the order as this place shares in" (358a20ff).[51] On all other occasions in the physical works, he uses it to refer exclusively to ensouled beings.[52] Furthermore, when Aristotle uses the term

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[50] The only other things he refers to as "imitating" in the physical works are: "art" (see Chapter Three), and certain features of animals (*History of Animals* 502b9; 609b16; 631b9) where it is used to describe an observed resemblance. In the next section, I discuss the possibility that imitate means resemblance in our passages.

[51] ἀεὶ γίγνεσθαι κατά τινα τάξιν, ὡς ἐνδέχεται μετέχειν τὰ ἐνταῦθα τάξεως.

[52] Aristotle uses "participate" in the following passages: *On Youth and Old Age* 479a28-479a31:"Generation is the initial participation, mediated by warm substance, in the nutritive soul, and life is the maintenance of this participation."; *On the Generation of Animals* I 23, 731b1f: "For against the latter the mere participation in touch and taste seems to be practically nothing, but beside plants and stones it seems most excellent." Cf. 731a32; 732b29; 735a7; II 1, 731a24: "A thing lives, then, in virtue of participating in the male and female principles; that is why even plants have some kind of life." *On the Generation of Animals* II 3, 736b1f: When and how and whence is a share in reason acquired by those animals that participate in this principle?; *On the Generation of Animals* II.5 741a25: "for the fact that these eggs go bad shows that they previously participate in some way in life." *On the Generation of Animals* III 7, 757b14: "Wind-eggs, then, participate in generation so far as is possible for them." *On the Generation of Animals* III 11, 761b23: "Such a kind of animal must be sought in the moon, for this appears to participate in the element removed in the third degree from earth." *De Anima* II 4, 415a29ff: "For the most natural function for living things, those that are complete and not deformed or generated spontaneously, is the production of another like itself, an animal an animal, a plant a plant, so that it can participate in the eternal and divine as far as possible. For all strive for this, and does

"participation" to characterize something about animals, it is not limited to a desire to share in the eternal and divine. While he thinks this is the most natural life function in which animals participate, he also says animals and plants participate in *every other* life function. The difference between "the most natural" and all the other life functions in which animals and humans share—sensation, appetite, locomotion and reason—is that the function of the nutritive soul is the most necessary. Being most necessary, however, is not usually characterized by Aristotle as being highly valued (*Metaphysics* A 1, 980b26ff). And while he does say that animals reproduce in order to participate in the eternal and divine, Aristotle does not say that living things imitate *the heavenly bodies* as he says the sublunary elements do (clearly, he could not say they participate in the heavenly bodies, cf. *Generation of Animals* II 3, 736b29-737a6); nor does he ever characterize their striving or desiring for perpetual existence as imitation. In fact, Aristotle distinguishes these quite consistently.

2.3.2 Imitation and Resemblance

There is an obvious response to these two restrictions on interpreting imitation and participation. Aristotle could simply be after their shared sense of "resemblance" (ὁμοιότης).Whether X imitates Y or X participates in Y, X and Y will resemble one another by sharing some relevant predicate. Aristotle normally reserves the term "resemblance" (ὁμοιότης) for this relation, but he could be using the expressions "imitation" and "participation" for dramatic effect. Nevertheless, on this view, he would be serious that resemblance is a final cause of both imitation and participation—both would be a striving or making oneself like that which they want to resemble.

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what it does by nature for the sake of it." Also in *De Anima*, 410b23; 415b5; 412a15. 416b9; 413b8; 415b25; 433b30; *De Caelo* II 12, 292a20.

There is an intuitive overlap among the concepts of image (εικών), likeness (ὁμοιότης) and imitation (μίμησις). In the *Phaedrus,* Socrates describes all the fallen souls "living here, honoring and imitating [the gods in whose choruses we danced] the way we can" (252d2).[53] To honour them and emulate them, they "make [the soul of their love] as like to their own god as possible" (253b1).[54] Here Plato suggests that to emulate the god is to make the world as much like god as possible, but a likeness, not an imitation. To what extent can we see the imitation of the heavens by water and air as a likeness of the sun's movement? First, some preliminaries.

If Aristotle understands imitation merely to mean resemblance, what would be the relata? Let's return to the problem text:

> The cause of this, as was often said, is circular motion: for only [circular motion] is continuous. That is also why whatever things change into one another according to their qualities and capacities, e.g. the simple bodies, imitate circular motion. For whenever air comes to be out of water, and fire out of air and again water out of fire, we say the coming-to-be has come around, by bending back again. Thus, by imitating circular motion rectilinear motion is continuous, as well. (*On Generation and Corruption* II 10, 336a1-337a7)

Aristotle's text rather ambiguously suggests two ways we could understand how the simple bodies are like circular motion. In one way, we might think it is the reciprocal transformation of the elements into one another that is like circular motion. Just as the sun will pass through Gemini, and then Cancer, Sagittarius and Aquarius, and back to Gemini, so the simple bodies will become fire, and then air, water, and earth. In this case, it is not the movements that are being compared, but the process of things passing

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[53] ἐκεῖνον τιμῶν τε καὶ μιμούμενος εἰς τὸ δυνατὸν ζῇ.

[54] ποιοῦσιν ὡς δυνατὸν ὁμοιότατον τῷ σφετέρῳ θεῷ.

through points in an abstract conceptual space. Alternatively, Aristotle might be comparing the movements themselves: just as circular movement is continuous, so rectilinear movement is continuous.

There is nothing definitive in the text that would allow one to decide between these two alternatives. I think it is more plausible that the movements themselves are being compared. The first suggests only the subject which imitates circular motion: those bodies which change into one another, i.e., matter which is reciprocally affected, or what-both-potentially-is-and-is-not. The latter makes explicit what the imitation consists in, namely rectilinear motion. Left to themselves, the elements would drift to their natural places and stop. Rectilinear motion, because it engages in a circle-like movement, will continuously occur.

Two scholars have recently endorsed the idea that Aristotle has "likeness" in mind when he says imitation. Monte Johnson, and in a different way David Charles, have both suggested that we need not understand imitation to mean anything particularly metaphysical. All Aristotle means when he says "imitate" is that the cycles "resemble" one another. Their views differ on whether or not we can call the resemblance teleological. On Johnson's view, the cyclical transmutation of the elements is teleologically explicable because it resembles the eternal motion of the heavens, which is paradigmatically teleologically explicable (Johnson 2005, 146-7). The elements receive some attenuated benefit because the cycle of transmutation allows them to exist eternally.[55] Nevertheless, Johnson thinks it is unlikely that Aristotle considered the

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[55] One sometimes hears the claim that the elements would cease to exist if they did not undergo cyclical transformation. I confess I do not understand the reasons for thinking this, since the elements would (presumably) go to their natural place and remain there. Perhaps the Θ 8 passage is what they have in mind? Charles (2012), "Teleological Causation" claims Aristotle does not consider what would happen to the

elements to be striving or desiring, and so a non-metaphysical sense of imitation, of resemblance, is likely all he meant (*ibid*., 147).

Charles also thinks that imitation should be understood as something closer to "is like" or "reflects," but his motivation for this is different from Johnson's. Charles denies there can be a teleological explanation of the elements because they are not the kinds of things that can have goals in the relevant sense (Charles 2012, 26). Charles admits that "the best way for them to continue to exist is to be disposed to take part in [their] cyclical pattern" of reciprocal transformation; but, for the cycle to be teleologically explicable, he thinks it would have to be shown why it was *good* for them to do this or have this done to them (*ibid*., 24). Charles rules out this possibility: his understanding of teleological explanation requires the agent or organism to be alive (*ibid*., 21). While their views specifically on teleology differ, both Johnson and Charles agree the sublunary bodies are not the kinds of things that can literally strive or desire. The question is whether Aristotle could intend "imitation" to mean "likeness?"

Besides having a useful term for likeness (ὁμοιότης), I think there are some conceptual reasons why we should resist this interpretation. There is a conceptual distinction (if not an epistemological one) between imitation and likeness. While both exhibit likeness, the kind of likeness involved in imitation is importantly different. This is how Plato puts it in the *Phaedo*, when he describes recollecting: "whenever someone, on seeing something, realizes that that which he now sees wants to be like some other reality but falls short

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sublunary bodies were the cosmos destroyed; however, he also suggests they would be destroyed were they not to undergo cyclical transformation.

and cannot be like that other since it is inferior" (74d9-e2, tr. Grube, modified).[56] Imitation suggests not simply that two things resemble one another (although they do), but that one member, the paradigm, has the predicate in stronger or more real or more knowable way. Imitation implies a kind of falling-short: two things may be able to be completely alike in some respect; no copy of a paradigm could ever perfectly manifest any predicate of the paradigm.

While there is a conceptual difference between the two, that does not mean Aristotle could not be using "imitate" as a synonym for "likeness." But I think the problem with interpreting imitation as likeness is that it fails to make sense of the direction of explanation, so to speak. Aristotle is trying to explain why the sublunary bodies imitate the heavens: "The cause of this [sc. the approach and retreat of the sun], as was often said, is circular motion … That is also why whatever things change into one another […] e.g. the simple bodies, imitate circular motion… […] by imitating circular motion rectilinear motion is continuous, as well." If "imitate" means "resemble," then, by substitution, Aristotle will also be committed to the claim that the rectilinear motion of the sun north and south is like the rectilinear motion of the elements up and down. However, the cause of *this* resemblance is not continuous circular motion. The cause of the rectilinear motion of the elements is either their nature, or whatever generated them, or the removal of what was preventing them from moving to their natural place. But, circular motion was brought in to explain both the movement of the sun north and south, and the continuity of generation. When Aristotle suggests the sublunary bodies' rectilinear locomotion imitates circular locomotion, an imperfect motion compared to a

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[56] 74d9-e2: ὅταν τίς τι ἰδὼν ἐννοήσῃ ὅτι βούλεται μὲν τοῦτο ὃ νῦν ἐγὼ ὁρῶ εἶναι οἷον ἄλλο τι τῶν ὄντων, 74.e.1 ἐνδεῖ δὲ καὶ οὐ δύναται τοιοῦτον εἶναι [ἴσον] οἷον ἐκεῖνο, ἀλλ' ἔστιν φαυλότερον.

perfect motion, this clearly seems like an instance of falling short of or failing to attain a paradigm. I suggest it is for this reason he used the term "imitate" instead of "resemble."

2.3.3 Imitation and the Good

I have argued so far that the sense of "imitation" Aristotle uses to describe the motion of the sublunary bodies is neither equivalent to "participation" nor "resemblance," but something closer to what I called the strict sense of paradigm and image. I do not take this to mean Aristotle thinks the sublunary world is literally an image of the heavens, any more than I think Plato thinks Bucephalus was literally an image of the Form of Horse, or that time is literally the moving image of eternity (*Timaeus* 37d6). Rather, these metaphors are the result of a perceptual grasp of similarities, and Aristotle thinks it is the philosopher or scientist who must inquire into whether the similarities can lead us to an explanation. The metaphor brings with it more than simply the perceived similarities, but a network of concepts that characterize the phenomena to be explained as something we already know, so that the scientist can go on to test if that characterization is appropriate. For Plato, the difficulty was trying to explain the relation between immaterial and material things. This is also Aristotle's problem in *Metaphysics*, and he will use different metaphors to describe the relationship between the cosmos and its immaterial source of order and intelligibility.

The explanation of the movement of the sublunary bodies, however, seems like one case where a metaphor is not needed. The efficient causal explanation seems quite intelligible without it. What reasons might Aristotle have for using a metaphor to describe the relation between two *material and sensible* things, especially a metaphor which he elsewhere finds problematic? There are two ways we might answer this question. One answer might be that Aristotle uses "imitation" to make intelligible some *final* cause that is left out of the efficient cause explanation. I will present an Aristotelian defense of such

a view, but I think, ultimately, this is not what Aristotle is trying to express when he claims the sublunary bodies imitate the celestial cycles. Another answer is that "imitation" makes something intelligible about the efficient cause of the sublunary cycles. This is the view that I will endorse, but I want to look at the first answer to try to motivate why I think the metaphor is not expressing something about final causes.

To understand "imitation" of the celestial by the sublunary cycles, we might look to something Aristotle thinks the efficient cause does not explain, and see if the metaphor of imitation might make this more intelligible. Today, we might wonder whether there is in fact anything left to explain after an efficient causal account is given. Theophrastus seems to have wondered this as well, namely whether the sublunary bodies (τῶν περὶ τὸ μέσον) are even parts of the cosmos or not, "since it happens as it were accidentally under the circular rotation that the changes to their [natural] places and into one another occur" (*Metaphysics* 5b23-26).[57] Still, one might believe that even though the sun's movement explains why the seasons occur when they do, or why the sublunary bodies transform into one another when they do, what it fails to explain is why the seasons are good, or why it is better that they occur. Perhaps he thinks there is some normative fact left to explain. This normative fact would have something to do with the sublunary elements' existence, or perhaps their changes into one another, or the precise periods at which these changes happen. Even though the efficient cause explains how these occur and how they will necessarily and eternally occur, it does not explain why it is good that they occur. To explain this, we need to add the condition that it is better for it to happen this way.

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[57] συμβάνει γὰρ οἷον κατὰ συμβεβηκὸς ὑπὸ τῆς κυκλικῆς περιφορᾶς καὶ εἰς τοὺς τόπους καὶ εἰς ἄλληλα τὰς μεταβολάς.

This suggests one way to understand the relationship between imitation and the first two metaphors I mentioned at the beginning of this section, that nature always desires the better and the god provided this benefit.

> This has reasonably turned out: for since we assert that nature desires the best in all things, and being is better than not being (the number of senses we mean by "being" was talked about in another work), and this cannot exist in all things because they are too far from the principle, the god, in the way that was left, completed the whole [sc. the universe], by making generation perpetual. For in this way being would be as coherent as could be, because what is closest to the being of substance is that generation always also come-to-be. (*On Generation and Corruption* II 10, 336b25-34)

This passage seems to suggest that the final cause of continuous generation is the continuity of being, understood as the completion of the cosmos. It is unlikely that Aristotle literally meant the god deliberated and acted for the sake of making being as continuous as possible, using the sun as an instrument to bring this about. But, we could take the god to be the final cause as aim for everything in the cosmos. The normative fact that is not explained in the efficient causal account is the fact that everything is as good as it can be. To say that all of nature desires or strives for that single goal would provide a teleological account of why what they do is good. Because the movement of the sublunary bodies is a kind of moving image of something better than them, any goodness they manifest would be explained by this relation: they are sufficiently *like* something good to qualify as being derivatively good. They may not be as good as what they imitate, but they are not just incidentally good either, since what they are imitating is goodness itself.

If Aristotle were thinking something like this, he would not necessarily have to admit that the elements have desires. He could simply take it as basic that all natural things aim at the good, and admit that, while it is not beneficial for the sublunary bodies to imitate

the heavenly motions (ἕνεκα οὗ τινι), it is nevertheless a better thing than something else (βελτίων). It is better because of some relation between the image and its paradigm. For this strategy to be successful, Aristotle would have to qualify his criticism in *Metaphysics* A 7 that the only way for something to be a cause *qua* good is for it to be a final cause, and not a formal cause.[58] One way he might go is to say the relation of a paradigm to its instance confers goodness to a thing *if that thing imitates something intrinsically good*. If my hand were guided by a skilled draughtsman, I might produce a beautiful drawing. While this would not entail that I am good, or even that I benefit by being a part of producing something beautiful, we would still be likely to say the drawing is good, and that the movements were good because the drawing was good. Aristotle, then, might not even need to explain why the elements are good through a final cause. He could explain why they are good insofar as they are imitations—insofar as they manifest some objectively good order.[59] In other words, the order of changes in the sublunary bodies might manifest what we could call beauty or elegance.

Imitation as an explanation of some aesthetic feature of the cosmos may be a direction an Aristotelian could take, but I admit it is rather far from the text. I think, when forced, the Aristotelian position must be that there is no final causal relationship between heaven as paradigm and the sublunary bodies which imitate it. The heavenly bodies do not operate for the sake of the sublunary ones, nor does it work the other way around.

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[58] "Those who say the one or the existent is the nature [of the good] say it is the cause of substance, but not, at any rate, that [anything] is or came to be for its sake" (*Metaphysics* A 7, 988b12-14).ὡς δ' αὕτως καὶ οἱ τὸ ἓν ἢ τὸ ὂν φάσκοντες εἶναι τὴν τοιαύτην φύσιν τῆς μὲν οὐσίας αἴτιόν φασιν εἶναι, οὐ μὴν τούτου γε ἕνεκα ἢ εἶναι ἢ γίγνεσθαι.

[59] A view along similar lines is developed in Judson (2005), *Aristotelian Teleology*.

So, to understand why Aristotle would describe their relationship as one of paradigm to image, we need to look somewhere else.

2.4 Paradigm and Explanation

It remains that there is a uniquely Aristotelian use of "imitation" in his physical writings. This sense does not suggest participation, and it does not suggest a mere likeness or a teleological relationship. It is not strictly artistic or emulative, either. Instead, Aristotle uses these senses to convey something about the relation of a paradigm to its image that applies only to the relationship between the celestial and sublunary bodies. The reason must be sought in his account of continuous generation itself.

To explain the continuity of generation, Aristotle appealed to the sun's apparent motion north and south between the tropics. The relationship between the sun and generation and life-cycles on earth can hardly be thought to be an Aristotelian novelty. What may have been novel was Aristotle's use of mathematical astronomy to account for the sun's apparent movement. But even this seems to be present already in the *Timaeus*.[60] What is unique to Aristotle is his characterization of the sun as an unmoved efficient cause, composed of matter of a different type. The matter of the sublunary world is matter which-can-be-or-not-be (*Generation and Corruption* II 9, 335a32-3), while the celestial realm is composed of what necessarily-is (*Generation and Corruption* II 9, 335a28f). Aristotle argues for the fifth element in *De Caelo* II against Platonists who conceived of the celestial as fire; but, this distinction is fundamental for Aristotle in order to explain the continuity of generation.

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[60] See Joachim (1922), *Aristotle's on Generation and Corruption*, *ad loc*.

It is rarely noted that the only texts in which the expression "being is better than not being" is found are his two texts on generation. The first is in our text, the other is in a parallel text at the beginning of *On the Generation of Animals* II 1:

> Τὸ δὲ θῆλυ καὶ τὸ ἄρρεν ὅτι μέν εἰσιν ἀρχαὶ γενέσεως εἴρηται πρότερον, καὶ τίς ἡ δύναμις καὶ ὁ λόγος τῆς οὐσίας αὐτῶν· διὰ τί δὲ γίγνεται καὶ ἔστι τὸ μὲν θῆλυ τὸ δ᾽ἄρρεν, ὡς μὲν ἐξ ἀνάγκης καὶ τοῦ πρώτου κινοῦντος καὶ ὁποίας ὕλης, προϊόντα πειρᾶσθαι δεῖ φράζειν τὸν λόγον, ὡς δὲ διὰ τὸ βέλτιον καὶ τὴν αἰτίαν τὴν ἕνεκά τινος ἄνωθεν ἔχει τὴν ἀρχήν.δὲ διὰ τὸ βέλτιον καὶ τὴν αἰτίαν τὴν ἕνεκά τινος ἄνωθεν ἔχει τὴν ἀρχήν. ἐπεὶ γάρ ἐστι τὰ μὲν ἀΐδια καὶ θεῖα τῶν ὄντων, τὰ δ᾽ ἐνδεχόμενα καὶ εἶναι καὶ μὴ εἶναι, τὸ δὲ καλὸν καὶ τὸ θεῖον αἴτιον ἀεὶ κατὰ τὴν αὑτοῦ φύσιν τοῦ βελτίονος ἐν τοῖς ἐνδεχομένοις, τὸ δὲ μὴ ἀΐδιον ἐνδεχόμενόν ἐστι καὶ εἶναι καὶ μεταλαμβάνειν καὶ τοῦ χείρονος καὶ τοῦ βελτίονος· βέλτιον δὲ ψυχὴ μὲν σώματος, τὸ δ᾽ ἔμψυχον τοῦ ἀψύχου διὰ τὴν ψυχὴν καὶ τὸ εἶναι τοῦ μὴ εἶναι καὶ τὸ ζῆν τοῦ μὴ ζῆν, – διὰ ταύτας τὰς αἰτίας γένεσις ζῴων ἐστίν· ἐπεὶ γὰρ ἀδύνατος ἡ φύσις τοῦ τοιούτου γένους ἀΐδιος εἶναι, καθ᾽ ὃν ἐνδέχεται τρόπον, κατὰ τοῦτόν ἐστιν ἀΐδιον τὸ γιγνόμενον. ἀριθμῷ μὲν οὖν ἀδύνατον – ἡ γὰρ οὐσία τῶν ὄντων ἐν τῷ καθ᾽ ἕκαστον· τοιοῦτον δ᾽ εἴπερ ἦν ἀΐδιον ἂν ἦν – εἴδει δ᾽ ἐνδέχεται. διὸ γένος ἀεὶ ἀνθρώπων καὶ ζῴων ἐστὶ καὶ φυτῶν.
>
> That the female and the male are principles of generation has been mentioned earlier, both what is their power and the account of their substance. Why, however, something comes to be and is female, another male, insofar as it happens from necessity—not only from the first mover but also from what kind of matter—our account must to try to show as it proceeds. But insofar as it happens because of the better and the cause for the sake of something, it has a higher principle.[61] For, since some of the things that exist are eternal and divine, while others admit of being and not-being, and the beautiful and the divine are always, according to their own nature, a cause of the better among things that admit of it, and what is not eternal is something that admits of being and is allotted a share [μεταλαμβάνειν] in the worse and the better. But soul is better than body, and what is ensouled than what lacks soul because of the soul, and being

[61] For this use of *anōthen*, LSJ points to Plato, *Phaedrus* 101d, and Aristotle, *Posterior Analytics* 97a33.

> than not being and living than not living—because of these causes there is generation of animals. For, since the nature of such a kind is incapable of being eternal, in what way [their] nature does admit of [eternal existence], in this way the generated thing is eternal. It is, therefore, impossible in number, since the substance of existing things is in the particular, and if [the particular] were [capable of existing eternally in number], it would be eternal [in number]. But [the generated thing] admits [of eternal existence] in kind. For this reason there is always a kind of human and animals and plants. (*On the Generation of Animals* II 1, 731b18-732a1)

I want to draw two comparisons between this passage and his account of generation in general. First, Aristotle claims he will give an efficient causal explanation of animal generation using the male and female as principles of generation—and he describes the male as the efficient cause which provides the form, and the female as that which provides the matter (732a1-11). Thus, like the teleological explanation in *On Generation and Corruption* II 10, there is an important sense in which Aristotle conceives these two efficient causal explanations to be grounded in a final cause. Aristotle asserts in both texts that generation takes place for the sake of the better.

The second similarity, however, suggests Aristotle's motivation for grounding the efficient cause this way. The whole explanation turns on pairs of contraries framed in normative terms: being is better than not being, soul is better than body, what is ensouled is better than what does not have soul. In both arguments, Aristotle is explaining, not just why something came to be, but also why one of two contraries came to be and not the other. This is a fact of how Aristotle conceives of matter. Aristotle defines matter as τὸ δυνατὸν εἶναι καὶ μὴ εἶναι (*Generation and Corruption* II 9, 335a32-3) and τὰ δ' ἐνδεχόμενα καὶ εἶναι καὶ μὴ εἶναι (*Generation of Animals* II 1, 731b25): what-can-be-or-not-be. Aristotle also treats matter correlatively, that is, for any form F, the correlative matter of F will be potentially matter for both F and not-F. Both better and

worse are already present potentially in the matter. To explain why S came to be F and not not-F, Aristotle thinks we give the efficient cause: S came to be F by the agency of T. But he still needs to give some sufficient reason for the change proceeding from not-F to F instead of the other way around. Otherwise, we will have no more explained why T causes F than not-F. Aristotle's solution is to designate one of the contrary pairs as better. So he will say the sun generates, but what it generates out of the matter is not the (privatives) water or earth; it causes the (positive) dry and moist exhalations. Similarly, the male generates, but it does not generate a corpse out of the menstrual blood but something living. The teleological explanation of generation is normative, but it is normative because of a world conceived as opposites.

Aristotle conceives of the agent of generation in both of these cases as unmoved movers. He argues this in *On Generation and Corruption* I 7, and concludes that any process of change must begin from a single, unmoved mover which causes the agent to act in a single uniform way. I will leave the discussion of this passage and its ontological implications for Chapter Two. Instead, I want to suggest that Aristotle defines efficient causes as causes for only one of a pair of contraries in order to avoid what he saw were serious difficulties in accounting for regular change through material cause explanations alone.

Aristotle found his predecessors' explanations of the sun's apparent rectilinear motion unsatisfying because they could not explain why the sun's motion was regular. If the sun moved north and south to graze on the earth's water, why did it not stay longer in the north after a particularly wet winter? He raises these criticisms earlier in *On Generation and Corruption* II 10. The phenomena that both Aristotle and his opponents are trying to explain is that the sun, as it moves north and south between the tropics, heats and cools different parts of the earth, and these variations in heat result in the seasons we

experience. This movement, however, is complex. The sun's apparent yearly motion involves two apparent opposite rectilinear movements: one from the northern tropic (Cancer) accelerating down towards the southern tropic (Capricorn), at which point the sun slows, stops, turns, and then accelerates again, moving back from south to north. It is worth noting that Aristotle considers this phenomenon among the causes of wonder (θαυμαστόν) which initially led humans to philosophize (*Metaphysics* A 2 983a15, cf. 982b11-28). Certainly, this would be a source of wonder if, as some of Aristotle's predecessors had thought, the cause of the sun's diurnal movement was some kind of cosmic vortex. Aristotle reports their attempts to explain this complex series of rectilinear movements in *Meteorology* II 2. Some explain the sun's movement north and south using the sun's appetite: the sun turns north and south every year, grazing on the moisture of the earth, staying in one spot until it exhausts the usable moisture and turning back to the other. Aristotle asks how the other heavenly bodies, which do not move north and south, manage to survive (*Meteorology* II 2, 354b33-5). Others explain that the sun, by warming the earth's moisture, produces winds which then blow the sun back and forth (a15). Aristotle remains unconvinced, because in each case the explanation of the apparent rectilinear motions of the sun was explained by the reciprocal action of the sun and earth.

Aristotle will not accept these explanations, in part because he does not think the sun is reciprocally affected by the earth, but, more importantly, because he thinks these kinds of explanations fail to give sufficient reasons for the stability of the period between the solstices (*On Generation and Corruption* II 10, 336b16-24). If there were more moisture in the north one year, why would the sun not remain there to forage longer? Or why would it not be blown further south by the greater ensuing wind? Aristotle's preferred solution is the one proposed by mathematical astronomy, namely that these alternating

movements can be shown to result from two uniform circular motions: the continuous diurnal motion of the sun from east to west, and the sun's continuous yearly motion west to east inclined slightly along the ecliptic. The aim of these criticisms is to set up the conditions that a proper efficient causal explanation must meet. It must be able to solve these problems, in order to establish that generation and corruption in the sublunary realm will (a) be continuous necessarily and (b) will occur roughly according to periods determined by the sun. His strategy will be to attribute this "rough" correspondence, which would be fatal to the theories of his predecessors, to irregularities in the matter (336b20-24).[62]

These criticisms, however, point to a deeper criticism of the materialists approach to explanation of regular change that Aristotle introduced in *Generation and Corruption* II 9:

> τῆς μὲν γὰρ ὕλης τὸ πάσχειν ἐστὶ καὶ τὸ κινεῖσθαι, τὸ δὲ κινεῖν καὶ ποιεῖν ἑτέρας δυνάμεως. Δῆλον δὲ καὶ ἐπὶ τῶν τέχνῃ καὶ ἐπὶ τῶν φύσει γινομένων· οὐ γὰρ αὐτὸ ποιεῖ τὸ ὕδωρ ζῷον ἐξ αὑτοῦ, οὐδὲ τὸ ξύλον κλίνην, ἀλλ' ἡ τέχνη. Ὥστε καὶ οὗτοι διὰ τοῦτο λέγουσιν οὐκ ὀρθῶς, καὶ ὅτι παραλείπουσι τὴν κυριωτέραν αἰτίαν· ἐξαιροῦσι γὰρ τὸ τί ἦν εἶναι καὶ τὴν μορφήν. Ἔτι δὲ καὶ τὰς δυνάμεις ἀποδιδόασι τοῖς σώμασι, δι' ἃς γεννῶσι, λίαν ὀργανικῶς, ἀφαιροῦντες τὴν κατὰ τὸ εἶδος αἰτίαν. Ἐπειδὴ γὰρ πέφυκεν, ὥς φασι, τὸ μὲν θερμὸν διακρίνειν τὸ δὲ ψυχρὸν συνιστάναι, καὶ τῶν ἄλλων ἕκαστον τὸ μὲν ποιεῖν τὸ δὲ πάσχειν, ἐκ τούτων λέγουσι καὶ διὰ τούτων ἅπαντα τἆλλα γίνεσθαι καὶ φθείρεσθαι· φαίνεται δὲ καὶ τὸ πῦρ αὐτὸ κινούμενον καὶ πάσχον.

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[62] See note in Joachim (1922), *Aristotle's on Generation and Corruption, ad loc*. The interpretation I give is close to the one presented in Menn (2012), "Aristotle's Theology" in Shields, Ed., *The Oxford Handbook of Aristotle* There is good deal of confusion in the literature about Aristotle's "mechanical" explanation of the sun's yearly motion. Some people think, like Mary Louise Gill, that the dual-motion Aristotle discusses is the sun's two *celestial* and *real* motions east-west (along the celestial equator) and west-east (along the ecliptic). By contrast, I am claiming the two motions are the *apparent* motions north-south and south-north. A thorough defense of this interpretation is not my aim here. For a good explanation of the other option, see Gill (1994), "Aristotle on Self-Motion" in Gill and Lennox, Eds., *Self-Motion: From Aristotle to Newton*, 258

> For, to begin with, it is characteristic of matter to suffer action, i.e. to be moved; but to move, i.e. to act, belongs to a different power. This is obvious both in the things that come-to-be by art and in those that come-to-be by nature. Water does not of itself produce out of itself an animal; and it is the art, not the wood, that makes a bed. Nor is this their only error. They make a second mistake in omitting the more controlling cause; for they eliminate the essential nature, i.e. the form. And what is more, since they remove the formal cause, they invest the forces they assign to the simple bodies—the forces which enable these bodies to bring things into being—with too instrumental a character. For since (as they say) it is the nature of the hot to dissociate, of the cold to bring together, and of each remaining contrary either to act or to suffer action, it is out of such materials and by their agency (so they maintain) that everything else comes-to-be and passes-away. Yet it is evident that even Fire is itself moved, i.e. suffers action. (*On Generation and Corruption* II 9, 335b30-336a8, tr. Joachim)

The materialists conceive of the simple bodies themselves, things like water and fire, as the causes of change. Even the more sophisticated materialists who explain change as the result of some δύναμις present in the matter, like the hot and the cold, also conceive of all change as the action of one of a pair of contraries on another. Aristotle is pointing out that, if we attempt to explain the regularity and order of change by appealing to material causes alone, we are liable to confuse our intentions for nature's.

Aristotle wants us to think of examples like throwing water on a fire: on throwing the water on the fire, we might unreflectively say that the water has cooled the fire. It is these cases where Aristotle thinks we are liable to go wrong, since both fire and water act on one another reciprocally and therefore there is just as much reason to say that the fire warmed the water as there is to say the water cooled the fire. The materialist explanation gives no sufficient reason why one is the agent and the other the patient, nor can it say

what would license describing one as agent rather than the other.[63] One might think, because the fire went out, we can say that the water was the efficient cause in this case, and in this case Aristotle would agree, but not because the water was an efficient cause, but because the person putting out the fire was the efficient cause and used the water as an instrument. He thinks this is precisely the problem with the materialists' way of approaching change. They "invest the forces they assign to the simple bodes with too instrumental (λίαν ὀργανικῶς) a character." The smith may say that the fire heated the iron, but the reason *he thinks* the fire heated the iron (fire makes things become hot) is not the same as the reason *why* the fire heated the iron (because he wanted to heat the iron in order to produce something). Aristotle thinks the mistake the materialists make is to abstract themselves out of the process, while leaving their intentionality in it, while the only proper way to describe the reciprocal affection of (say) the iron and fire is as a kind of mixture (μίξις cf. *On Generation and Corruption* I 10, 327a30f). Since the materialists will be unable in principle to say which of two contraries acted on the other, they will also be unable to explain how anything as complex as an animal came to be out of them.[64] The matter is incapable of acting without being acted upon, and so cannot produce a single, uniform motion in what it affects.

Aristotle thinks that, in order to be an efficient cause properly speaking, it must be reciprocally unaffected or unmoved, and a cause of only one of two contraries (*On*

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[63] Menn (2010), "On Socrates' First Objections to the Physicists - *Phaedo* 95e8-97b7", *Oxford Studies in Ancient Philosophy*, 96 has recently argued this criticism originates in Plato's critique of material cause explanation in *Phaedo*.

[64] Aristotle consistently rejects the idea that animals can be spontaneously generated by the matter; the *sun* can generate animals spontaneously. He considers fire (*De Anima* II 4, 415a1f; *On the Generation of Animals* II 3, 737a6) and water *On Generation and Corruption* II 9 above. Likely these were entertained by someone.

Generation and Corruption I 7, cf. *Physics* III 2-3).[65] The sun, in order to be a cause of *continuous* generation must also be unmixed with the sublunary elements, which might change, and it must be separate so that, while it is the cause of effects in the matter, the matter is not a cause of effects within it. Finally, the sun's motion must be the efficient cause of a single effect, otherwise there would be no sufficient reason to explain why it causes generation instead of the perishing of the sublunary body.[66] The clearest way Aristotle can think of to express this direction of efficient causal influence is to say that "the simple bodies imitate circular motion" (τὰ ἁπλᾶ σώματα μιμεῖται τὴν κύκλῳ φοράν). Thus, the relation between the two kinds of body—immortal and perishable—is one of imitation: the sun, as efficient cause, causes an image of its circular movement in the continuous rectilinear movement of earth, water, air and fire.

It is no surprise, therefore, when Aristotle gives analogous explanations of generation in plants and animals, that he describes nature as "fashioning" or "crafting" the embryo in the womb. Both the metaphor of craft and that of imitation are means of conveying the apparent truth that the heavens and living natures are the sources of regular, ordered change. They differ in that, while animals produce something that is one in species (*Generation of Animals* II 1, cited above),[67] or another like itself (τὸ ποιῆσαι ἕτερον οἷον αὐτό) (*De anima* II 4, 416a28), the sun creates an image of itself. Animals, in other

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[65] For a more developed account of this, see Chapter Two. The relation of *On Generation and Corruption* I 7 and the *De Anima*'s account of the soul as an unmoved mover is worked out in detail in Menn (2002), "Aristotle's Definition of Soul and the Programme of the *De Anima*", *Oxford Studies in Ancient Philosophy* 22.

[66] Cf. *On Generation and Corruption* II 11, 337a22: "what initiates [the movement] must be single, unmoved, ungenerated, and incapable of alteration."

[67] There is also resemblance to the parent, but Aristotle never speaks of these as 'imitations'. Cf. *Generation of Animals* IV 3, 767a36 *ff.*

words, create tokens of the same type. Their reproductive faculty is an efficient cause of one effect: the production of something specifically like himself. The sun, however, has a different kind of nature from that found in the sublunary realm: its nature is eternal and its movement continuous, but what it creates is not something else eternal and continuous, but a moving image of itself. To make this difference clear, he calls the one the demiurgic nature (ἡ δημιουργήσασα φύσις, *On the Parts of Animals* I 5, 645a9), and the other θεῖον.

2.5 Conclusion

I have attempted to show that there is a uniquely Aristotelian sense of "imitation" in his natural philosophy. On the one hand, he uses the metaphor of "craft" to describe species-specific generation. On the other, he uses the metaphor of "imitation" to describe the sun's efficient causal relationship to sublunary bodies. The sun is the cause of generation to the sublunary bodies, and so it is an efficient cause of order to the perishable things it acts on. However, it is not a cause of something's being what it is. The sun is not, for instance, a cause of *what fire is*, but it is a cause of fire's actuality and of its actualization occurring with a roughly periodic order. Finally, when Aristotle refers to being as better than not being, and the god or divine acting for the sake of the better, he is giving a sufficient reason to account for the direction of change in the matter from one contrary to another. This need not suggest Aristotle is confused or less pious for appealing to metaphors of craftsman or paradigms, nor does it suggest he is engaged in what he himself would call bad science. Rather, it suggests a careful use of metaphor as a heuristic "to help get hold of something fresh."

To conclude, I present a summary of the results of this investigation into metaphor in Aristotle's science. Aristotle thinks metaphor can deploy what I call theoretic necessities, expectations for what an appropriate scientific explanation must be like.

Metaphors, therefore, are heuristics and a part of Aristotle's method of inquiry. One use of metaphor that posed a problem for my view is 'imitation', which, on the majority view, Aristotle uses to explain the final cause of sublunary entities. I have argued, instead, that when he begins inquiring into the causes that explain why the seasons follow certain changes in the heavens, Aristotle thinks the metaphor of *imitation* provides a heuristic for how to investigate those causal relations. The cycle of the sublunary bodies is an *imitation* of the cycle of the heavenly bodies, as a statue is a representation or imitation of a model. This metaphor might be justified by our acquaintance, either through observation or authority, with similarities between both phenomena; but, what justifies the extension of causal relations from one domain (artistic production) to another domain (the seasonal cycles) is the ontological implication of metaphor: both in fact share some predicate or predicates, which will relate them as genus to species, species to genus, genus to genus, or analogically. Of course, Aristotle does not think we can *know* the ontological ground of this similarity until we have a proper scientific definition of both phenomena. We cannot know, for instance, that both the seasons and artistic representations are species of imitation until we have a proper scientific definition of both. Only then will we know in the strict sense whether the metaphor is appropriate. Aristotle, however, recognizes other grades of epistemic assent: we might have a true belief that the cycle of the seasons and artistic representations are similar, because they both seem to resemble but fall short of some model or pattern. Then again, our belief might be grounded in myths or religious commitments, for instance that the heavenly bodies are divine and creative forces in the world around is. Such true beliefs provide some justification for thinking that the causes of both phenomena are similar. Working out the details is where much of science gets done.

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3. On the Principle of Separation in Aristotle's Biology*

εἴπατε δ' ὡς τὰ πρῶτα θεοὶ καὶ γαῖα γένοντο[...]

Hesiod, *Theogony*, l. 108.[1]

3.1 The Myth of Separation

In *Theogony*, Hesiod explains the origin of the sexes as the result of the first act of violence, an act that brought about a new world order.[2] After Gaia was formed out of Chaos, she herself bore Ouranos and the two together produced the race of Titans. Ouranos, however, bound himself to Gaia in continuous sexual union and this union forced their offspring deep within the bowels of the earth. And the order of Titans remained hidden in their mother until she was able to convince her son, Cronus, to castrate Ouranos from within her, separating the earth from the sky and the female from the male, and this separation allowed Gaia to bring out into the world all those forms latent within her depths.

The existence of males and females suggested to Hesiod that reproduction in the natural order requires their separation, that offspring would be impossible without them. Yet, when Aristotle came to give a naturalistic account of reproduction, he denied the separation of male and female was necessary. Instead, he claims it is better, and for this reason, wherever it is possible, males and females will be separate.

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* All translations are my own unless otherwise noted.

[1] "Tell me, O Muse, how, at first, gods and earth came to be..."

[2] *Theogony*, ll. 116 *ff.*

Aristotle argues for this conclusion at the beginning of Book Two of *On the Generation of Animals* (731b18-732a10), and central to the argument is what we might call, the "principle of separation." The principle of separation is one of a family of normative principles that makes reference to the comparative value of correlative opposites.[3] Aristotle uses these principles in several well-known teleological accounts of natural phenomena, and all of these explanations, in turn, use the relative value of certain locations or things as an explanation of the phenomena being investigated. For example, he invokes the principle that the right-hand side is more honourable than the left to explain the universal tendency of things—both heavenly and terrestrial—to move towards the right (*De Caelo* II 5, 288a2-10; *On the Gait of Animals* 4, 706a20-26). Similar principles include "the upper is more honourable than the lower," "form is more divine than matter," and "the separation of the superior from the inferior is better."

There are two questions we might ask about the legitimacy of these normative principles in Aristotle's natural philosophy. First, it is hard to see how these are empirically robust first principles established inductively by observations of the natural world. Rather, they seem to reflect common Greek attitudes and prejudices, which Aristotle simply takes over unchallenged. Second, they do not seem to be methodologically sound. According to his standards for scientific explanations, appeals to what is "better" or "best" should always be said *relative* to the specific substance being explained (*Physics* II 7; *On the Gait*

[3] Because these opposites are primarily described spatially—up and down, right and left—Mariska Leunissen has called them "principles of balanced distribution." Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 124.

of Animals 2). In light of this they seem to have too wide a scope to be explanatorily useful.[4]

In this paper, I use Aristotle's explanation of the separation of the sexes in *On the Generation of Animals*, which appeals to the principle that "the separation of the superior from the inferior is better," as a case study for exploring these questions. What is important about the "principle of separation" is that Aristotle uses it to explain not only why males are separate from females (*On the Generation of Animals* II 1, 732a5), but also why some animals have multi-chambered hearts (*On the Parts of Animals* III 4, 666b21-667a6), why animals that move are right-handed (*On the Gait of Animals* 4, 706a20), and why the upper parts of the body are separated from the lower parts (*On the Parts of Animals* III 10, 672b19). Given its range of uses, I maintain that this principle is not a piece of unreflective prejudice, but that there are good Aristotelian reasons grounding it. I will argue that the principle does indeed make sense, but only in light of Aristotle's prior understanding of efficient causation: if regular, ordered change is one of Aristotle's *explanada*, then he has reason to say it is always better (although perhaps not necessary) for an agent of such change to be unaffected when it acts.

However, even if the principle of separation has some justification, its use in scientific contexts still raises questions. Is the principle of separation methodologically sound or is it too general? What does it suggest about the role of dialectically established principles (*endoxa*) in natural science?[5] Finally, what is *the epistemic status* of this and other

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[4] Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 123

[5] Charles Kahn, for instance, suggests that if a claim like "it is better for the superior to be distinct" is regarded as an explanation, "it might well impeded the search for a genuinely functional account of the

normative principles? Are they meant to be premises in the ultimate demonstrative explanation? Or, following Leunissen's suggestion, are they heuristic devices that point us towards the ultimate causes that figure in the demonstrative explanation?[6] Answering these questions will help us gain a better understanding of the role of such normative principles in Aristotle's natural science.

3.2 The Question

The "principle of separation" occurs in several different formulations in the biological works, and as we will see, Aristotle always presents it as a justification for why the "nobler" or "superior" member of a pair of opposites is separated from the less-valued member. In *On the Generation of Animals* II 1, it appears as: "the separation of the superior from the inferior is better." Aristotle uses this principle in explanations involving correlative opposites like up and down, right and left, and, in the argument for the separation of the sexes, male and female. At the beginning of II 1, he reminds us that "the female and the male are principles of generation" (731b18) and asks "why something comes to be and is female, another male" (b20). He says he will go on to explain why distinct sexes exist "insofar as it happens from necessity," and he turns to this in Book Four of the *Generation of Animals*. But his immediate concern is to explain why distinct sexes come to be "because of the better and the cause for the sake of

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separation of the sexes." Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology" in Balme and Gotthelf, Eds., *Aristotle on Nature and Living Things*, 195.

[6] Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 42. A similar view is also given in Gotthelf (1988), "The Place of the Good in Aristotle's Natural Teleology", *Proceedings of the Boston Area Colloquium in Ancient Philosophy* 4, 134.

something" (b22-3).[7] He claims the reason "has a *higher* [ἄνωθεν] principle" (b23), and what follows is a complex argument establishing the final cause of generation itself. Having established the final cause of generation, he gives the following argument for the final cause of the separation of the sexes:[8]

> [i] ἐπεὶ δὲ τούτων ἀρχὴ τὸ θῆλυ καὶ τὸ ἄρρεν ἕνεκα τῆς γενέσεως ἂν εἴη τὸ θῆλυ καὶ τὸ ἄρρεν ἐν τοῖς <ἔχ>ουσιν. [ii] βελτίονος δὲ καὶ θειοτέρας τὴν φύσιν οὔσης τῆς αἰτίας τῆς κινούσης πρώτης – ᾗ ὁ λόγος ὑπάρχει καὶ τὸ εἶδος – τῆς ὕλης, [iii] βέλτιον καὶ τὸ κεχωρίσθαι τὸ κρεῖττον τοῦ χείρονος. [iv] διὰ τοῦτ' ἐν ὅσοις ἐνδέχεται καὶ καθ' ὅσον ἐνδέχεται κεχώρισται τοῦ θήλεος τὸ ἄρρεν· [v] βέλτιον γὰρ καὶ θειότερον ἡ ἀρχὴ τῆς κινήσεως ᾗ τὸ ἄρρεν ὑπάρχει τοῖς γιγνομένοις – ὕλη δὲ τὸ θῆλυ.[vi] συνέρχεται δὲ καὶ μίγνυται πρὸς τὴν ἐργασίαν τῆς γενέσεως τῷ θήλει τὸ ἄρρεν· αὕτη γὰρ κοινὴ ἀμφοτέροις.
>
> [i] Since the female and the male are a principle of [living things], the female and the male are for the sake of generation among existing things.[9] [ii] But as the first moving cause (to which belongs the account and the form) is better and more divine in its nature than the matter, [iii] so also the separation of the superior from the inferior is better. [iv] For this reason, among whatever admits [of separation] and as far as it admits of it, the male has been separated from the female. [v] For, the principle of motion, by which the male belongs to generated things, is better and more divine, while the female is matter. [vi]But the male comes together

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[7] The meaning of ἄνωθεν (which I have translated, 'higher') is unclear. Peck (1963), *Aristotle. Generation of Animals*, *ad loc*, suggests it is a reference to the prime mover, apparently since the heavens and the god are 'up there'. Balme (1972), *Aristotle. De Partibus Animalium I and De Generatíone Animalium I (with Passages from Ii. 1-3)*, *ad loc* suggests a deflationary reading: it can mean simply "prior" (he cites Bonitz' *Index Aristotelicus* 68b44, 69a20) and suggests Aristotle is referring to a prior final cause, i.e., generation. However, if the prime mover is a final cause, it too is "prior" and so Balme's suggestion does not solve the issue. I present my own solution below.

[8] I discuss the first part this argument in chapter one. Other interpretations are offered by Balme (1972), *Aristotle. De Partibus Animalium I and De Generatíone Animalium I (with Passages from Ii. 1-3)*, *ad loc*, Kahn (1985), "The Place of the Prime Mover in Aristotle's Teleology", Lennox (2001), *Aristotle's Philosophy of Biology: Studies in the Origins of Life Science*, 133-154, and Mirus (2004), "Aristotle's 'Agathon'", *The Review of Metaphysics* 57(3).

[9] Alternatively, "among things that have males and females."

> and mixes with the female for the task of generation, since this [task] is shared by both of them. (*On Generation of Animals* II 1, 732a1-732a10)

In the argument, the principle of separation—[iii] "the separation of the superior from the inferior is better"—is presented as the reason "because of the better and for the sake of something" for distinct sexes. Aristotle argues [ii] the moving cause, which has the form, is better and more divine than the matter and [iii] the separation of the superior from the inferior is better; but since [v] the male is the moving cause, the female the matter, therefore, [iv] the male is separated from the female as far as possible. The argument is rather straightforward, but given his characterization of males and females as principles of generation, questions arise about how to interpret the principle of separation. The argument begins with the claim that generation is the final cause of males and females. This follows from the fact that they are principles of living things: what male and female principles are principles *for* is the generation of living things. Aristotle, in fact, has stated this claim at the beginning of II 1, but his argument for this claim is found in *Generation of Animals* I 18-21, and it is worth looking at his argument here, since how he characterizes males and females as principles is important for understanding much of the argument.

In *On the Generation of Animals* I 18-21, Aristotle gives arguments to characterize males and females as a particular kind of principle of living things. He thinks they are not, as many of his predecessors believed, principles as elements or constituents of living things; rather, he believes that they are moving and material causes. He introduces his argument by asking "how is it that the male contributes to generation, and how is the seed from the male a cause of what is produced" (I 21, 729b1-2 tr. Balme)? He then gives two answers, one according to reason (κατὰ τὸν λόγον) and one empirical (κατὰ τὴν αἰσθήσιν). The rational argument turns on Aristotle's distinction between agents and patients of change. If the female, *qua* female, is identified with the patient, while the

male *qua* male is the agent of generation, then since "we do not see one thing being produced out of agent and patient in the sense that the agent is present within the product, nor indeed (to generalize) out of mover and moved" (729b10-11 tr. Balme), then "clearly it is not necessary that something should come away from the male; and if something does come away, it does not follow that the offspring is made out of it as out of something present within, but only as out of mover and form, in the way that the cured invalid is the product of the medical art" (729b18-22 tr. Balme).[10] The point of the analogy to the medical art is that, just as in the case of a medicine, no part of the doctor is a material constituent of the health of patient, so also in the case of reproduction, no part of the male is a constituent of the being of the offspring. Rather, the male is a moving cause of the offspring, as the doctor is a moving cause of health, and the female is a material cause of the offspring, as a sick patient is the material cause of health.

To return to Aristotle's argument for the separation of the sexes, he posits that [ii] the principle of motion (the moving cause "to which belongs the account and the form," i.e., the first moving cause and not simply the body of the semen or the vital heat) is "better and more divine" than the matter on which it acts, and in premise [v] he brings in his conclusion from *On the Generation of Animals* I 21 to infer that the male, which is the principle of motion, is better and more divine than the female. And from the inference that the male is better and more divine than the female, along with the principle of separation ([iii] the separation of the superior from the inferior is better), he concludes,

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[10] This is discussed in detail in Preus (1970), "Science and Philosophy in Aristotle's *Generation of Animals*", *Journal of the History of Biology* 3(1).

[iv] "among whatever admits [of separation] and as far as it admits of it, the male has been separated from the female."

One problem for interpreting this passage is Aristotle's move from premise [ii] (as the first moving cause (to which belongs the account and the form) is better and more divine in its nature than the matter) to premise [iii], the principle of separation (*so also* the separation of the superior from the inferior is better). Is Aristotle inferring the principle of separation from the fact that the male is moving cause and the female the material, or is it an assumption? The principle of separation is also problematic for two further reasons. One reason is that the scope of the premise is unclear: whether Aristotle is inferring premise [iii] from premise [ii] or not, he does not state whether the inference is restricted to efficient causes or to principles, or even whether its scope is unrestricted.[11] There are, therefore, three possible way to understand the premise: the fact that "separation is better" might follow from something about moving causes and material causes (i.e., it is better *for* moving causes to be separate from their matter); or Aristotle might think it is better for principles in general to be separate from that what they are principles of; or the claim might simply be, for any two things, if one is better than the other, then the separation of those two things is also better.

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[11] Balme's translation forces the issues. He translates, "but the proximate moving cause is...better; and it is better that the more excellent be separated from the worse" Balme (1972), *Aristotle. De Partibus Animalium I and De Generatíone Animalium I (with Passages from Ii. 1-3)*, *ad loc*. Peck in the Loeb edition and Platt in the Revised Oxford Translation leave the inference ambiguous. Peck translates: "as the proximate motive cause...is better and more divine...it is better also that the superior one should be separate...." Peck (1963), *Aristotle. Generation of Animals*, 133. Platt's text reads: "as the first efficient cause...is better and more divine..., it is better that the superior principle should be separate..." Barnes (1984), *The Complete Works of Aristotle: The Revised Oxford Translation*.

Another reason the premise is problematic is that Aristotle provides us with no reasons for thinking it is true. In fact, it is quite easy to come up with counter-examples where it is clearly false. Aristotle would have to admit that, sometimes, it is better for the superior to be united with what is inferior. It is certainly better for an artist to be united with the material she works on, as it is better for a doctor to be in contact with her patient. And in the very case under consideration, certainly it is better sometimes for the male to be united with the female, the superior and the inferior, if the final cause of males and females is *generation*. If males and females are moving and material causes of generation, they would presumably need to be united for generation to occur. And Aristotle himself seems to add this, almost as an aside, when he says [vi] "the male comes together and mixes with the female for the task of generation, since this [task] is shared by both of them." Like Hesiod, Aristotle sees some connection between separation of the sexes and generation, but he must also admit that generation equally requires the union of both sexes. Separation is not always better. The question then, is what "separation" means in this context. Does it mean physically distinct? Not in physical contact? Or does is it a negative characterization, suggesting merely that males and females are not always engaging in reproduction?

There is a further problem for Aristotle if the scope of the premise is unrestricted. Aristotle thinks that plants as well as animals have both male and female principles; and while these principles are located in distinct beings in most animals, they are united in plants.[12] And since the argument is meant to explain that male and female animals exist

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[12] *Generation of Animals* I 18, 724b10; cf. I 23, 731a29-30. At *On the Generation of Animals* I 1, 715b19, he states simply that there are no males and females among plants, although sometimes plants are called "male" or "female" "in virtue of resemblance and analogy" (b21). His point, then, is not about whether plants have

in order that the male and female *principles* of generation might be separate, the argument should equally apply to plants. The principle of separation should apply equally to plants as well as to animals, but if it did, it would fail to explain why male and female principles are separate in the one but not the other. Without a criterion for excluding plants from what admits of separation, the argument fails.

One way Aristotle might avoid these difficulties would be if such a criterion were implicit in Aristotle's methodological commitments. One of these commitments, stated in *Physics* II 7 and *On the Gait of Animals* 2, is that the better is always a cause, not without qualification (ἁπλῶς), but relative to the substance of each thing (πρὸς τὴν ἑκάστου οὐσίαν) (*Physics* II 7, 198b8-9).[13] On this reading, when Aristotle says 'the separation of the superior from the inferior is better', he does not mean it is just better *that* the two should be separate. Rather, he means the separation of the superior is better *for* something. Aristotle's reference to the value of separation might be understood in terms of "advantage for" or "contribution to" the life of an organism. If we interpret it in this way, Aristotle would not be claiming that separating the superior from the inferior is the final cause of the separation of the sexes. Rather, the existence of separate sexes would be beneficial for or contribute to some other function of animals. The principle of separation, then, would not be a full explanation in itself, but a heuristic for

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male or female principles (or both) but whether there are male and female *plants* as there are male and female animals.

[13] *Physics* II 7, 198b8-9: "καὶ διότι βέλτιον οὕτως, οὐχ ἁπλῶς, ἀλλὰ τὸ πρὸς τὴν ἑκάστου οὐσίαν"; repeated at *On the Gait of Animals* 2. It does not matter for my argument whether "relative to each substance" means "each particular substance taken severally" or "each substance taken inclusively." The first (strong) reading entails that what something is better for must be a particular thing. The second (weak) reading entails that better in natural science does not apply universally but only relatively. These issues are discussed in Johnson (2005), *Aristotle on Teleology*, 92-93. For a recent survey of this dispute, see Sedley (2010), "Teleology: Aristotelian and Platonic" in Lennox and Bolton, Eds., *Being, Nature, and Life in Aristotle*, 198.

discovering the biological advantage provided by separation, and also what it is about animals (and not plants) that accounts for the presence of this advantage. According to Leunissen, Aristotle uses such "teleological principles" to pick out both the vital function that benefits from a particular part or its differentiation, and also "why this part is in fact the best fit for the animal that has it."[14] In essence, then, teleological principles are quasi-explanations that lead us to answers to two related questions: Why is a feature found (or lacking) in some organisms but not in others? What is that feature for? The question, then, is what Aristotle might think separation is better *for* in such a way that it contributes some benefit to an animals' way of life.

3.3 Separation and Sensation

If the principle of separation were a teleological principle, then, as many scholars have suggested, one plausible answer to the question, "what is separation for?" would be some contribution it makes to sensation.[15] The central text that supports this view is in *On the Generation of Animals* I 23:

> Καὶ ταῦτα πάντα εὐλόγως ἡ φύσις δημιουργεῖ. τῆς μὲν γὰρ τῶν φυτῶν οὐσίας οὐθέν ἐστιν ἄλλο ἔργον οὐδὲ πρᾶξις οὐδεμία πλὴν ἡ τοῦ σπέρματος γένεσις, ὥστ' ἐπεὶ τοῦτο διὰ τοῦ θήλεος γίγνεται καὶ τοῦ ἄρρενος συνδεδυασμένων,

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[14] Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 208.

[15] The earliest testimony I have been able to find for this interpretation is in Michael of Ephesus' commentary on the *Generation of Animals*. Theophrastus says next to nothing about sexual differentiation in plants, except to say that "male" and "female" are applied to plants homonymously. More recently, this has been suggested by Lulofs (1957), "Aristotle's Περι ΦΥτων", *The Journal of Hellenic Studies* 77(1) In his commentary on *On the Generation of Animals* II 1, 732a3, Balme suggests separation occurs "presumably because the male can function better as a cognitive animal when not combined with the more material female nature." See Balme (1972), *Aristotle. De Partibus Animalium I and De Generatíone Animalium I (with Passages from Ii. 1-3)*, *ad loc*. Also, Robert Mayhew, citing Balme's, has made much the same point: Mayhew (2004), *The Female in Aristotle's Biology: Reason or Rationalization*, 39 n20. See also, Lennox (2001) "Are Aristotelian Species Eternal", 133. Henry, "How sexist is Aristotle's developmental biology", *Phronesis* 52, 2007, 17-18.

> μίξασα ταῦτα διέθηκε μετ᾽ ἀλλήλων· διὸ ἐν τοῖς φυτοῖς ἀχώριστον τὸ θῆλυ καὶ τὸ ἄρρεν. ἀλλὰ περὶ μὲν τούτων ἐν ἑτέροις ἐπέσκεπται, τοῦ δὲ ζῴου οὐ μόνον τὸ γεννῆσαι ἔργον (τοῦτο μὲν γὰρ κοῖνον τῶν ζώντων πάντων), ἀλλὰ καὶ γνώσεώς τινος πάντα μετέχουσι, τὰ μὲν πλείονος τὰ δ᾽ ἐλάττονος τὰ δὲ πάμπαν μικρᾶς. αἴσθησιν γὰρ ἔχουσιν, ἡ δ᾽ αἴσθησις γνῶσίς τις. ταύτης δὲ τὸ τίμιον καὶ ἄτιμον πολὺ διαφέρει σκοποῦσι πρὸς φρόνησιν καὶ πρὸς τὸ τῶν ἀψύχων γένος. πρὸς μὲν γὰρ τὸ φρονεῖν ὥσπερ οὐδὲν εἶναι δοκεῖ τὸ κοινωνεῖν ἁφῆς καὶ γεύσεως μόνον, πρὸς δὲ φυτὸν ἢ λίθον θαυμάσιον· ἀγαπητὸν γὰρ ἂν δόξειε καὶ ταύτης τυχεῖν τῆς γνώσεως ἀλλὰ μὴ κεῖσθαι τεθνεὸς καὶ μὴ ὄν. διαφέρει δ᾽ αἰσθήσει τὰ ζῷα τῶν ζώντων μόνον. ἐπεὶ δ᾽ ἀνάγκη καὶ ζῆν, ἐὰν ᾖ ζῷον, ὅταν δεήσῃ ἀποτελεῖν τὸ τοῦ ζῶντος ἔργον, τότε συνδυάζεται καὶ μίγνυται καὶ γίγνεται ὥσπερ ἂν εἰ φυτόν, καθάπερ εἴπομεν.
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> And nature reasonably fashions all these things. For, the substance of plants is no other function or activity than the generation of seed, so that, since this comes about because of the union of the female and the male, [nature], mixing them, has brought them together. For this reason, among plants, the female and the male are not separate. [...] The function of the animal is not only generation (for this is common to all living things), but they also all share in some knowledge – some more, some less, some very little – for they have perception, perception being a certain knowledge. (If we consider the value of this we find that it is of great importance compared with the class of lifeless objects, but of little compared with the use of the intellect. For against the latter the mere participation in touch and taste seems to be practically nothing, but beside absolute insensibility it seems most excellent; for it would seem a treasure to gain even this kind of knowledge rather than to lie in a state of death and non-existence.) Now it is by sense-perception that an animal differs from those organisms which have only life. But since, if it is a living animal, it must also live; therefore, when it is necessary for it to accomplish the function of that which has life, it unites and copulates, becoming like a plant, as we said before. (*On the Generation of Animals* I 23, 731a25-b8)

It is natural to see in this passage a claim that separation is somehow beneficial to sensation. Plants have no other function than generation of seed, and so their sexes are not separate; animals, however, also share in perception, and this seems to imply that, *if plants did* have some other function like sensation, it *would* be better if their sexes were

separate. Exactly how separation benefits sensation is unclear, but we could reconstruct plausible advantages for an animal. Separation might be better for sensation because animals, were they constantly united, would be distracted from other activities like perceiving and moving and combinations that make up a particular animal's way of life. Michael of Ephesus suggests such a final cause in his commentary on this passage:

> Since in addition to [the task of] generating [offspring], animals also share in knowledge, the male and the female in animals are separated from one another, so that they might live rightly and unimpeded with respect to that capacity for knowledge [ἵν' ἀνεμποδίστως καὶ καλῶς διατελῶσι περὶ τὰς γνώσεις ὧν μετειλήφασι]. For the mixing of the male and female together with one another brings about confusion [σύγχυσις], and their knowledge [γνῶσις] would be altogether impotent [ἀδρανὴς] and confused [συγκεχυμένη] and not pure and steady [οὐ καθαρὰ καὶ ἑδραία]. (*ps*-Philoponus [Michael of Ephesus], *Paraphrase on the Generation of Animals*, 64.21-25)[16]

Sexual reproduction, Michael asserts, is a hindrance to our highest capacity. Thus, the advantage organisms receive from having separate sexes is a reprieve from sexual activity that might have impeded organisms from exercising whatever share in a rational capacity they have. Perhaps, then, the final cause of separation is *intermittent* sexual reproduction.

If Aristotle did think separation contributed to sensation, his reasons are never spelled out. Robert Mayhew, following a suggestion of David Balme's, claims that "[t]he essential difference between plants and animals is that plants do not possess any cognitive abilities, whereas every animal possesses some kind of cognition. So, Aristotle reasons, this separation must have something to do with cognition" (Mayhew, 39 n20).

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[16] However, Michael also thinks separation was an act of providence, the active wish of a God trying to make everything like itself.

Yet, as Mayhew goes on to note, "it is still unclear what (cognitive) function separating the male and the female serves" (*ibid*.). It is unclear, I suggest, not only because Aristotle fails to state what the advantage might be; it is also unclear whether or not Aristotle draws any causal inference from this correlation. Michael's commentary is instructive on this point, not because he got Aristotle right, but because he was forced to invent some advantage that having separate sexes might confer. Had Aristotle stated a positive position on this somewhere, he likely would have provided that answer. And this suggests he could not find any such advantage in Aristotle's texts. Aristotle may have left open the question of what benefit separation might have, or he may not have thought there was any advantage for the organism at all.[17] More importantly, Aristotle does not use any language in this passage that suggests he is talking about advantage at all. He refers to a scale of value amongst kinds of living things; but this does not, without reasons, entail advantage. That separation contributes to sensation is something Aristotle could have said, and perhaps, according to Michael, should have said, but he does not. Thus, it remains to consider some other reason for the connection between sensation and separation.[18]

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[17] When Mayhew writes, "(cognitive) function", the parentheses could be seen as an admission that it is open to Aristotle to think some function other than cognition is on the table. Mayhew does not go on to suggest what this might be. The problem, obviously, is that there is no reason to think, even given a correlation between separate sexes and organisms with cognition, that cognition is the relevant feature that *benefitted* by separation. The interpretation assumes Aristotle thought this correlation (separate sexes and perceptual capacity) must be teleologically—i.e., directly and causally—related.

[18] Another problem for this view is that it suggests *On the Generation of Animals* I 23 and II 1 form a single argument. This is suggested by Balme (1972), *Aristotle. De Partibus Animalium I and De Generatíone Animalium I (with Passages from Ii. 1-3)*, *ad loc*, and followed by Lennox (2001), *Aristotle's Philosophy of Biology*. However, the textual evidence suggests they are two independent arguments. If the two passages formed one argument, we would expect to find some textual markers suggesting this. I 23, however, breaks-off abruptly with ἀλλὰ περὶ μὲν τῆς τούτων γενέσεως ὕστερον λεκτέον, suggesting the discussion is complete, and Aristotle is rushing it to conclusion. The "μέν" in this sentence strengthens the "ἀλλά": "but, we'll have to talk about the generation of these things later." *On the Generation of Animals* II 1 begins with, τὸ δὲ θῆλυ καὶ

When Aristotle says in *Generation of Animals* II 1, "wherever and as far as possible, the male and female are separate," he leaves no criterion for determining where exactly it is possible. But, if we look to texts where Aristotle states the kind of things in which separation exists, I think this criterion becomes evident. So, at the beginning of *On the Generation of Animals*, he says "speaking generally we may say whichever of the animals has the power of locomotion [...] in all of these males and females exist" (*On the Generation of Animals* I 1, 715a26-28). And again, just after the argument for the separation of the sexes he says "Of [the animals with sense perception], in almost all that can move about, the female and the male are separate for the reasons already stated" (*On the Generation of Animals* II 1, 732a13-15). These texts suggest the kind for which Aristotle thinks separation exists are not simply those that can perceive, but those that can move around.

On the Generation of Animals I 23 also begins by stating "in all animals that can move about the female is separated from the male,"[19] whereas in plants "these capacities [αἱ δυνάμεις] are mixed and the female is not separate from the male"[20] (*Generation of Animals* I 23, 730b32-731a4). Aristotle, then, is not talking about male and female as members of a species, but as capacities for generation. He goes on to claim "And nature

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τὸ ἄρρεν ὅτι μέν εἰσιν ἀρχαὶ γενέσεως εἴρηται πρότερον. If this were the continuation of an argument, we would expect to find a reference to what was said immediately prior. We don't; instead, we find Aristotle mentioning something εἴρηται πρότερον , which not only suggests whatever was said previously is complete, but also looks like he is pointing back to the earlier discussion of the male and female as principles of generation, a discussion he feels it necessary to differentiate from the one he is about to begin. The discussion he has in mind is most likely *On the Generation of Animals* I 18-23, or even the whole of *On the Generation of Animals* I, and it seems, therefore, that when composing II 1, he considered the discussion of the male and female as principles of generation to be complete.

[19] Ἐν μὲν οὖν τοῖς ζῴοις πᾶσι τοῖς πορευτικοῖς κεχώρισται τὸ θῆλυ τοῦ ἄρρενος.

[20] μεμιγμέναι αὗται αἱ δυνάμεις εἰσί, καὶ οὐ κεχώρισται τὸ θῆλυ τοῦ ἄρρενος.

reasonably fashions all these things" because it mixed the male and the female principles together so that they are not separate, because "plants have only the activity of production of seed." We might think this implies that nature also acted reasonably when it separated the sexes in animals; but Aristotle does not say this. He only claims that animals also share in a kind of knowledge, sense-perception, and that they come together like plants when it is time to carry out that function common to all living things.

When Aristotle says that "nature acts reasonably," he is using the metaphor of nature as an intentional agent to describe the well-adaptedness of living things. But it could also be understood as a quasi-explanation for non-separate sexes in stationary creatures. It is no accident that he says nature *mixes* the male and the female in the case of plants. It is no accident because there could be no way for the *plants themselves* to mix their sexes.[21] Aristotle is arguing that, in the case of plants, the sexes cannot be separate because they *only* have the function of reproduction. Here the emphasis of "only" must be that they do *not* have perception. For, if they *had* perception, specifically the higher faculties of perception at a distance, they would also have they capacities of desire and locomotion. And if they had these capacities, they could mix their sexes themselves. However, since they can neither perceive a mate, nor desire one, nor move towards one, Aristotle thinks nature acted reasonably: reasonably because it would be impossible for plants to reproduce if the sexes were separate. An animal, however, has the faculty of perception, and some have the faculty of locomotion. So in those kinds of living things, with both the faculty of perception and locomotion, it is possible for the sexes to be separate.

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[21] The point is made by Sprague (1999), "Plants as Aristotelian Substances" in Gerson, Ed., *Aristotle 1 Logic and Metaphysics*, 361–362.

Animals can have separate sexes because they can perceive one another at a distance (they can find a mate) and unite for the purpose of reproduction (move towards one another). Plants, however, can do neither: if they were separate they could not reproduce all. Recall, at the same time Cronus castrated Ouranos, the seed of Ouranos fell upon the sea, creating Aphrodite, the goddess of sexual desire, and the means by which the separated poles of male and female might still come together to bear fruit. It is in virtue of desire, which Aristotle thinks necessitates perception, that it is possible for the sexes to be separate. This is the connection between sensation and separation: the argument of *On the Generation of Animals* I 23 explains, not why the sexes are separate, but where separate sexes are possible.

It is unlikely, therefore, that Aristotle thought the principle of separation was a heuristic for picking out some biological advantage. He neither specifies any advantage for separation, nor does the correlation between sensation and separation suggest one. We must, therefore, look for other explanations of what the principle is doing.

3.4 Separating Agents

The principle of separation is not meant to guide us to an explanation in terms of some advantage for an organism. This need not imply, however, that the principle conflicts with Aristotle's methodological commitments. As we will see, the principle expresses a central Aristotelian idea about the nature of efficient causation: that an efficient cause, to be a source of regular, ordered change, must be reciprocally unaffected by its matter. The principle, therefore, is normative, but it is an expression of the normative features

implicit in Aristotle's account of natural, ordered change. I want, then, to return to *Generation of Animals* II 1:[22]

> [i] But since the female and the male are a principle of [living things], the female and the male are for the sake of generation among existing things. [ii] But as the first moving cause (to which belongs the account and the form) is better and more divine in its nature than the matter, [iii] so also is the separation of the superior from the inferior better. [iv] For this reason, among whatever admits [of separation] and as far as it admits of it, the male has been separated from the female.

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[22]My view is much informed by Witt (2005), "Form, Normativity and Gender in Aristotle a Feminist Perspective" in Freeland, Ed., *Feminist Reflections on the History of Philosophy*. I disagree with some details of her interpretation, but it is an excellent guide to these issues. Witt interprets the argument for the principle of separation "as a means of keeping the better, more divine principle (form) from the inferior, material principle." She argues that "[t]he better, more divine principle needs a location separate from the inferior material principle. Hence, the need for two sexes. On my interpretation the characterization of the two principles in this text simply re-states the intrinsic normative features of form and matter in Aristotle's hylomorphism. Their respective locations (form in the male and matter in the female), however, is not an intrinsic feature of hylomorphism. The locations of the better principle and the worse principle reflect the value accorded to men and women in Aristotle's culture. Where would one locate a more divine, better principle than in the male, given the respective social and political positions of men and women?" (Witt, 126-7). On Witt's view, Aristotle's attribution of greater divinity and goodness to males follows from a kind of associative chain of reasoning: divinity and goodness belongs to the form, form belongs to the first efficient cause, and the first efficient cause belongs to the male but not the female. And so, the male is better and more divine than the female because it is associated with the form. But why should Aristotle attribute divinity and goodness to the formal cause? Presumably, because it is prior in actuality to the matter on which it operates. In other words the formal-efficient cause is actually-F because it contains the form, whereas the material cause is only potentially-F because it lacks form, and since form is the end of a teleological process, and the actual existence of a form is better, something that is actually-F is better than something that is only potentially-F. I think there are two problems with this as an interpretation of [ii]. First, neither the male nor the female contributes anything to the process of generation that is actually-F. The male seed has soul potentially, as does the female *katamenia*. Second, both a male and female animal are actually-F. If we are to claim the actuality/potentiality distinction is doing any work in this passage, we would have to say that the female is less actually-F, or imperfect, while the male is actually-F. This is something Aristotle will go on to say, but he cannot say it here. If he did, the argument would be question begging: the reason for distinct sexes is precisely what is at issue. Nor does he say the male is better than the female because the female is a deformed or imperfect male, because the distinction he is making is not between what is actually F and what is imperfectly actually-F, but between what is actually-F (formal-efficient cause) and what is only potentially-F (material cause). These are not males and females themselves, but the principles the possession of which determines whether something is a male or a female.

The structure of [ii] and [iii] as a whole makes it clear enough that Aristotle thinks [ii] is somehow meant to account for, or at least make plausible, [iii]. And, it is clear that the main subjects of [ii] are not form and matter, but efficient and material causal principles.[23] Nor is Aristotle talking about any chance cause of motion, but only those which are teleological causes, i.e., first causes of motion having a λόγος or form, what he equivalently calls ἄρχαι or principles of motion.[24]

When Aristotle says the one is the first cause of motion and the other is matter, this is clearly meant to recall his discussion of males and females in the first book of *On the Generation of Animals* where he claims that the "male is *qua* male, the agent, i.e., from whence the principle of motion [τὸ δ'ἄρρεν, ᾗ ἄρρεν, ποιητικὸν καὶ ὅθεν ἡ ἀρχὴ τῆς κινήσεως]" and "the female is *qua* female the patient [τό γε θῆλυ, ᾗ θῆλυ, παθητικόν]" and that, taken generally, agent and patient is the highest kind characterizing each of them [τὰ ἄκρα ἑκατέρων] (*On the Generation of Animals* I 21, 729b10-11). On the hypothesis, then, that Aristotle is using normative language to talk about efficient causal principles, we can ask why he might think it better for such a principle to be separate from its patient.

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[23] While Aristotle certainly thinks form is, in some sense, better than matter, I do not think the form / matter distinction is what is being emphasized in [ii] and [v]. If it were, it would be hard to make sense of premise [iii], the principle of separation. This principle, applied in this case, would seem to imply that it is better for the superior form to be separate from the inferior matter. Aristotle, however, thinks this is impossible. And even if it were possible, the argument would nevertheless suggest that it is better for what is actually-F to be separate from what is potentially-F, an even more problematic claim: that formal-efficient causes should always, wherever possible, be separate from material causes would entail that it is *better* for two correlative potentialities not to be in contact. This is the same as saying it is better that the teacher be separate from the student or carpenter separate from the wood.

[24] [ii] reiterated in [v]: βέλτιον γὰρ καὶ θειότερον ἡ ἀρχὴ τῆς κινήσεως; cf. *De anima* II 4, 415b28 *ff.*, where Aristotle differentiates between fire as an efficient cause of growth and the soul as an efficient cause of growth containing a λόγος and limit.

Aristotle begins his explanation of the separation of the sexes in *On the Generation of Animals* II 1 by appealing to what he calls "a higher" principle. I suggest that he is arguing from a higher principle because an explanation why separation is better derives not from biology, but from Aristotle's account of change. Aristotle is arguing analogically from the general causal pattern he sees in all natural and teleological change to the relationship between the male and female in animal reproduction.[25]

Now, before looking at the connection between [ii] and [iii], I want to examine in more detail the principle of separation itself. The principle of separation states that "the separation of the superior from the inferior is better," but it is not clear what kind of separation Aristotle means. The way we are most accustomed to think of "separation" in Aristotelian philosophy is in terms of Aristotle's criticisms of separate forms. "Separate" in these cases often means ontological independence, and what is separate is "a this" or "this something": τόδε or τόδε τι. Thus, when two things are separate, it implies they are each independent substances. There is, however, another sense of separate, which is, I think, implied by the language Aristotle uses in this passage.

In premise [ii], Aristotle says that a certain kind of ἀρχή, the ἀρχή of motion, is "better" and "more divine." One of the primary senses of ἀρχή is not only that which is prior in knowledge or explanation, but also an efficient cause which "rules."[26] Similarly, the terms κρείττων and χείρων in premise [iii] often imply rank in a hierarchical sense, as superior and inferior do in English. So, in calling a principle superior, Aristotle is following a common Greek usage of a term that describes a hierarchical relationship of

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[25] Cf. *On the Parts of Animals* I 5, 645b22-27.

[26] See *Metaphysics* Δ1, 1013a9-14.

rule. In the *Gorgias*, for instance, Callicles defines justice as "the superior ruling the inferior and having a greater share," (*Gorgias* 483d6) and while Socrates questions Callicles' definition of superiority, he does not question that the superior should *rule* the inferior. Similarly, in the *Laws*, the Athenian stranger assumes that "every state must contain those who rule and those who are ruled" (*Laws* III 689e4-5)[27] and, sets it down as the fifth law of the city that the superior should rule the inferior (690b1 *f.*).[28] And Aristotle, as well, takes "superior" to imply a relation of rule, and applies this relation to the soul and the body: as he says in the *De anima,* (recalling Socrates' criticisms of the materialists and their search for a "stronger and immortal Atlas" in the *Phaedo*[29]) it must be soul, and not some other material principle, which keeps the matter of the body together because "it is impossible that anything be superior to soul and rule it" (*De anima* I 5, 410b13).[30]

One of the features common to these hierarchical relations is that the superior is always separated from or unmixed with its inferiors. In the "noble lie" of the *Republic*, for instance, the auxiliaries and rulers are kept unmixed from the many. And Plato's reason seems to be that separation prevents the guardians from getting caught up in the desires and passions of the masses, allowing the superiors to rule with stability.[31] And in the

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[27] Ἄρχοντας δὲ δὴ καὶ ἀρχομένους ἀναγκαῖον ἐν ταῖς πόλεσιν εἶναί που.

[28] Πέμπτον γε οἶμαι τὸ κρείττονα μὲν ἄρχειν, τὸν ἥττω δὲ ἄρχεσθαι.

[29] *Phaedo* 99c.

[30] ἀπορήσειε δ' ἄν τις καὶ τί ποτ'ἐστὶ τὸ ἑνοποιοῦν αὐτά· ὕλη γὰρ ἔοικε τά γε στοιχεῖα, κυριώτατον δ'ἐκεῖνο τὸ συνέχον, ὅ τί ποτ' ἐστίν· τῆς δὲ ψυχῆς εἶναί τι κρεῖττον καὶ ἄρχον ἀδύνατον· ἀδυνατώτερον δ'ἔτι τοῦ νοῦ· εὔλογον γὰρ τοῦτον εἶναι προγενέστατον καὶ κύριον κατὰ φύσιν, τὰ δὲ στοιχεῖά φασι πρῶτα τῶν ὄντων εἶναι. This is a clear echo of *Laws* X 896e9-897a1.

[31] *Republic* 431a3-e2.

Timaeus, Plato argues that the three souls present in the human body are separated by partitions to prevent the ruling part from being disturbed by what it governs. The intellective soul is separated from the mortal soul by the neck, and again, within the mortal soul, the part with θύμος or spirit is separated by the diaphragm from the part with ἐπιθυμία or appetite. The intellective soul was separated so that the "disturbances" (παθήματα) of the mortal soul would "stain the divine soul only to the extent that was absolutely necessary [σεβόμενοι μιαίνειν τὸ θεῖον, ὅτι μὴ πᾶσα ἦν ἀνάγκη]" (69d7-70a2), thus allowing "the best part among them all to be left in charge [τὸ βέλτιστον οὕτως ἐν αὐτοῖς πᾶσιν ἡγεμονεῖν ἐᾷ]" (70c1). And the appetitive soul was placed down in the gut, as far away from the immortal and spirited soul as possible, so that, "making as little clamor and noise as possible," the supreme part could "take its counsel about what is beneficial for one and all [parts of the soul]" (70e5-71a3).[32] Plato's explanations of these various physiological features of humans, then, assumes that if something is to be able to rule, it must be separate from what it rules, not to prevent them from interacting, but to prevent what is controlled from disturbing what controls.

The most obvious antecedent to Plato's use of "separation" and "rule" expressing such a causal relationship is the cosmogony of Anaxagoras. Anaxagoras reasoned that νοῦς, which was "the absolute ruler" [αὐτοκρατὲς] must be "unmixed with any of the other stuff" of the cosmos, for if it were mixed, "it would be hindered [...] so that it could not rule [κρατεῖν] any of the stuff as it now does being alone by itself" (DK 12).[33] Like Plato,

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[32] ἵν' οὖν ἀεὶ νεμόμενον πρὸς φάτνῃ καὶ ὅτι πορρωτάτω τοῦ βουλευομένου κατοικοῦν, θόρυβον καὶ βοὴν ὡς ἐλαχίστην παρέχον,τὸ κράτιστον καθ' ἡσυχίαν περὶ τοῦ πᾶσι κοινῇ καὶ ἰδίᾳ συμφέροντος ἐᾷ βουλεύεσθαι, διὰ ταῦτα ἐνταῦθ' ἔδοσαν αὐτῷ τὴν τάξιν.

[33] DK 12 (=Simplicius *in Phys.* 164.24 f). I am not certain of *Anaxagoras'* reasons for claiming that νοῦς must be separate and unmixed: why, for instance, if a portion of νοῦς contained a portion of hot or sweet its activity would be "hindered." There is, however, no scholarly consensus. Cleary, Anaxagoras thinks being

Aristotle also agrees with Anaxagoras that what rules must be separate from what is ruled; however, Aristotle explicitly integrates Anaxagoras' claims into his own causal theory: "Anaxagoras is right when he says that νοῦς is unaffected and unmixed, since he makes it the principle of motion; for it could cause motion in this way [i.e., in a constant and uniform way] only by being itself unmoved and it could have control only by being unmixed" (*Physics* VIII 5, 256b25-27). Aristotle agrees with Anaxagoras because on his own analysis of change, the first agent or principle of motion in an efficient causal series must be essentially unaffected when it acts.

All explanations of change in Aristotle's philosophy, and all things that change, require an agent and patient. But in natural and other teleological contexts, agent and patient are arranged hierarchically, one strictly acting and the other strictly being acted upon.[34] So, he says in *De anima* III 5, that νοῦς is "separate, unaffected and unmixed" because "what acts is always more honourable than what is acted upon, and the principle than its matter" (*De Anima* III 5, 430a17-19).[35] The hierarchy consists in an efficient causal

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mixed would somehow interfere with the causality of νοῦς; but since it is unclear what and how νοῦς is supposed to cause, it is also unclear just how being mixed would interfere with νοῦς as an agent. Menn (1995), *Plato on God as Nous*, 28, suggests the independent status of νοῦς is somehow connected with a problem about the unity of its activity. If νοῦς is to account for the stable world-order, while at the same time being physically present in different portions of matter at the same time, its actions must somehow be coordinated in all of those various portions. Menn thinks Anaxagoras is addressing some concern like this with the thesis that νοῦς is unmixed. While this may be right, I think it may also have to do with Anaxagoras' view that the quality of some portion of matter is determined by whatever predominates, and so, if there were a portion of matter in which νοῦς did not predominate, if a portion of matter had more hot than it did νοῦς, then it would not be able to bring about its characteristic effect or bestowing rationality. For a similar view to mine, see Sedley (2007), *Creationism and Its Critics in Antiquity*, Chatper 1.

[34] Menn (2002), "Aristotle's Definition of Soul and the Programme of the *De Anima*", *Oxford Studies in Ancient Philosophy* 22; Falcon (2005), *Aristotle and the Science of Nature: Unity without Uniformity*, 25 *ff.*

[35] De Anima III 5, 430a17-19: "καὶ οὗτος ὁ νοῦς χωριστὸς καὶ ἀπαθὴς καὶ ἀμιγμὴς τῇ οὐσίᾳ ὢν ἐνεργείᾳ. ἀεὶ γὰρ τιμιώτερον τὸ ποιοῦν τοῦ πάσχοντος καὶ ἡ ἀρχὴ τῆς ὕλης." For my argument, it doesn't matter if we think this is to be identified with the divine νοῦς of Metaphysics Λ or something like an individual human agent intellect.

asymmetry between agents and patients: the agent *qua* agent is unaffected or unmoved by the patient when it acts "like, the art of medicine: for when it produces health, it is in no way affected by the patient who is being healed" (*On Generation and Corruption* I 7, 324a35-b1). This asymmetry does not exist, however, across all of nature. The material, like the food or the drug acting as instruments of the agent, are always affected when they act: "the food, *when it produces* [health], *is also affected* in some way: for it is heated or cooled or otherwise affected at the same time that it acts."

Aristotle posits unmoved agents as principles of motion to account for the stability and regularity of natural change.[36] Since these unmoved agents are unchanged when they act, so long as they are in the appropriate relation with their patient they will bring about their characteristic result. And while the natural philosopher does not explain these unmoved principles (since, as unmoved things they are not part of the study of nature, cf. *Physics* II 7, 198a36-b3), the natural philosopher assumes them, as efficient causes, to explain natural movement, change and generation.

I would add, however, that the subject matter of natural science is whatever contains in itself one of these unmoved efficient principles.[37] Natural, living substances are *self-*moved movers, and on Aristotle's analysis, one part of a self-moved mover is an unmoved principle or agent while the other part is a moved patient. The unmoved principle of motion must be unmoved *per se,* or it would cease to cause the motion which it essentially causes; however, the principle of motion is still moved *per accidens*

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[36] See Furley (1989), "Self-Movers", *Cosmic Problems: Essays on Greek and Roman Philosophy of Nature*, 122-123 and Menn (2002), "Aristotle's Definition of Soul and the Programme of the *De Anima*", 83-139.

[37] Aristotle does not think unmoved movers in the natural world are completely unmoved. Cf. *Physics* III 1, 201a20-27; 2, 202a3-11; VIII 5-6; *On Generation and Corruption* I 7.

when the natural composite thing moves itself or is moved *per se* by other things (*Physics* VIII 6, 259a17-18) And as a consequence "it is impossible that [the unmoved mover moved *per accidens*] should cause continuous motion" (259a22) because it "stands in different relations to the things that it moves, so that the motion it causes will not be the same: by reason of the fact that it occupies contrary positions or assumes contrary forms it will produce contrary motions in each several thing that it moves" (260a5-10). Thus, while some first efficient causes, like the first mover of *Metaphysics* Λ or the active νοῦς of *De anima* III 5, are both unmoved and unmixed and so can have perfect control over what they move, most natural things, animals in particular, have their efficient causes "mixed": animals are moved *per se,* either by external influences or by themselves. Insofar as their unmoved principles realize their activities in bodies (the body acting, as it were, as an instrument) the animal is moved *per se* when it acts. Insofar as the soul acts using heat, for instance, its activity of heating is affected *per se* by external, material sources of cold. And so the animal body more closely resembles the food or the drug administered by the doctor than the art of medicine.

Now, I have used the term "hierarchical" to describe the asymmetrical efficient causal relationship between agent and patient. Aristotle, however, calls this relationship "separation" (*Generation and Corruption* I 7 324b18-22). And many explanations involving the separation of parts Aristotle calls "better," "superior," "honourable," or "divine," appeal to this pattern of explanation. The prevalence of right-handedness is explained by the separation of the noble right from the inferior left, which occurs because the right contains the principle of motion (*On the Gait of Animals* 4 706a9-a25). The midriff is explained as being for the sake of keeping the more honourable heart, the principle of sensation, away from the less honourable stomach, so that the heart will remain unaffected by digestive heat (*Parts of Animals* III 10, 672b8-24).

Similar explanations exist for the chambers of the heart (*On the Parts of Animals* III 4, 666b21-667a6), and the posture of different animals (*On the Gait of Animals* 5, 706b9-16).

To return to the *Generation of Animals*, we can see how the two claims, "as the first moving cause (to which belongs the account and the form) is better and more divine in its nature than the matter" and "so also is the separation of the superior from the inferior better" are related. Given the first efficient cause is an embodied principle of teleological change, it is better that it be reciprocally unaffected by the matter on which it acts, since being unaffected ensures that the principle is better able to produce regular and uniform effects.[38] Imagine, in place of Aristotle's metaphor of nature as a doctor doctoring himself,[39] a surgeon "surgeon-ing" himself. This might give a clearer illustration of why it is sometimes better to have the agent separate from the patient. The principle of separation is not, therefore, an unqualified normative principle, but relative to natural teleological agents and their patients.

Many of Aristotle's explanations involving the separation of a principle from its patient presuppose this explanatory schema. The separation of the efficient cause from its material entails that the efficient cause will be less affected accidentally. And while the physical separation of the efficient and material cause into distinct entities it not necessary for regular generation, the separation is better because it contributes to the end of regular generation by keeping the efficient cause more unaffected. Generation

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[38] Devin Henry suggests a possible final cause for separate sexes is to keep the male principle from being contaminated by the female. Henry (2007), "How Sexist Is Aristotle's Developmental Biology?", *Phronesis* 52(3), 17. This essay fills out his suggestion.

[39] *Physics* II 8, 199b30.

itself, however, has a best way of occurring independent of how it occurs in animals. And this best way derives, not from empirical observation, but from the conditions of order presupposed by Aristotle's natural philosophy and the corresponding form that any explanation of natural, teleological change must take.[40]

3.5 Aristotle's Principle of Separation

I want to bring out some implications this analysis has for Aristotle's use of normative language in natural science. Aristotle often makes claims like the right, front and upper places are "more honourable" and "better" than their opposites,[41] and in each case, the "better" or "more honourable" direction is separated from its correlative opposite because it is "better" for them to be separate. So, for example, in his explanation of the diaphragm, which separates the heart from the stomach, Aristotle says that nature "divided the more honourable from the less honourable in whatever sorts of things it was possible to divide the up and the down" (*Parts of Animals* III 10, 627b21-22).[42] In the *On the Gait of Animals,* he says that "the right being separated from the left is better by nature" (*On the Gait of Animals* 4, 706a20)[43] and concludes that humans must be

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[40] Cf. *Metaphysics* Λ4, 1070b10-b35.

[41] Cf. for instance, *On the Parts of Animals* III 3, 665a22-25, where he says all three: "In general, the better and more honourable, wherever nothing else greater interferes, of the upper and the lower is more in upper things; of the front and the back in front things; of the right and the left in right things." (Ὅλως δ' ἀεὶ τὸ βέλτιον καὶ τιμιώτερον, ὅπου μή τι μεῖζον ἕτερον ἐμποδίζει, τοῦ μὲν ἄνω καὶ κάτω ἐν τοῖς μᾶλλόν ἐστιν ἄνω, τοῦ δ' ἔμπροσθεν καὶ ὄπισθεν ἐν τοῖς ἔμπροσθεν, τοῦ δεξιοῦ δὲ καὶ ἀριστεροῦ ἐν τοῖς δεξιοῖς.)

[42] *On the Parts of Animals* III 10, 627a21-22: καὶ διεῖλε τό τε τιμιώτερον καὶ τὸ ἀτιμότερον, ἐν ὅσοις ἐνδέχεται διελεῖν τὸ ἄνω καὶ κάτω. Aristotle takes this explanation, roughly unaltered, from *Timaeus* 69d6-70a2, except where Plato held each part of the soul had a different part in the body, Aristotle thinks all parts of the soul are primarily located in the same part, namely the heart.

[43] *On the Gait of Animals* 4, 706a20-25: φύσει δὲ βέλτιον τὸ δεξιὸν τοῦ ἀριστεροῦ κεχωρισμένον. διὸ καὶ τὰ δεξιὰ ἐν τοῖς ἀνθρώποις μάλιστα δεξιά ἐστι. διωρισμένων δὲ τῶν δεξιῶν εὐλόγως τὰ ἀριστερὰ ἀκινητότερά ἐστι, καὶ

"most natural" because humans most of all show the distinctions of right and left, front and back, up and down.[44] What determines superiority in honour and goodness is the fact that one opposite is an ἀρχή or principle.[45]

G.E.R. Lloyd noted that these distinctions were part of a common Greek belief in the auspiciousness of up, right and front, and the inauspiciousness of down, left and back. This belief is represented in the Pythagorean *συστοιχία* or table of opposites, where right, front, up, male, light, and unity are associated together as "good" ἄρχαι, and their opposites as bad ones.[46] In his study, Lloyd was puzzled by a contradiction he saw between two Aristotles: on the one hand, there was the Aristotle who argued that sexual differentiation could not (as Anaxagoras and Leophanes would have it) be accounted for by appealing to the inherent value of the right and the left;[47] on the other hand, there was the Aristotle who argued that humans are "most natural" because they were the most right handed, most erect and most forward facing of animals.[48] So, Lloyd developed an anthropological explanation for this contradiction, and concluded that Aristotle "stubbornly" adhered to the common Greek belief that right is superior to left,

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ἀπολελυμένα μάλιστα ἐν τούτοις. καὶ αἱ ἄλλαι δ' ἀρχαὶ μάλιστα κατὰ φύσιν καὶ διωρισμέναι ἐν τῷ ἀνθρώπῳ ὑπάρχουσι, τό τ' ἄνω καὶ τὸ ἔμπροσθεν.

[44] In *On the Parts of Animals* III 5, 667b32-668a4, Aristotle also claims that, in whatever things the front is more honourable and more suited to rule, in these things the great blood vessel is more honourable and suited to rule than the aorta, and attributes this identification to the fact that the great blood vessel is in front, the aorta in the back. He notes that in many animals the aorta is indistinct.

[45] Aristotle makes this claim in detail for each of the cardinal directions in *On the Gait of Animals* 4, 705a28-706a25, but is stated succinctly in *DC* II 2, 284b10.

[46] See Lloyd (1962), "Left and Right in Greek Philosophy", *The Journal of Hellenic Studies* 82, 59 *ff.* Lloyd also points to Plato *Republic* X, 614c *ff.* (the Myth of Er), where virtuous souls travel up, to the right, with their tokens on their fronts, while vicious souls travel down, to the left, with their tokens on their backs.

[47] *On the Generation of Animals* IV 1, especially 763b30 *ff.* and 765a4 *ff.*

[48] *On the Gait of Animals* 4, 706a10 *ff.*

the upper to the lower, etc., because Aristotle believed that each is naturally and essentially superior "in man, and man is the norm by which [Aristotle] judges the rest of the animal kingdom."[49] On Lloyd's interpretation, then, Aristotle assigned right, front, etc., the status of ἄρχαι, which Lloyd takes to mean inherently "superior" and "more honourable" than what are not ἄρχαι, in order that the distinctions naturally present in human beings would serve as an ideal to which the whole natural kingdom aspires.[50]

While Lloyd's conclusions are anthropologically insightful, I think they neglect Aristotle's philosophical motivations for assigning the status of ἄρχαι to certain of these pairs of opposites. First of all, while there is certainly a sense in which much of Greek philosophy and Greek culture in general viewed the world anthropocentrically (and even Hellenocentrically), there was also a strong trend among many Greek philosophers, beginning with Xenophanes, of looking at the world non-anthropocentrically. As Catherine Osborne has argued in the case of Plato: "There is [...] a link between the structure of reality, the nature of causal explanation, and the position of man between the beasts and the gods."[51] For Plato, humans may have been better than the animals, and so perhaps could act as a standard against which to judge them, but humans themselves were understood to be imperfect realizations of a divine ideal.[52] While it is possible that Aristotle moved away from Plato in this respect, there are many texts, like *On Generation and Corruption* II 11, *Metaphysics* Λ6-10, and our focal text, *On the*

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[49] Lloyd (1962), "Left and Right in Greek Philosophy", 5.

[50] Lloyd (1962), "Left and Right in Greek Philosophy", 66

[51] Osborne (1988), *Topography in the Timaeus: Plato and Augustine on Mankind's Place in the Natural World*, Proceedings of the Cambridge Philological Society 108.

[52] Pellegrin (1986), *Aristotle's Classification of Animals: Biology and the Conceptual Unity of the Aristotelian Corpus*. Pellegrin argues that Aristotle uses human beings as the model animal in his zoology.

Generation of Animals II 1, which show he was still committed to it when he wrote *them*.

All the same, I think asking questions about which cultural normative beliefs might be influencing Aristotle's own beliefs about ideals in nature misses the fact that Aristotle is often quite happy showing how his philosophical system can accommodate the views of his predecessors.[53] This is how he treats the distinctions of direction in D*e Caelo* II 2, 284b6-33. Aristotle begins by asking whether we should, as the Pythagoreans do, apply the distinction of the principles of right and left to the body of the heaven, or whether there is a more proper way [μάλλον ἑτέρως] of putting the matter:

> Εὐθὺς γὰρ πρῶτον, εἰ τὸ δεξιὸν ὑπάρχει καὶ τὸ ἀριστερόν, ἔτι πρότερον τὰς προτέρας ὑποληπτέον ὑπάρχειν ἀρχὰς ἐν αὐτῷ. Διώρισται μὲν οὖν περὶ τούτων ἐν τοῖς περὶ τὰς τῶν ζῴων κινήσεις διὰ τὸ τῆς φύσεως οἰκεῖα τῆς ἐκείνων εἶναι· φανερῶς γὰρ ἔν γε τοῖς ζῴοις ὑπάρχοντα φαίνεται τοῖς μὲν πάντα τὰ τοιαῦτα μόρια, λέγω δ' οἷον τό τε δεξιὸν καὶ τὸ ἀριστερόν, τοῖς δ' ἔνια, τοῖς δὲ φυτοῖς τὸ ἄνω καὶ τὸ κάτω μόνον. Εἰ δὲ δεῖ καὶ τῷ οὐρανῷ προσάπτειν τι τῶν τοιούτων, καὶ τὸ πρῶτον, καθάπερ εἴπομεν, ἐν τοῖς ζῴοις ὑπάρχον εὔλογον ὑπάρχειν ἐν αὐτῷ· τριῶν γὰρ ὄντων ἕκαστον οἷον ἀρχή τις ἐστίν. Λέγω δὲ τὰ τρία τὸ ἄνω καὶ τὸ κάτω, καὶ τὸ πρόσθιον καὶ τὸ ἀντικείμενον, καὶ τὸ δεξιὸν καὶ τὸ ἀριστερόν· ταύτας γὰρ τὰς διαστάσεις εὔλογον ὑπάρχειν τοῖς σώμασι τοῖς τελείοις πάσας. Ἔστι δὲ τὸ μὲν ἄνω τοῦ μήκους ἀρχή, τὸ δὲ δεξιὸν τοῦ πλάτους, τὸ δ' ἔμπροσθεν τοῦ βάθους. Ἔτι δ'ἄλλως κατὰ τὰς κινήσεις· ἀρχὰς γὰρ ταύτας λέγω ὅθεν ἄρχονται πρῶτον αἱ κινήσεις τοῖς ἔχουσιν. Ἔστι δὲ ἀπὸ μὲν τοῦ ἄνω ἡ αὔξησις, ἀπὸ δὲ τῶν δεξιῶν ἡ κατὰ τόπον, ἀπὸ δὲ τῶν ἔμπροσθεν ἡ κατὰ τὴν αἴσθησιν· ἔμπροσθεν γὰρ λέγω ἐφ' ὃ αἱ αἰσθήσεις. Διὸ καὶ οὐκ ἐν ἅπαντι σώματι τὸ ἄνω καὶ κάτω καὶ τὸ δεξιὸν καὶ ἀριστερὸν καὶ τὸ ἔμπροσθεν καὶ ὄπισθεν ζητητέον, ἀλλ' ὅσα ἔχει

[53] For example, in his explanation of nutrition in *De Anima* II 4, where he explains in what respect like is fed by like, and like is fed by unlike. He claims his predecessors were both right and wrong. For Aristotle's views about such assimilation or interpretation, see *Metaphysics α* 993a30-993b11.

> κινήσεως ἀρχὴν ἐν αὐτοῖς ἔμψυχα ὄντα· τῶν γὰρ ἀψύχων ἐν οὐθενὶ ὁρῶμεν ὅθεν ἡ ἀρχὴ τῆς κινήσεως.
>
> At the start we may say that, if right and left are applicable [to the heaven], there are prior principles which must first be applied. These principles have been analysed in the discussion of the movements of animals, for the reason they are proper to animal nature. For in some animals we find all such distinction of the parts as this of right and left are clearly present, and in others some; but in plants we find only above and below. Now if we are to apply to the heaven such a distinction of parts, we must expect, as we have said, to find in it also that distinction which in animals is found first of them all. The distinctions are three, namely, above and below, front and its opposite, right and left—all these three oppositions we expect to find in the perfect body—and each may be called a principle [ἀρχή]. Above is the principle of length, right of breadth, front of depth. Or again, we may connect them with the various movements, taking principle to mean that part, in a thing capable of movement, from which movement first begins. Growth starts from above, locomotion from the right, sense-movement from the front (for front is simply the part to which the senses are directed). Hence we must not look for above and below, right and left, front and back, in every kind of body, but only in those which, being animate, have a principle of movement within themselves. For in no inanimate thing do we observe a part from which movement originates. (*De Caelo,* II 2 284b6-33, tr. Stocks, modified)

In this passage Aristotle is pointing out that, while it is correct to call above, right and front principles of spatial directions, as the Pythagoreans do, principles of spatial direction are not the correct principles to start from if we are trying to explain motion. Aristotle's reasons, though not explicit, seem to be that the Pythagoreans make an illicit move by taking principles of body in general, which are properly the domain of *geometry*, and applying them as if they were principles of moving things, which are properly the domain of *natural science*, specifically the subordinate science of living or self-moving

things. That is not to say that geometrical principles are useless to natural science – they are useful insofar as they apply to body.[54] Nevertheless, Aristotle is arguing here that if the distinctions of right and left, etc. are to have a role as principles of self-moving things, they must be principles of certain kinds of motions, and specifically principles of the kinds of motion we find in self-moving things. The kinds of motion appropriate to self-moving things are the primary biological functions: the principles of growth, sensation and locomotion.[55] Aristotle goes so far as to say that we misapply the terms for these pairs of opposites, "right and left," "up and down," "front and back," when we apply them to inanimate things, because inanimate things have no principle of motion in themselves. So Aristotle is quite intentionally appropriating these spatial distinctions, from the Pythagoreans or whoever, while at the same time interpreting them by defining them functionally, and defining one of each pair (the right, the up, and the front) as a principle of motion or change—as an efficient cause of a specific motion or vital function proper to natural things—and the other of each pair (left, down, back) as its correlative patient.[56]

This is, of course, the same way Aristotle describes males and females in particular, and principles of motion in general, in the argument for the separation of the sexes: the moving principle is more divine, and the matter, i.e., that on which the moving principle acts, is less so.[57] Aristotle, then, uses normative language to describe a particular relation

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[54] See, for example, *On the Gait of Animals* 2, 704b17-21.

[55] Parallel passages are at *De Anima* II 4, 415b28 *ff.*; and *On the Gait of Animals* 4, 705b30 and 5, 706b9-15. This point is raised by Lennox (2001), *Aristotle's Philosophy of Biology*, 151-152.

[56] *On the Gait of Animals* 4, 705b30-706a5.

[57] Cf. for example, *On the Generation of Animals* IV 3, 765b11: λέγω δ' ἀρχὴν οὐ τὴν τοιαύτην ἐξ ἧς ὥσπερ ὕλης γίγνεται τοιοῦτον οἷον τὸ γεννῶν, ἀλλὰ τὴν κινοῦσαν πρώτην, ἐάν τ' ἐν αὐτῷ ἐάν τ' ἐν ἄλλῳ τοῦτο δύνηται ποιεῖν.

between certain agents and patients, specifically, those ἄχαι of motion or change responsible for the vital functions of generation, nutrition, sensation and locomotion. In each case of male, up, front and right, the ἄρχαι of motion is "more honourable" or "more divine" than that on which it acts because the principle determines the movement or activity in question. And if the principle is to act invariably, it is better for the principle to be reciprocally unaffected when it acts.

Where Hesiod in *Theogony* explains the separation of males and females as the result of the first unnatural act, Aristotle explains it in terms of the structure of nature itself. For Aristotle, the thesis that the separation of the sexes is better for generation follows from his programmatic requirements for any explanation of natural change. If an agent is to be a regular and effective cause, if it is to act for some goal always or for the most part, the agent must be as unmoved as possible. We see this same causal structure repeated throughout Aristotle's biology. Natural things, composites of unmoved and moved movers, achieve this to varying degrees of success, both within species and across the whole chain of being. But since his world is ordered in this way, Aristotle need not rely on absolute assumptions about the values of males and females and about good and bad. Perhaps, then, we can agree with Lloyd when he says Aristotle stubbornly adheres to Greek beliefs about value. But, I think it would be better to say that, as with most beliefs, Aristotle critically accepts them.[58] His main interest, however, lies in grounding those he accepts in his own science, to show that his analysis can make sense of them more than the analyses of his predecessors.

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[58] By "critically accepts" I do not mean to suggest that Aristotle is critical of assigning the predicate "male" to the more divine principle, and "female" to the less divine. The claim is not meant to be apologetic. Rather, I mean to emphasize that Aristotle is less interested in challenging accepted beliefs (*endoxa*) about the relative worth of males and females, and more interested in challenging contentious claims about the kinds of principles relevant to natural scientific explanation.

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4. Art and Nature in Aristotle's *Physics*[*]

Some Antecedents

> *En la genèse d'une doctrine scientifique, il n'est pas de commencement absolu ; si haut que l'on remonte la lignée des pensées qui ont préparé, suggéré, annoncé cette doctrine, on parvient toujours à des opinions qui, à leur tour, ont été préparées, suggérées et annoncées ; et si l'on cesse de suivre cet enchaînement d'idées qui ont procédé les unes des autres, ce n'est pas qu'on ait mis la main sur le maillon initial, mais c'est que la chaîne s'enfonce et disparait dans les profondeurs d'un insondable passé.*
>
> Pierre Duhem (1913), *Le Système du Monde*, 5.[1]

In Chapter One, I defend the view that Aristotle uses metaphor to characterize natural phenomena in such a way that we can begin to inquire into their causes. In Chapter Two, I show that he sometimes adopts these characterizations from popular and expert opinions, but grounds them in his analysis of the conditions which an efficient cause must satisfy if it is to be a cause of regular, ordered change. This paper furthers these studies by looking to how he uses the analogy between art and nature to guide his questions about how inquiry in natural science should proceed if it is to explain the regularities in the world around us. Aristotle's views on the analogy between art and nature are often seen as a response to Plato's, especially his views in the *Timaeus*.[2] I trace

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[*] All translations are my own, except where noted.

[1] Duhem (1913), *Le Système Du Monde*, 5.

[2] Lennox (2001), "Material and Formal Natures in Aristotle's *De Partibus Animalium*", *Aristotle's Philosophy of Biology: Studies in the Origins of Life Science*; Menn (1995), *Plato on God as Nous*; Furley (1996), "What Kind of Cause Is Aristotle's Final Cause?" in Frede and Striker, Eds., *Rationality in Greek Thought*; Falcon (2005), *Aristotle and the Science of Nature: Unity without Uniformity*; Johansen (2004), *Plato's Natural Philosophy: A Study of the Timaeus-Critias*; Leunissen (2010), *Explanation and Teleology in Aristotle's Science*

a different line of influence from the Hippocratics, through Democritus and Plato, to Aristotle's claim that "art imitates nature." I argue that this is an epistemological claim about how methods of production were first discovered in the arts, and that by looking to how the Greeks viewed discovery and progress in the arts, we can shed some light on Aristotle's expectations for a scientific investigation into nature, in particular his views concerning the method of inquiry he thinks the natural scientist should adopt.

Aristotle often raises methodological questions about how inquiry (ζητήσις) into nature should proceed if it is to result in scientific knowledge about its objects (ἐπιστήμη). For example, in the introduction to the *Parts of Animals* I 1, he asks whether the natural philosopher should inquire into nature the same way the mathematical astronomer inquires into celestial movement, or whether she should inquire as one would when inquiring into the production of an artefact (*Parts of Animals* I 1, 639b5 *ff.*).[3] Another example comes from *Physics* II 2, where he asks whether the science of nature is concerned exclusively with the form of natural things or the matter, or whether it is, like the arts of medicine and house-building, knowledge of both together (194a15-194a27). These questions assume, as James Lennox puts it, that "an inquiry has alternatives," and Aristotle often thinks the alternatives offered by his predecessors "are inappropriate in various ways and have inhibited progress" in developing a science of nature (Lennox 2011, 40). Since Aristotle often uses these questions to motivate his own method in natural science, one thing he presents himself as doing is providing the appropriate method for inquiring into different domains of nature.

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of Nature, Chapter Five; Henry (2013), "Optimality and Teleology in Aristotle's Natural Science", *Oxford Studies in Ancient Philosophy* 45.

[3] *Parts of Animals* I 1.

One of Aristotle's frequent strategies for answering these questions is to appeal to the arts (αἱ τέχναι) for insight into how the inquirer into nature should proceed. So, for example, he answers his question in *Parts of Animals* I 1 by claiming the natural philosopher should proceed the same way one would in house-building [περὶ τὴν οἰκοδόμησιν], by stating the form of the house first, and then showing why it comes to be the way it does because of the form it has (640a15-18).[4] And this implies that we must first inquire into what a house is before we can inquire into how it came to be (Lennox 2011, 35-39). In *Physics* II 2, he answers his question about which nature, the form or the matter, science will study by arguing, "if art imitates nature [ἡ τέχνη μιμεῖται τὴν φύσιν], and it belongs to the same science [τῆς δὲ αὐτῆς ἐπιστήμης] to know the form and the matter up to a point [...] it would also belong to natural science to know both natures" (194a21-194a27). The strategy, therefore, makes use of an analogy between two domains, art and nature, to justify extending a method of inquiry from one domain to another.

There are, however, three puzzles for this kind of strategy given Aristotle's understanding of the analogy between art and nature. First, there is a puzzle about the justification for the strategy. What aspect(s) of this analogy justifies extrapolating from art to natural science with respect to its methodological principles? One similarity often proposed is that he relies on the teleological character of causation in both art and nature: art and nature are goal-directed, efficient causes of what they produce.[5] To secure the analogy, in several places Aristotle provides independent reasons for believing

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[4] See also *Generation of Animals* V 1, 778b1-18.

[5] Lennox (2008), "'As If We Were Investigating Snubness' : Aristotle on the Prospects for a Single Science of Nature", *Oxford Studies in Ancient Philosophy*, 175-181. Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 16-17, 39, 218.

that nature, like art, is a cause that acts for the sake of something.[6] Some scholars, however, have suggested that Aristotle uses the analogy to argue from the teleological structure of the arts to the teleological structure of nature.[7] Evidence for this view is found in *Physics* II 8, where he says, "generally art in some cases completes what nature is unable to complete, and in other cases imitates it. If, therefore, artificial products are for the sake of an end, so clearly also are natural products"[8] (199a15-18). Yet, regardless of how Aristotle is using the analogy, the strategy of using the arts to inform the method of inquiry in natural science will depend on how convincing one finds this analogy to be.

A second puzzle for Aristotle's strategy involves the application of the analogy. Even if Aristotle can establish that the analogy between art and nature is close enough, how much can we infer about natural phenomena on its basis? Aristotle sometimes seems to use the general characterization of art and nature as analogues to infer quite specific explanations in natural science. So, in the *Generation of Animals* he claims that "semen acts in the same way that rennet acts on milk; for rennet is milk containing vital heat [θερμότητα ζωτικήν], which brings the similar material together and sets it, and the semen acts in the same way on the nature of the menstrual blood" (*Generation of*

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[6] Aristotle argues for this in *Physics* II 8, *Parts of Animals* I 1, *Generation of Animals* II 1. The most discussed argument is the "rainfall example" presented in *Physics* II 8, 198b10-199a8.There are disputes (which I do not engage here) about how this argument is to be interpreted. See Furley (1985), "The Rainfall Example in Physics Ii.8" in Balme and Gotthelf, Eds., *Aristotle on Nature and Living Things*; Sauve Meyer (1992), "Aristotle, Teleology, and Reduction", *Philosophical Review* 101(4); Sedley (2007), *Creationism and Its Critics in Antiquity*, Chapter 6; Cooper (1987), "Hypothetical Necessity and Natural Teleology", *Gotthelf and Lennox* 1987; Johnson (2005), *Aristotle on Teleology*. Good surveys of the literature can be found in Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, Chapter 1 and Gotthelf (2012), *Teleology, First Principles and Scientific Method in Aristotle's Biology*, Chapter 3.

[7] Granger (1993), "Aristotle on the Analogy between Action and Nature", *The Classical Quarterly* 43(1), 170.

[8] ὅλως δὲ ἡ τέχνη τὰ μὲν ἐπιτελεῖ ἃ ἡ φύσις ἀδυνατεῖ ἀπεργάσασθαι, τὰ δὲ μιμεῖται. εἰ οὖν τὰ κατὰ τέχνην ἕνεκά του, δῆλον ὅτι καὶ τὰ κατὰ φύσιν.

Animals II 4, 739b21-25). And, in the *Meteorology* he claims, "broiling and boiling occur by art [γίγνονται μὲν τέχνῃ], but the same general kind of thing (τὰ εἴδη καθόλου), as we said, also [occurs] by nature [φύσει]. The affections produced [τὰ γιγνόμενα πάθη] are similar though they lack a name, since art imitates nature [μιμεῖται γὰρ ἡ τέχνη τὴν φύσιν]" (381a30 *ff.*). But why does he think that the specific processes we develop in the arts, like broiling or cheese-making, could be used to guide inquiry into natural processes? It is one thing to think art and nature are both goal-directed efficient causes; he would need further reasons for thinking the same kinds of material-efficient causal processes occur in the arts and in nature, and further reasons for choosing one of the artistic processes, e.g. cooking, over another, e.g., sculpting. One might object that Aristotle is stretching the analogy too far, and that his grounds for this (the perception that curds and embryos are similar[9] or that "art imitates nature") are too weak.[10]

Related to the first two puzzles is a puzzle about ambiguity. As we have seen, Aristotle's strategy seems to trade on an ambiguity between two senses of art which do not obviously translate into two senses of nature (Lennox 2008, 176-177). Art is, for Aristotle, both a goal-directed efficient cause and a body of knowledge (in Aristotle's terminology, an ἐπιστήμη). At least in some cases, it is not clear why he thinks the analogy between art and nature as goal-directed efficient causes implies there should also be similarities between art (as a *form of* knowledge) and natural science. If, as he says, "art imitates nature," why would that lead us to think that knowledge in the arts in general

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[9] In response to the question of which artistic process to use as a model, Devin Henry suggests (personal communication) that, from evidence in the *History of Animals*, Aristotle seems to appeal to apparent similarities, i.e., observation, to justify using art as a source domain from which to understand nature by analogy.

[10] Lloyd (1996), *Aristotelian Explorations*, 83-103.

should imitate natural science? If anything, it seems the claim should be the other way around: if Aristotle thinks artistic forms of knowledge imitate natural science, then natural science should be used as a model for inquiring into artefacts (Lennox 2008, 177). [11]

One way to approach these puzzles is to compare Aristotelian natural teleology with Plato's artistic teleology. Most scholars agree that, when Aristotle characterizes nature like an art, he is responding to the teleological account of the cosmos in Plato's *Timaeus*,[12] and an important difference in their views of teleology is how they understand the relationship between art and nature. For Plato, art (specifically the art of the cosmic demiurge) is prior to generated natural things (*Timaeus* 27d-29b, 46d-e; cf. *Laws* X 892b-c), while for Aristotle, it is the other way around. In natural generation, the principle or cause of change is internal to the thing being generated (*Physics* II 1, 192b20-23), while in artistic production, the principle or cause is external to the product. Thus, even if Aristotle occasionally uses language which might be suggestive of a craftsman-like nature, this language should be taken metaphorically (Henry 2013). Instead, we might think what Aristotle is doing is refining Plato's mythical account in

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[11] At the level of application, Lloyd has argued that, while the general concept of "cooking" or "concoction" (πέψις) helps Aristotle find connections among different phenomena, its weakness lies in the generality which suggested those connections: "the connections [Aristotle] apprehends run ahead of the theoretical explanations he can offer." Lloyd (1996), *Aristotelian Explorations*, 95 At the level of justification, however, the analogy plays an important didactic role in making the causal structures Aristotle thinks exist in nature more explicit. Cf. Lennox (2008), "Aristotle on a Single Science of Nature", 181-183. Also, Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 16-17.

[12] For example, Lennox (2001), "Unnatural Teleology", Menn (1995), *Plato on God as Nous*, Furley (1996), "What Kind of Cause Is Aristotle's Final Cause?", Falcon (2005), *Aristotle and the Science of Nature: Unity without Uniformity*, Johansen (2004), *Plato's Natural Philosophy: A Study of the Timaeus-Critias*, Sedley (2007), *Creationism and Its Critics in Antiquity*, Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, Chapter Five, Henry (2013), "Optimality and Teleology in Aristotle's Natural Science"

the *Timaeus*: language that suggests nature is art-like (or artefact-like) is a *metaphor* Aristotle uses to express the fact that art is nature-like.[13] One way scholars think Aristotle expresses this contrast is with the phrase, "art imitates nature."[14]

The idea that art imitates nature, however, is not Aristotelian in origin: its roots lie in both the Hippocratic and Atomist traditions. This paper is an attempt to establish the influence of this tradition on Aristotle's method of inquiry in natural science in order to show that the *dictum* "art imitates nature" is not meant to imply a commitment to natural teleology. Instead, it is an epistemological claim about how the arts were first discovered, and implies that the arts have discovered a method of systematic inquiry or research (ζητήσις) into the natural origins of their methods. Thus, Democritus claims "we are pupils of the animals in the most important things: the spider for spinning and mending, the swallow for building, and the songsters, swan and nightingale, for singing, by way of imitation" (DK 68B154). And the Hippocratic author of *Visits* claims "[the patients'] nature is the doctor that cures illness [νούσων φύσιες ἰητροί]" to justify the methods used in medicine by appealing to their discovery in nature (*Visits,* 6.5.1). I argue that Aristotle uses this epistemological sense of "art imitates nature" in his attempt

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[13] Broadie (2007), *Aristotle and Beyond: Essays on Metaphysics and Ethics*, 85-100, especially 193-194, argues that the analogy of art to nature presents nature as an idealized artist who never deliberates and rarely makes mistakes, although she thinks Aristotle's views on art are determined by his views on nature, rather than the other way around. She concludes, "when nature is compared to craft, it is the first that prescribes what the second must mean in this alignment."

[14] Johnson claims that the target is Plato, particularly *Laws* X, where Plato claims art is prior to nature and chance (889b). "While Plato thinks that nature and natural causes are secondary to intelligence and art, Aristotle holds that the existence of art as a cause for the sake of which confirms that nature is *a fortiori* a cause. This is because art imitates nature, or fills in where nature leaves off." Johnson (2005), *Aristotle on Teleology*, 123. Leunissen is skeptical that the model of the arts is used to justify Aristotle's natural teleology, since art is ontologically dependent on the teleology of nature; instead, she thinks the claim serves a didactic purpose. Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 16-18. On these issues, see also Lennox (2008), "Aristotle on a Single Science of Nature", 181-183.

to motivate a method of inquiry in natural science. To establish this claim, I will first look at how the idea that art imitates nature was used by Hippocratic authors to justify a method of inquiry in the arts, and how that method of inquiry was adopted by Plato as a way to motivate a scientific rhetoric in the *Phaedrus*. I will then turn to the phrase in Aristotle. "Art imitates nature" appears three times in Aristotle's extant treatises: once in *Meteorology*, and twice in the *Physics*. [15] I will apply the results of the study of the Hippocratics and Plato to these three uses. But, before I begin, I want to give a general characterization of art as it was understood in the fifth and fourth centuries, and show what aspect of art was adopted by Aristotle as a model for a theoretical science of nature.

4.1 Art as Inquiry

In the *Metaphysics*, Aristotle says that "every science seeks [ζητεῖ] certain principles and causes concerning each of the things known by it, e.g. medicine and gymnastics and the rest of the sciences, productive [τῶν ποιητικῶν] and mathematical [μαθηματικῶν]" (*Metaphysics* K7, 1063b35-1064b3).[16] Similarly at the beginning of the *Physics,* he says "in all disciplines [τὰς μεθόδους] which have[17] principles, causes and elements, knowledge, especially scientific knowledge [τὸ εἰδέναι καὶ τὸ ἐπίστασθαι], follows from an

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[15] It is found at *Physics* II 2, 194a21; *Physics* II 8, 199a17; *Meteorology* IV 3, 381b6. It is also found twice in Iamblichus, *Protrepticus* (identified by as Aristotle) IX 49.3-51.6 (= During B13-14 = Rose 51R^3); and once in ps-Aristotle, *De Mundo* 5, 396b12.

[16] Πᾶσα δ' ἐπιστήμη ζητεῖ τινὰς ἀρχὰς καὶ αἰτίας περὶ ἕκαστον τῶν ὑφ' αὑτὴν ἐπιστητῶν, οἷον ἰατρικὴ καὶ γυμναστικὴ 1064a.1 καὶ τῶν λοιπῶν ἑκάστη τῶν ποιητικῶν καὶ μαθηματικῶν.

[17] Ross (1953), *Aristotle. Metaphysics*, *ad loc* suggests, following Simplicius, that the antecedent of ὧν is an implied but missing ταῦτα: τὰ ἔχοντα ἀρχάς, the things having principles, i.e., the objects of τὸ εἰδέναι καὶ τὸ ἐπίστασθαι. It is not clear to me why the antecedent should not be τὰς μεθόδους, since there are some disciplines that do not have principles, namely, the science of first principles. For more on Aristotle's use of the term μεθόδος, see Lennox (2011), "Aristotle on the Norms of Inquiry", *HOPOS: The Journal of the International Society for the History of Philosophy of Science* 1(1).

acquaintance with them" (184a10-12).[18] The start of the *Physics* is Aristotle's attempt to motivate an inquiry "to determine things concerning these principles [διορίσασθαι τὰ περὶ τὰς ἀρχάς]" (184a14-16), and one thing he is particularly interested in motivating is the very possibility of natural science (ἡ περὶ φύσεως ἐπιστήμη), since this possibility was sometimes doubted in the Old Academy.[19] However, he is more specifically trying to motivate an inquiry into the principles of natural science, since, as he will go on to show in the rest of *Physics* I, he does not think anyone has quite succeeded in finding them.[20] In the passage from the *Metaphysics*, he uses the examples of medicine and gymnastics as obvious cases of *sciences* (ἐπιστῆμαι) which seek the principles and causes of what they know, and it is worth asking why he thinks both the theoretical study of physics and the art of gymnastics are both engaged in the same kind of kind of inquiry.

The development of the productive arts and theoretical sciences is useful here. Already by the fifth century, τέχναι were understood to be highly specialized, though productive,

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[18] Ἐπειδὴ τὸ εἰδέναι καὶ τὸ ἐπίστασθαι συμβαίνει περὶ πάσας τὰς μεθόδους, ὧν εἰσὶν ἀρχαὶ ἢ αἴτια ἢ στοιχεῖα, ἐκ τοῦ ταῦτα γνωρίζειν. Compare to the more "productive" sounding introduction to NE I 1, Πᾶσα τέχνη καὶ πᾶσα μέθοδος, ὁμοίως δὲ πρᾶξίς τε καὶ προαίρεσις, ἀγαθοῦ τινὸς ἐφίεσθαι δοκεῖ· διὸ καλῶς ἀπεφήναντο τἀγαθόν, οὗ πάντ' ἐφίεται (1094a1-3).

[19] Cf. Menn (1995), *Plato on God as Nous*, 60-62. The status of the *Timaeus* is a tricky issue. On the one hand, it is clear Plato describes his account as an εἰκός μῦθος or "likely story", and that Plato does not think of it strictly as science (ἐπιστήμη). Then again, Plato does not think anything is strictly a science except dialectic and perhaps mathematics. Aristotle, at any rate, does not suggest that what Plato was after in *Timaeus* is different from what he is after in the *Physics*, and usually treats Plato's views in *Timaeus* on par with the Ionians and Democritus. When he attacks Plato in the *Metaphysics* I do not remember there being any sense in which Aristotle is attacking the views Plato puts forward in *Timaeus*, which also suggests Aristotle agrees that whatever physics studies, whether Aristotle's or Plato's, is importantly different from whatever is studied by first philosophy, what Aristotle calls σοφία.

[20] The relation between *Physics* I and the theory of demonstration in the *Analytics* is discussed in Bolton (1991), "Aristotle's Method in Natural Science: Physics I" in Judson, Ed., *Aristotle's Physics, a Collection of Essays*, 1-29.

forms of knowledge. In his study of the historiography of τέχνη, Leonid Zhmud notes four common characteristics of τέχνη:

> 1) τέχνη is meant to be useful; 2) each τέχνη serves a definite purpose: medicine keeps one healthy, agriculture provides one with food, etc.; 3) τέχνη is based on the knowledge of specialists who are in command of all means necessary to their ends; and 4) each τέχνη can be transferred by teaching; only that which can be transferred by teaching is entitled to be called a τέχνη.[21]

Zhmud, following earlier studies, believes that these characteristics describe a genuine theory of science whose aim is productive, rather than theoretical, knowledge."[22] However, the boundaries between theoretical and practical knowledge at this time are fuzzy, and, in general, the newly-developing "theoretical" sciences of the classical Greece arose from reflection on τέχνη and used it as a model for their own research. This has recently been argued by Zhmud, who shows that by the fifth and fourth centuries, the theoretical aspect of τέχνη began to emerge and come apart from the utilitarian or productive one. It might be better to call it the methodological aspect, since it was the τέχνη conceived of as systematic research that was adopted as a model by the new sciences. In the fifth century, to the old Ionian sciences of astronomy (ἀστρονομία, from νόμος) and geometry (γεωμετρία, from μέτριος),[23] the sciences of arithmetic (ἀριθμητική), logistics (λογιστική), harmonics (ἁρμονική) were added, and in the fourth century,

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[21] Zhmud (2006), *The Origin of the History of Science in Classical Antiquity*, 46.

[22] Zhmud (2006), *The Origin of the History of Science in Classical Antiquity*, 47, 48n14, who notes that the τέχνη and ἐπιστήμη are, generally, not distinguished in Plato's dialogues.

[23] Aristophanes (*Nubes* ll. 201-3) explicitly mentions these as disciplines taught in the "Thinkery."

mechanics (μηχανική) and optics (ὀπτική) follow.[24] These sciences are conceived of as τέχνη (e.g. ἡ ὀπτική τέχνη), not as productive, but theoretical.

When, at the beginning of his theoretical investigation into the causes, principles and elements of natural science Aristotle calls the discipline ἡ περὶ φύσεως ἐπιστήμη (*Physics* I 1, 184a15), he refers to it as ἐπιστήμη explicitly to indicate he has more in mind than simple ἱστορία (or research), which Aristotle thinks only states the facts that need to be investigated, and which is the kind of investigation he thinks many of the Presocratic physicists undertook. Elsewhere, however, especially in the *Metaphysics*, he explicitly refers to physics as ἡ φυσική or ἡ φυσικὴ ἐπιστήμη. I have found no sources before Aristotle where the term "φυσική" means a body of knowledge or a discipline.[25] Clearly, he does not mean that physics is a productive science; but, it is also clear that he is thinking of science in terms of τέχνη, and that he is either appropriating or extending the theoretical aspect of τέχνη as he understands it to the study of the natural world.

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[24] Zhmud (2006), *The Origin of the History of Science in Classical Antiquity*, 47.

[25] The term φυσική in this sense is entirely absent before Aristotle, and I am almost sure it is either his invention or others around the Old Academy. Variants of φυσικός,ή,όν are almost completely absent as well. The earliest reference I have found is the first cited by LSJ: Xenophon *Memorabilia* 3.9.1, where Socrates asks if courage is διδακτὸν ἢ φυσικόν. A TLG search agrees with LSJ that the term is not in Plato. There is nothing of it in Diels-Kranz fragments of Empedocles, Anaxagoras, or Democritus, although it occurs regularly in *testimonia*. The only other authors who make use of it, very infrequently, are the Hippocratic writers. It is found once in *De mulierum affectibus,* 230.68: Πειρῶ δὲ φυσικὸς εἶναι ("try to be natural"). In *Peri hemdomandōn,* 50.18, we find αὐτὴ ἡ ὥρη ξυμμαχῇ τῇ νούσῳ, οἷον καύσῳ θέρος, ὑδρωπικῷ χειμών· ὑπερνικᾷ γὰρ τὸ φυσικόν ("[the situation is dangerous] when the season itself fights along with the disease, like summer with fever or winter with dropsy: for τὸ φυσικόν completely prevails"). And in *Epistulae,* 2.3 Τὰ φυσικὰ βοηθήματα οὐ λύει τὴν ἐπιδημίην λοιμικοῦ πάθους ("Natural cures will not free a place from a pestilent disease"). The author goes on to say that nature heals natural illness, while epidemics require art.) Mansfeld, based on Hellenistic and Theophrastean terminology, dates *Peri hemdomandōn* to 400 BCE at the absolute earliest, and almost certainly not written before 350 BCE. See Mansfeld (1970), *The Pseudo-Hippocratic Tract Περι Ἑβδομαδων Ch. 1-11 and Greek Philosophy*, 52.

That he calls this science φυσική suggests he is continuing a tradition that conceived of theoretical knowledge along the lines of the theoretical reflection on τέχνη.[26]

Of course, Aristotle adopts or coins names for many sciences that are not obviously productive using this technical convention, notably practical science (πρακτική - knowledge of how to act) and first philosophy (knowledge of separate, immaterial objects, what he sometimes calls θεολογική or the highest form of θεωρητική, although he does refer to all forms of reflective knowledge as θεωρητική, cf. *Metaphysics* E 1, 1025b19). It would, of course, be a gross oversimplification to say that Aristotle is conceiving of all sciences as simply instances of τέχνη.[27] My point, however, is not that Aristotle is conceiving of these disciplines as τέχνη in the productive sense, but that what he thinks an ἐπιστήμη or science is, is something that developed from the kind of reflection on the world that was done by those who developed the arts. Aristotle explicitly acknowledges this. In his cultural history at the beginning of *Metaphysics* A, he sees science as progressing through stages, where the necessary τέχνη which produced means for survival developed first, followed by the arts for producing pleasure, and finally the theoretical disciplines, which were concerned with knowledge itself (980b26-981b24). And while theoretical knowledge is not itself productive, he nevertheless identifies what aspect of τέχνη he thinks is common to all sciences: "every science seeks [ζητεῖ] certain principles and causes concerning each of the things known by it." Aristotle sees the general characterization of τέχνη as an inquiry (ζητήσις) into the causes

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[26] *Metaphysics* 1005b2, 1025b19, 1026a36, 1026a12, 1026a19, 1064a31; *On the Parts of Animals* 641b1; he will also use φυσική to describe processes that are natural, as opposed to artificial [τεχνική], again on the model of the arts.

[27] Similarly in English: biology and eulogy are not both sciences; pathology, technology, methodology—these sometimes refer to the study of a particular subject (of disease, of tools, or of methods), and sometimes to the subject itself (diseases, tools, and methods).

and principles of a specialized subject matter (πραγματεία) as something common between art and science.

4.2 Hippocratic Theories of Art

The notion of art as a method of inquiry developed in the course of fifth century, in part among the Sophists, but also among the Hippocratic authors who were attempting to clarify the method that medical inquiry should follow.[28] The discussion arose in the context of debates about the role of luck and art in medicine. Many of the doctors were engaged in a kind of public relations programme to demonstrate that medicine was, in fact, a τέχνη and that their results, when they had any, were not the result of luck (τύχη) but of the art. The author of *On the Places in Man* argues that "the man who has this understanding of medicine [ἰητρικὴν ἐπίσταται] least depends on luck [τύχη]" and "all medicine has advanced, and its finest established techniques seem to have very little need of luck"(*On the Places in Man,* 46.2-4, tr. Schiefsky). Luck is self-ruled (αὐτοκρατὴς) but "ungovernable, and it is not its way to come in response to one's wish, but knowledge [ἐπιστήμη] is governable and brings success [εὐτυχής] when the one with knowledge wishes to use it" (*On the Places in Man,* 46.6-7, tr. Schiefsky). Art and knowledge differ from luck insofar as what results from knowledge exhibits a regular connection between cause and effect, while none of the results of luck do.[29] The author of *On Ancient Medicine* continues this kind of argument claiming, if medicine were not an art, all doctors would be equally bad and "all the affairs of the sick would be governed by chance

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[28] I will not speak directly about the development of τέχνη among the Sophists. See, Zhmud (2006), *The Origin of the History of Science in Classical Antiquity*, Chapter 2; Schiefsky (2005), *Hippocrates, on Ancient Medicine*, 36-37.

[29] Schiefsky (2005), *Hippocrates, on Ancient Medicine*, 7.

[τύχη] (*On Ancient Medicine,* 1.2, tr. Schiefsky); as it is, "[s]ome practitioners are bad, while others are much better" which we would not expect to find "if medicine did not exist at all and if nothing had been examined or discovered in it" (*ibid*). The author's point is not merely that some doctors are good and some doctors are bad, but that the doctors who are good are able to produce regular results in virtue of their art or knowledge.

In the context of asserting that the doctor's art and knowledge differentiated the results of medicine from those of luck, some Hippocratics began to ask what this art was. One of the clearest examples of this kind of discussion appears in *On Ancient Medicine*. The author is trying to prove that medicine has discovered [εὑρημένη] a principle and a method [καὶ ἀρχὴ καὶ ὁδὸς εὑρημένη] (*On Ancient Medicine,* 2.1, tr. Schiefsky), not only for applying medical treatment, but for discovering new treatments. He claims the method of medicine is ancient, and was discovered in the course of learning which foods were conducive to health and which were harmful.[30] He opposes this to the method proposed by new doctors who, assuming "newfangled hypotheses [κενῆς αὐτέην ὑποθέσιος]" like the principles of Empedocles' system, try to ground medicine in principles that are ultimately unverifiable [τὰ ἀφανέα τε καὶ ἀπορεόμενα] (*On Ancient Medicine,* 1.3, tr. Schiefsky).[31] The author and his opponents differ in what they take the

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[30] *On Ancient Medicine* 3.1-6.

[31] He seems to have in mind the kind of explanation we see in *On Fleshes*. "About what is in the heavens, I have no need to speak, except insofar as is necessary in order to explain how man and the other animals are formed and come into being, what the soul is, what health and sickness are, what in man is evil and what good, and where his death comes from" (*On Fleshes* I, tr. Potter). The author continues by asserting three basic "stuffs" – heat, which is immortal, all-perceiving and intelligent; earth, which is cold and dry; and air, which is in between. He asserts that the cosmos began when a great cosmic vortex arose and began separating out these elements. From this turbulence, most of the heat was separated and became the heavens, while some remained below. In time, the earth began to dry out by the heat, and "the material left behind

starting point of medicine to be, but the existence of a debate suggests they agreed an appropriate starting point for medicine exists, and determining what this is, and what the appropriate method is that proceeds from it, is subject to rational scrutiny.

Whatever method the art of medicine ends up following, it will be the kind of method that allows the doctor to demonstrate that his results originate in art and not in chance. To prove this, the doctor will need to show the method can establish a causal connection between the practice of medicine and successful outcomes.[32] As Schiefsky points out in his study of *On Ancient Medicine*:

> To confront the claim that the successes of medicine were due to τέχνη, not τύχη, it was necessary to do more than just point to successful results; the doctor also had to be able to show that those results were actually due to medical treatment. Hence he needed knowledge of causes, knowledge which would enable him to explain and justify his practice and so establish a direct connection between that practice and a successful outcome—or explain why he was not at fault in cases of failure. The importance of the concept of φύσις in this context results from the close association between the notions of φύσις and cause. With φύσις was associated the notion of the regularity of nature, the idea that phenomena had natural causes that could at least in principle be discovered by human beings and that were not due to arbitrary divine intervention. … Knowledge of φύσις brought with it the knowledge of causes, and hence the ability to explain and justify medical practice. (Schiefsky, 10)

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engendered putrefactions about themselves, which had the forms of tunics. Now what was heated for a great time and happened to arise from the putrefaction of the earth as fat, and containing the least moisture, quickly burnt up and became bones. That, on the other hand, which happened to be more gluey and to contain cold could not be burnt up on being heated or become dry, […] took a form rather different […] and became cords and vessels." Potter (1995), *Hippocrates: Volume Viii, Places in Man. Glands. Fleshes. Prorrhetic 1-2. Physician. Use of Liquids. Ulcers. Haemorrhoids and Fistulas*. Schiefsky (2005), *Hippocrates, on Ancient Medicine*, 19-21 gives other examples of this kind of theorizing.

[32] Schiefsky (2005), *Hippocrates, on Ancient Medicine*, 10.

According to Schiefsky, the starting point of medicine for the Hippocratics was nature itself. Some doctors will look to a more general conception of nature, like those who take on the hypotheses of Presocratics, others, like the author of *On Ancient Medicine* and *On the Places in Man* will start from human nature. Either way, starting with a general grasp of the way nature operates, the doctor can justify his practice (why it was successful in one case, unsuccessful in another) and also, since the principle is sufficiently general, apply that knowledge in unfamiliar situations. Furthermore, since this knowledge rests on general theories of human nature, as opposed to individual cases, the method of reasoning from human nature to treatment is something that can be taught.[33]

One question faced by the author is trying to prove that medicine has discovered (εὑρημένη) a principle and a method (καὶ ἀρχὴ καὶ ὁδὸς εὑρημένη), not only for applying medical treatment, but for discovering new treatments (*On Ancient Medicine,* 2.1). As a method of inquiry (ζήτησις), τέχνη is a kind of systematic research, whose aim is the discovery (εὕρησις) of new knowledge, skills or products.[34] The notions of inquiry and discovery as sources of knowledge were also associated with two related pedagogical instruments: learning and imitation (μάθησις and μίμησις).[35] Earlier discoveries became the objects of learning and imitation; and these concepts formed the basis of pedagogy. Among the Sophists, especially, pedagogy was imitation, as they presented their students

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[33] Schiefsky (2005), *Hippocrates, on Ancient Medicine*, 10-11

[34] Zhmud (2006), *The Origin of the History of Science in Classical Antiquity*, 47.

[35] The development of Greek education and culture (παιδεία) is complex. I am following closely two studies on this subject: Jaeger (1957), *Paideia: The Ideals of Greek Culture* documents the history of culture in Greece and, more recently, Zhmud (2006), *The Origin of the History of Science in Classical Antiquity* looks at the historiographical tradition in antiquity, particularly the development of writing about the history of τέχνη and science.

with models (παραδεῖγμα) of speeches, and their students learned by literally copying (μιμεῖται) these models with modifications to suit different situations.[36] Education as imitation, however, has earlier roots than the Sophistical method of education. It also served as a model for explaining the origin of arts and acquisition of new techniques. If the only way to learn something new is through discovery or imitation, there must have been someone who first discovered the art, who was then imitated by everyone else. Before the fifth century, it was often claimed that humans learned the arts from gods, different gods being assigned to different arts. But in the fifth and fourth centuries, this mythological view came to be replaced by "rationalist" (but in many ways equally mythical) accounts of the *prōtoi heuretai*—the first discoverers of some craft or technique.[37] The first discoverer is a necessary condition for any account that assumes knowledge is passed on by imitation. Both Plato and Aristotle, in trying to trace back a specific discipline to its founder, are following a characteristically Greek tradition of accounting for the origins of knowledge and culture on the model of imitation.

Many of the Hippocratics, however, explained the discovery of crafts not only through imitation of a first discoverer or divine figure like Asclepius, but through the imitation of nature itself. The author of *On Diet* almost makes a parody of the idea when he claims that all the human arts arose from imitating human nature: "they use arts that are like human nature, but they do not know, for the mind of the gods taught [them] to imitate what is their own, knowing what they are doing but without knowing what they are

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[36] Jaeger (1957), *Paideia: The Ideals of Greek Culture*, 286-331.

[37] Zhmud (2006), *The Origin of the History of Science in Classical Antiquity*, 34-44.

imitating" (*On Diet,* 11.2-3).[38] The author gives example after example of instances of the bodily processes the arts imitate: forging iron tools is like physical training (11.13); carpenters, by pushing and pulling saws, imitate the pushing and pulling of air in breathing (11.16); everything from cooking (11.18) and building (11.17) to basket-weaving (11.19). All are equally imitations of human nature. The connections the author finds between the arts and nature seem incredible, but what does it mean to describe the arts as imitations of natural processes? One thing it suggests is that the author believes nature is intelligible: we have in some sense learned reliable methods of production from nature, since we "know what we are doing" even if we do not attend to the fact that these methods are reliable precisely because they are instances of things that already happen in nature. It also suggests the author believes the reliability of technical methods must be explained in terms of the regularity already present in natural processes (11.10-12).[39] The author thinks, however, that the reliability of nature is not in need of further explanation, because nature does not, like an artist, learn its techniques by imitating anything else. Instead, "nature from herself knows these things" (15.7).[40]

The hypothesis that nature is self-taught allows the author of *On Diet* to explain the reliability of τέχνη on the grounds that nature is cause of regular effects. It might also be

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[38] τέχνῃσι γὰρ χρεόμενοι ὁμοίῃσιν ἀνθρωπίνῃ φύσει οὐ γινώσκουσιν· θεῶν γὰρ νόος ἐδίδαξε μιμέεσθαι τὰ ἑωυτῶν, γινώσκοντας ἃ ποιέουσι, καὶ οὐ γινώσκοντας ἃ μιμέονται.

[39]The author grounds the regularity of nature itself in divine providence, claiming "the gods arranged the nature of all things" φύσιν δὲ πάντων θεοὶ διεκόσμησαν· ἃ μὲν οὖν ἄνθρωποι ἔθεσαν, οὐδέκοτε κατὰ τωὐτὸ ἔχει οὔτε ὀρθῶς οὔτε μὴ ὀρθῶς· ὁκόσα δὲ θεοὶ ἔθεσαν, αἰεὶ ὀρθῶς ἔχει (*On Diet*, 11.9-10). But he is primarily interested in showing that it is because nature is regular that our arts exhibit the degree of reliability and regularity that they do.

[40] Ἡ φύσις αὐτομάτη ταῦτα ἐπίσταται. Thus, the author of *Visits* can claim that "[the patients'] nature is the doctor that cures illness (νούσων φύσιες ἰητροί) (*Visits,* 6.5.1), and (ps?)-Epicharmus, when describing how a hen knows to sit on her eggs, claims "nature alone knows how it is with this wisdom, for she has learned from herself" (Fr.4).

seen as an extension of the idea of τέχνη onto nature itself, as though nature were a kind of artist, or the art itself.[41] Yet, more importantly it implies a commitment to the intelligibility of nature, something the early Greek doctors could appeal to in order to defend their craft against those who claim their results are no more than luck. If the causes operative in cases of health or disease could be shown to be intelligible, then it made little difference whether or not they might ultimately be caused by the gods. So long as they could be reliably discerned and understood, they could provide an adequate foundation for medical techniques. The commitment to the intelligibility of nature is what allows the author of *On the Sacred Disease* to claim the "sacred" disease is no more or less sacred than any other. The author zealously attacks the "quacks" (ἀλαζόνες) who he claims, because of their failure to discern true treatments, called the disease "sacred" (ἱερῆς) in order to mask their ignorance (οὐδὲν ἐπιστάμενοι) (*On the Sacred Disease* 1-2). The author asserts that the disease has a nature (φύσις) and a cause (προφάσις), but one people have failed to grasp because of their inexperience (ἀπειρίης) (*On the Sacred Disease* 1.1-5). With experience, however, he thinks the doctor can find reliable treatments, because the doctor will be able to discover its cause (αἴτιος). But this only serves to emphasize the fact that the medical art, as an inquiry, relied on the assumption that nature itself was a cause whose regularities were intelligible, and open to rational inquiry. And the claim that "art imitates nature" is just the claim that the reliability of productive methods in art presuppose that nature, as a cause, is a cause of intelligible effects.

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[41] Jaeger (1957), *Paideia: The Ideals of Greek Culture*, Volume 3, 27.

4.3 Plato on Inquiry in Medicine and Rhetoric

Plato picks up these themes in a discussion in the *Phaedrus*. There, Socrates discusses what method the art of rhetoric should follow, and one method he proposes is the method of "Hippocrates." Plato is using the discussion about method in medicine to suggest that a similar method could be used to develop a scientific rhetoric. In the dialogue, Socrates says that "the greatest of the arts [μεγάλαι τῶν τεχνῶν] (269e4) requires speculation about nature [πέρι φύσεως] (270a1).[42] The method of "Hippocrates" starts with an inquiry into human nature to discern what human nature is, and how this nature regularly interacts with other things. Once these general causes are uncovered, the method becomes something that can be taught.

Socrates wonders whether "the method [τρόπος] of medicine [is] in a way the same as the method of rhetoric" (270a1, tr. Nehamas and Woodruff, modified). They are in a way the same since in both cases "we need to determine the nature of something [δεῖ διελέσθαι φύσιν]—of the body in medicine, of the soul in rhetoric. Otherwise, all we will have will be an empirical and artless practice [μὴ τριβῇ μόνον καὶ ἐμπειρίᾳ]" (270b4-6, tr. Nehamas and Woodruff, modified). As we will see, Plato uses these terms in the *Gorgias* to discredit rhetoric as an art, claiming instead that it is only a "knack" and the image of justice. Justice is a true art which serves a corrective function for the soul analogous to

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[42] This might be taken to suggest the "Hippocrates" Plato has in mind is closer to the doctors the author of *On Ancient Medicine* is arguing against. Jaeger suggests that Plato's characterization of "Hippocrates' method" is too general to determine direct antecedents in the extant Hippocratic corpus, but that the method seems similar to the one presented by the author of *On Ancient Medicine*. See Jaeger (1957), *Paideia: The Ideals of Greek Culture*, Volume 3, 22-23. I tend to agree with Jaeger, but I think we can also see that the method in any case begins from the nature of the body, and both groups take it for granted that the nature of the body is (in some sense) "reducible" to or explained in terms of what it is made from. Plato is also willing to group Anaxagoras in with "Hippocrates", since he thinks Pericles was the greatest orator because he learned this kind of knowledge about nature from him.

medicine for the body. Rhetoric, on the other hand, is something more like a kind of pastry-making: it has the appearance of being good for the body without actually being so. Plato's concern in the *Phaedrus*, however is not to discredit rhetoric, but to motivate the possibility of a "scientific" art of rhetoric. Thus, he applies to rhetoric the method of inquiry he attributes to "Asclepius' descendent"—a method of "thinking systematically about the nature of anything [διανοεῖσθαι περὶ ὁτουοῦν φύσεως]" (270d1) to show, on the model of the medical art, what rhetoric would be like if it were truly an art. The method he has in mind, however, is not a method of productive rules, but a second order investigation into the principles of medicine itself, which must be carried out if "we intend to become experts [τεχνικοί] and capable of transmitting our expertise" (270d2). Socrates says:

> Isn't this the way to think systematically [διανοεῖσθαι] about the nature of anything? First, we must consider whether the object regarding which we intend to become experts and capable of transmitting our expertise [αὐτοὶ τεχνικοὶ καὶ ἄλλον δυνατοὶ ποιεῖν] is simple or complex. Then, if it is simple, we must investigate its power: What things does it have what natural power of acting upon [τίνα πρὸς τί πέφυκεν εἰς τὸ δρᾶν ἔχον]? By what things does it have what natural disposition to be acted upon [τίνα εἰς τὸ παθεῖν ὑπὸ τοῦ]? If, on the other hand, it takes many forms, we must enumerate them all and, as we did in the simple case, investigate how each is naturally able to act upon what and how it has a natural disposition to be acted upon by what [τί ποιεῖν αὐτὸ πέφυκεν ἢ τῷ τί παθεῖν ὑπὸ τοῦ]. (270c10-d7 tr. Nehamas and Woodruff, modified)

It is clear from other dialogues that Plato is critical of the kinds of objects the Presocratics (or some of the doctors) decided to become experts in, since the kinds of things they bother about cannot be sources of order in things. In the *Phaedo* most notably, Plato raises problems for Presocratic claims that the order of generation and perishing, and of natural things in general, can be attributed to material causes alone, since these causes cannot account for the order of the things they compose (*Pheado* 98d-99d). Instead, he posits Forms and souls which participate in forms as sources of order

(*Phaedo* 100b-106b).[43] Plato's intention in the *Phaedrus*, however, is not to say that Anaxagoras or "Hippocrates" were correct in the choice of their principles; rather, they were correct in assuming that any art needed to determine what those principles were if it was to be successful. This kind of inquiry, which an art must engage in to justify its practical methods, is one that describes the causal relations among those principles. In the case of medicine, it may be how the body reacts to different treatments, or even how the hot acts on the moist (*On Fleshes* 1-3). Similarly, in rhetoric, the causal relations may be among different kinds of souls and different kinds of speeches (*Phaedrus* 271d-e). Whatever the subject of the art ends up being, those who want to be experts (τεχνικοί) in their art, who want to produce regular results and teach the art to others, must be able to discern the regular (here, efficient) causal connections and ground these connections in the natures of those objects.

Plato also thinks there is a normative aspect to art, since the aim of an art is to produce something and production requires an objective standard, a model, to serve as the goal of the art. This is expressed more clearly in the *Gorgias*, where Plato's aim is to show why what the sophists call rhetoric is not an art at all. To show this, he distinguishes between τέχνη itself and what seems to be one, but is more appropriately called a "knack [ἐμπειρία] or "routine [τριβή]" (463b3-4). Like the discussion in the *Phaedrus*, Plato uses medicine as his model for what an art should be like, and why, compared to this model, the Sophists' rhetoric is no art. He instead likens rhetoric to pastry-baking since, unlike medicine, pastry-baking "has no account of the nature (τὴν φύσιν) of whatever things it applies by which it applies them, so that it's unable to state the cause of each thing. And

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[43] See, e.g. Sedley (2007), *Creationism and Its Critics in Antiquity*, Chapter 4, , Menn (2010), "On Socrates' First Objections to the Physicists - *Phaedo* 95e8-97b7", *Oxford Studies in Ancient Philosophy*

I refuse to call anything that lacks such an account a craft" (465a3-6, tr. Zeyl).[44] Plato is trying to argue that a pastry-baker's apparent skill at discerning which foods are pleasant and which are not is a result of his experience of what foods in the past produced pleasure and what foods did not. He may have learned recipes for some sweet foods from a previous cook, or he may have reproduced models of pleasant pastries. However, the pastry-baker does not know why one food is pleasant and another is not, nor could he explain why to anyone. The doctor, on the other hand, could explain why something is healthy: he knows why certain foods cause different reactions in the body, and he can teach this. The condition something must meet to be considered an art is that it possesses the kind of knowledge the doctor has about the nature of human beings. A craft is whatever can state the causes for which it does what it does, where those causes are grounded in an account of their nature and the nature they act on. A knack does not meet this condition, because the success or failure of a knack does not rely on anything objective to begin with.

Plato's point, however, in making the distinction between pastry-baking and medicine is not only to show that medicine has knowledge of the causes of health and disease. He also wants to suggest there is a difference in kind among their respective ends. The aim of the art of medicine is not just to know about the body, but also about health. Medicine assumes the body has a best state [*εὐεξίαν*] (464a3), and its goal is to either bring this about or maintain it.[45] Pastry-baking, too, has a goal, but it is not a goal based in the nature of the body itself; rather, it is based on people's perceptions of what tastes

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[44] τέχνην δὲ αὐτὴν οὔ φημι εἶναι ἀλλ' ἐμπειρίαν, ὅτι οὐκ ἔχει λόγον οὐδένα ᾧ προσφέρει ἃ προσφέρει ὁποῖ' ἄττα τὴν φύσιν ἐστίν, ὥστε τὴν αἰτίαν ἑκάστου μὴ ἔχειν εἰπεῖν. ἐγὼ δὲ τέχνην οὐ καλῶ ὃ ἂν ᾖ ἄλογον πρᾶγμα.

[45] 464c4: ἀεὶ πρὸς τὸ βέλτιστον θεραπευουσῶν.

good and what does not. Thus, it "pretends to know the foods that are best for the body" but in fact, it only guesses, and "takes no thought at all of whatever is best" (464c5-e2, tr. Zeyl). Of course, we could imagine a scientific pastry-maker who knows about molecular cooking and why different esters cause different reactions on the tongue. Plato might even allow that this kind of pastry production is truly an art, since it knows the nature of the body and how certain foods cause changes in the body. This is, I think, precisely Plato's point. If the pastry-maker had such knowledge, he would no longer be exercising a 'knack', but would be a doctor—although a perverted or vicious one if he knew his products did not produce health and continued to produce them anyway. Thus, in the *Gorgias*, Plato is making the normative aspect of productive knowledge explicit, something that was not stated among the Hippocratics, and he is grounding it in the nature of the things it produces or maintains. An art is a body of knowledge that discerns regular causal connections, and it grounds these in the nature of its objects of study; but it is also a normative kind of knowledge, which aims always to provide care for the best state of its objects [ἀεὶ πρὸς τὸ βέλτιστον θεραπευουσῶν] (464c4). But, more importantly for my purposes here, it is a method of inquiry that aims at making new discoveries, and it is systematic insofar as it begins from certain general first principles that guide inquiry in discovering causal connections among phenomena.

4.4 Aristotle: the Technical Model Applied to Physics

The theoretical aspect of τέχνη continued to influence Aristotle's thinking about science as a search for causes. By the time of the *Metaphysics*, Aristotle has already started to distinguish productive sciences (ποιητικαί) from theoretical ones (θεωρητικαί). Yet he still finds it important to remind his audience that they are distinct, and for this reason,

he and refers to his *Ethics* for a more precise account of their differences.[46] Aristotle also continues to follow Plato, and distinguishes τέχνη from experience or a knack (*Metaphysics* A 1, 980b26-981a12), although the distinction is not as sharp in Aristotle as it is in Plato. Aristotle thinks that with enough experience in something, a person is likely to become technically proficient at it, perhaps even more proficient than someone with only theoretical knowledge (*Metaphysics* A 1, 981a13 *ff.*). What Aristotle maintains, however, is the belief that the person of experience can neither teach nor make systematic progress, since any discoveries she makes will be accidental (981b14 *ff.*). And in describing the project of the *Metaphysics* as an inquiry into the kinds of causes and principles that wisdom itself will study[47], Aristotle is still thinking about ἐπιστήμη on the model of τέχνη, and continuing in the tradition of seeking the appropriate causes, but also, like Plato did for rhetoric in the *Phaedrus*, refining the method of inquiry so that it is appropriate for each discipline.[48] What is appropriate for each discipline will vary. Unlike some Academics, who tried to apply mathematical precision and methods to many disciplines, Aristotle thinks "it is the mark of an educated man to look for precision in each class of things just so far as the nature of the subject admits" (*Nicomachean Ethics* I 2, 1094b24 *f.*). And so, part of Aristotle's project, whether in

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[46] *Metaphysics* A 1, 981b25-17: εἴρηται μὲν οὖν ἐν τοῖς ἠθικοῖς τίς διαφορὰ τέχνης καὶ ἐπιστήμης καὶ τῶν ἄλλων τῶν ὁμογενῶν.

[47] *Metaphysics* A 1, 982a4-6: ταύτην τὴν ἐπιστήμην ζητοῦμεν, τοῦτ' ἂν εἴη σκεπτέον, ἡ περὶ ποίας αἰτίας καὶ περὶ ποίας ἀρχὰς ἐπιστήμη σοφία ἐστίν.

[48] On the departments of physics as kinds of inquiry, cf. *On the Parts of Animals* I 1, 645a21-3: οὕτω καὶ πρὸς τὴν ζήτησιν περὶ ἑκάστου τῶν ζῴων προσιέναι δεῖ μὴ δυσωπούμενον ὡς ἐν ἅπασιν ὄντος τινὸς φυσικοῦ καὶ καλοῦ. "In this way as well we must approach inquiry into each of the animals without disgust, since in all of them exists something natural and worthwhile." On celestial physics as inquiry, see *De Caelo* II 1, 286a5. On the study of the soul as inquiry, see *De Anima* I 2, 403b24. On physics in general as inquiry into sensible things, see *Physics* III 5, 204a 35.

physics or in ethics, is to show how his own method is a development and refinement of the methods of his predecessors. and then to isolate the appropriate first principles of these sciences at a general level, so that others can continue the work of seeking the facts and working out the causal relations that account for them. Once the appropriate first principles have been found, and the method refined, "it would seem that any one is capable of carrying on and articulating what has once been well outlined, and that time is a good discoverer or partner in such a work; to which facts the advances of the arts are due; for any one can add what is lacking" (1098a22-26).[49] Rarely, however, does Aristotle claim to be starting a new discipline; instead, he sees his own work as perfecting or completing the advances made by others.[50]

This leads to the other characteristic of τέχνη that continued to be associated with ἐπιστήμη once the two notions began to come apart: ἐπιστήμη, like τέχνη, is teachable. Unlike people who have experience, "in general it is a sign of the man who knows, that he can teach, and therefore we think art more truly knowledge than experience is; for artists can teach, and men of mere experience cannot" (*Metaphysics* A 1, 981b8). Sometimes teaching took the form of imitating the products of an expert. Notably the method of education used by the Sophists and teachers of Eristic consisted in just this:

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[49] The same point is made at *Sophistical Refutations* 34, *Metaphysics* A and α. See note below.

[50] In *Sophistical Refutations* 34 he suggests that he thinks the whole development of syllogistic is, in fact, an entirely new discipline, and this obviously has extensive implications for how he conceives of both acquiring facts, giving definitions, and presenting demonstrations. However, logic seems to be the only discipline which he claims to have invented. Even in *Metaphysics*, he prefers to think of himself as one of a line of thinkers investigating σοφία and first principles. The doxography of *Metaphysics* A and the description of progress in attaining truth in α1 might serve rhetorical purposes, but it is clear that Aristotle is one, if not the first, philosopher to see his place in the history of thought. This view is developed in Jaeger (1957), *Paideia: The Ideals of Greek Culture*, 3-7, and seems to influence the work of Zhmud (2006), *The Origin of the History of Science in Classical Antiquity*, Chapter 4.

giving model speeches to imitate and modify as needed for particular purposes.[51] Aristotle is especially critical of this model of education. In the *Sophistical Refutations*, he complains that "they trained people by imparting to them not the art but its products" and that training that proceeds by giving its students models to copy is like "anyone professing that he would impart a form of knowledge to obviate any pain in the feet, were then not to teach a man the art of shoe-making or the sources whence he can acquire anything of the kind, but were to present him with several kinds of shoes of all sorts—for he has helped him to meet his need, but has not imparted an art to him" (183a20f).[52] But his criticism is not directed against imitation as such; rather, he is critical of the Sophists because they claimed to be teaching students by having them imitate their products, when the students ought to have been imitating their method of producing them. As Aristotle suggests, the reason the Sophists and the teachers of Eristic did not teach their method was that they did not have one: "concerning deduction [συλλογίζεσθαι], we had absolutely nothing from the past to go on, but, inquiring with practice, we worked for a very long time [sc. to arrive at this method]" (184b1-3).[53] Aristotle thinks what should be imitated, instead, both in art and science, is the proper method of inquiry which leads to further discovery.[54]

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[51] Jaeger (1957), *Paideia: The Ideals of Greek Culture*, Volume 2, 259-263

[52] Compare to Plato's criticisms of the poets in *Republic* X.

[53] περὶ δὲ τοῦ συλλογίζεσθαι παντελῶς οὐδὲν εἴχομεν πρότερον λέγειν ἢ τριβῇ ζητοῦντες πολὺν χρόνον ἐπονοῦμεν.

[54] *Sophistical Refutations* 34, 184b6: λοιπὸν ἂν εἴη πάντων ὑμῶν [ἢ] τῶν ἠκροαμένων ἔργον τοῖς μὲν παραλελειμμένοις τῆς μεθόδου συγγνώμην τοῖς δ' εὑρημένοις πολλὴν ἔχειν χάριν ("what work remains for all of you, our students, is the task of extending us your pardon for the shortcomings of the method, and for the discoveries thereof your warm thanks").

Like Plato's attempt to motivate a scientific rhetoric in the *Phaedrus*, and his own development of a scientific eristic in the *Sophistical Refutations*, one of Aristotle's tasks in the *Physics* is to motivate a scientific investigation into nature on the same model of τέχνη. In *Physics* I 1, when he claims "in all disciplines which have principles, causes and elements, knowledge, especially scientific knowledge (τὸ εἰδέναι καὶ τὸ ἐπίστασθαι), follows from an acquaintance with them" (184a10-12),[55] he is proposing an inquiry into the starting points of explanation in physics. In the course of *Physics* I, Aristotle arrives at the three elements physics will start from, matter, form and privation (*Physics* I 7-9). In Book II, he posits that nature is a *per se* efficient cause in things, but he recognizes that this is problematic, since there are two "natures" that fit this criteria—nature as form and nature as matter:

> καὶ γὰρ δὴ καὶ περὶ τούτου ἀπορήσειεν ἄν τις, ἐπεὶ δύο αἱ φύσεις, περὶ ποτέρας τοῦ φυσικοῦ. ἢ περὶ τοῦ ἐξ ἀμφοῖν; ἀλλ' εἰ περὶ τοῦ ἐξ ἀμφοῖν, καὶ περὶ ἑκατέρας. πότερον οὖν τῆς αὐτῆς ἢ ἄλλης ἑκατέραν γνωρίζειν; εἰς μὲν γὰρ τοὺς ἀρχαίους ἀποβλέψαντι δόξειεν ἂν εἶναι τῆς ὕλης(ἐπὶ μικρὸν γάρ τι μέρος Ἐμπεδοκλῆς καὶ Δημόκριτος τοῦ εἴδους καὶ τοῦ τί ἦν εἶναι ἥψαντο)· εἰ δὲ ἡ τέχνη μιμεῖται τὴν φύσιν, τῆς δὲ αὐτῆς ἐπιστήμης εἰδέναι τὸ εἶδος καὶ τὴν ὕλην μέχρι του (οἷον ἰατροῦ ὑγίειαν καὶ χολὴν καὶ φλέγμα, ἐν οἷς ἡ ὑγίεια, ὁμοίως δὲ καὶ οἰκοδόμου τό τε εἶδος τῆς οἰκίας καὶ τὴν ὕλην, ὅτι πλίνθοι καὶ ξύλα· ὡσαύτως δὲ καὶ ἐπὶ τῶν ἄλλων), καὶ τῆς φυσικῆς ἂν εἴη τὸ γνωρίζειν ἀμφοτέρας τὰς φύσεις.
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> For, about this as well someone might raise an *aporia*: since there are two natures, with which is the student of nature concerned? Or is he concerned with the combination of the two? But if the combination of the two, then also each severally. Then, does it belong to the same or to

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[55] Ἐπειδὴ τὸ εἰδέναι καὶ τὸ ἐπίστασθαι συμβαίνει περὶ πάσας τὰς μεθόδους, ὧν εἰσὶν ἀρχαὶ ἢ αἴτια ἢ στοιχεῖα, ἐκ τοῦ ταῦτα γνωρίζειν. Compare to the more "productive" sounding introduction to NE I 1, Πᾶσα τέχνη καὶ πᾶσα μέθοδος, ὁμοίως δὲ πρᾶξίς τε καὶ προαίρεσις, ἀγαθοῦ τινὸς ἐφίεσθαι δοκεῖ· διὸ καλῶς ἀπεφήναντο τἀγαθόν, οὗ πάντ' ἐφίεται (1094a1-3).

> different [sciences] to gain knowledge [γνωρίζειν] of each? Looking to the ancients, it would seem to be concerned with the matter. (Empedocles and Democritus grasped the form and essence only a little bit.) But if on the other hand art imitates nature, and [it is the task] of the same science to know [τῆς δὲ αὐτῆς ἐπιστήμης εἰδέναι] the form and the matter up to a point (e.g. the doctor has a knowledge of health and also of bile and phlegm, in which health [exists] and the builder both of the form of the house and of the matter, that it is bricks and beams, and so forth), if this is so, it would also be the part of natural science also to know both natures. (*Physics* II 2, 194a15-194a27, tr. Hardie and Gaye, modified)

Aristotle is attempting to motivate the use of τέχνη as an appropriate model for understanding nature because it provides an answer to the question about the unity of natural science. If nature is like a τέχνη, then just as an art must know both the matter and the form it produces in the matter, so physics will also know both causes. The physicist can study both the matter and the form "up to a point, perhaps, as the doctor must know sinew or the smith bronze, until he understands the purpose of each [τίνος [γὰρ] ἕνεκα ἕκαστον]" (194b9-12).[56] The doctor hypothesizes or assumes what health is, and knows the forms of the matter (like sinew or other homoeomoerous tissues of the body) insofar as he produces health by acting on them. This model only works, however, if we can conceive of nature as manifesting this same instrumental structure as art (Lennox 2008, 181). The question is: what grounds does Aristotle have for suggesting it does? He seems to be suggesting that it is self-evident that 'art imitates nature', and this is sufficient justification for using art as a model. But how are we to understand this assertion?

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[56] μέχρι δὴπόσου τὸν φυσικὸν δεῖ εἰδέναι τὸ εἶδος καὶ τὸ τί ἐστιν; ἢ ὥσπερ ἰατρὸν νεῦρον ἢ χαλκέα χαλκόν, μέχρι τοῦ τίνος [γὰρ] ἕνεκα ἕκαστον. Ross notes (*ad loc.*) that the γάρ seems to be a later insertion.

One way we might try to understand this, as Ross suggests, is to assume Aristotle is referring to art and nature as productive causes: if art imitates nature, then "the study of art must conform to the study of nature," because the ends of the arts are subordinated to natural ends.[57] It is true that Aristotle sometimes subordinates artistic teleology to natural teleology. The art of medicine acts for the purpose of bringing about the natural good state of the body. House-building, too, might be thought to be subordinated to natural ends by ensuring survival through the protection of the body and possessions like food. If this were what Aristotle meant by "art imitates nature," then he would be saying something like, 'since art acts for human ends, and humans are natural, then there are ends in nature; therefore, nature must be teleologically structured, and so natural science will study both nature as matter and nature as form.'[58]

However, it is not clear why imitation should mean the same thing as subordination. The assertion, if it were Aristotle's, would be novel, since the claim that "art imitates nature" never meant anything like this before. A similar view is attributed to Democritus:

> We are pupils of the animals in the most important things: the spider for spinning and mending, the swallow for building, and the songsters, swan and nightingale, for singing, by way of imitation. (DK 68 B154)

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[57] Ross (1955), *Aristotle's Physics*, *ad loc*.

[58] Jaeger (1957), *Paideia: The Ideals of Greek Culture*, Volume 3, 74n72, asserts something along these lines: "It is a characteristically Aristotelian view that nature is purposive in a higher degree even than art, and that the purposiveness that rules in handiwork, whether art or craft, is nothing but an imitation of the purposiveness of nature. The same view of the relation between these two things is often briefly expressed in the second book of the *Physics*, which is one of Aristotle's earliest writings." Precisely what Jaeger means is not clear. In a footnote he suggests, "all arts are merely man's attempt to compete with the organic and creative nature, and this competition necessarily takes place in another medium (that of artificial construction), in which it is never possible to speak of an end (*telos*) in the highest or organic sense", but I admit I find this equally obscure.

But Democritus, of course, did not think that nature manifested an instrumental structure.[59] For him the idea that the arts imitate nature explains how the arts were first discovered.[60] Democritus' view echoes the Hippocratic author of *On Diet*, who claims we "use arts that are like human nature, but [we] do not know" (*On Diet* 11.2) and that nature did not learn how to act from anything else, but "from herself knows these things" (*On Diet* 15.7).[61] It also echoes the author of *Visits*, who claims that "[the patients'] nature is the doctor that cures illness (νούσων φύσιες ἰητροί) (*Visits* 6.5.1). [62] And (ps?)-Epicharmus, as well, when explaining how a hen knows to sit on her eggs, claims "nature alone knows how it is with this wisdom, for it has learned from itself" (Fr. 4). In all of these instances, the claim idea that the arts imitate nature is bound up with the idea that nature somehow "knows what to do" or that it is "self-taught."

If "art imitates nature" implies that nature is "self-taught," this gives some insight into the ambiguity in the word "nature" in this claim. If we think that nature means exclusively a goal-directed productive cause, then it is not clear why he thinks the analogy between art and nature implies there should also be similarities between art, as a *form of* knowledge, and natural science. If, however, the phrase "art imitates nature" is taken to express an epistemic relation the ambiguity seems less problematic. The ontological priority of nature does not entail the epistemic priority of nature. But this is

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[59] Sedley (2007), *Creationism and Its Critics in Antiquity*, 154, claims for the atomists, "[i]nvariably, craftsmanship improves on a process or activity already present in nature."

[60] Brancacci and Morel (2007), *Democritus : Science, the Arts, and the Care of the Soul*, 191-194.

[61] Ἡ φύσις αὐτομάτη ταῦτα ἐπίσταται.

[62] Schiefsky (2007), "Galen's Teleology and Functional Explanation", *Oxford Studies in Ancient Philosophy*, 68, suggests that analogies between art and nature were used regularly in Greek science as a heuristic device for learning about nature. I agree with Schiefsky to a point. I am not certain the arts were *recognized* as heuristic devices for understanding nature.

not what imitation was meant to express in this context in authors before Aristotle. Instead, it was meant to express the epistemic priority of nature. Nature, metaphorically, "knows" what it is doing: its order is intelligible, and this intelligible order can serve as the starting point for our own productive knowledge, and, as Aristotle thinks, our theoretical knowledge about how nature works.

This epistemic sense of "art imitates nature" is also the sense attested in authors after Aristotle. Lucretius, a later example of the idea in the atomist tradition, describes the natural origins of artistic methods in *De rerum natura* V.[63] He speculates that the observation of lightning or of branches rubbing together in the wind and catching fire "may well have given fire to mortal men"; and that "the sun instructed" humans to cook when they saw how it warmed things and softened things (*De Rerum Natura* V 1091-1109).[64] He similarly attributes the art of song to observation of birds singing and wind whistling (1379ff) and agriculture techniques, not only sowing seeds (1361-7), but complex procedures like grafting (1367-9) and tilling to improve flavour (1380f). Similar examples of art as deriving from the imitation of natural processes occur in

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[63] For a contrasting view, see Jaeger (1960), *Aristotle: Fundamentals of the History of His Development*, 75n71: "Democritus has a similar but distinct doctrine [*sc*. of art imitating nature] when he calls men the pupils of the animals, of the spider weaving and mending , of the swallow in building, and the songbirds in song (frg. 154). With the last cf. Lucretius V 1379. Lucretius also derives cookery (1. 1102) and sowing and grafting (1. 1361) from the imitation of nature, which he certainly got from Democritus by way of Epicurus.) But Aristotle is concerned with something entirely new. He refers the proposition that art is an imitation of nature to the teleological character of all human construction, and grounds it in the teleological view of nature.

[64] Illud in his rebus tacitus ne forte requiras, / fulmen detulit in terram mortalibus ignem / primitus, inde omnis flammarum diditur ardor; / multa videmus enim caelestibus insita flammis / fulgere, cum caeli donavit plaga vaporis. / et ramosa tamen cum ventis pulsa vacillans / aestuat in ramos incumbens arboris arbor, / exprimitur validis extritus viribus ignis, / emicat inter dum flammai fervidus ardor, / mutua dum inter se rami stirpesque teruntur. / quorum utrumque dedisse potest mortalibus ignem. / inde cibum quoquere ac flammae mollire vapore / sol docuit, quoniam mitescere multa videbant / verberibus radiorum atque aestu victa per agros.

Cicero (*De Legibus* I, 26)[65], Seneca (*Epistulae Morales,* 90.22-4)[66], and Galen (*On the Natural Faculties,* 18).[67] In none of these examples is "art imitates nature" a teleological notion, but is instead a way to explain the origin of technical methods of production.

The same sense is found in Theophrastus as well. In *On the Causes of Plants*, he observes that "some [plants] work together [συνεργεῖν] to preserve and propagate others"[68] and states that "the deciduous help the evergreen, since it happens that the earth is manured (as it were) by the decomposing leaves, and this is useful for good feeding and making the seeds sprout" (*On the Causes of Plants,* 2.18.1).[69] He pairs this with an example from farming, where "plants [are] sown among the young vines when the growers wish to reduce their excess fluid" (*ibid*.).[70] The farmer learns to fertilize the soil by observing the effects of rotting leaves on seed growth, and he learns to sow plants among vines, by observing how certain plants interact when growing together spontaneously, "for we must take it that such relations as these, in plants of spontaneous growth as well, belong

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[65] Artes uero innumerabiles repertae sunt, docente natura, quam imitata ratio res ad uitam necessarias sollerter consecuta est. (Innumerable arts have likewise been discovered by the teaching of nature; for reason imitates art, and skilfully discover all things necessary to the happiness of life.)

[66] Seneca attributes to Posidonius the view that humans learned to mill wheat into flour by looking at teeth grinding: Deinde non est contentus his artibus, sed in pistrinum sapientem summittit. Narrat enim quemadmodum rerum naturam imitatus panem coeperit facere.

[67] Νυνὶ δὲ τοῦτ' αὐτοῖς ἐνδεῖ τὸ ἔργον οὐδὲ καθ' ἕνα τρόπον εἰς μίμησιν ἐνδεχόμενον ἀχθῆναι μὴ ὅτι τοῖς παιςὶν ἀλλ' οὐδ' ἄλλῳ τινὶ· μόνης γὰρ τῆς φύσεως ἴδιον ἐστιν. Galen presents an interesting exception: children make balloons from the bladders of pigs and heat them so that they expand. The skin of the bladder thins as it expands because the process is artificial. If this were a natural process, the nature would continue to bulk up the skin as it grew by nourishing it. As it is, art is unable to imitate nature in, since nourishing is a proper function of nature alone.

[68] συνεργεῖ πρὸς τὴν ἀλλήλων σωτηρίαν καὶ γένεσιν.

[69] ἐν μὲν γὰρ τοῖς ἀγρίοις τὰ φυλλοβόλα τοῖς ἀειφύλλοις ὅτι σηπομένων ξυμβαίνει καθάπερ κοπρίζεσθαι τὴν γῆν ὃ καὶ πρὸς εὐτροφίαν καὶ πρὸς τὴν βλάστησιν τῶν σπερμάτων χρήσιμον.

[70] Ἐν δὲ τοῖς ἡμέροις ὅσα τοῖς φυτοῖς ἐπισπείρουσι τῶν ἀμπέλων ἀφαιρεῖν βουλόμενοι τὸ πλῆθος τῆς ὑγρότητος.

to the nature of the plants, especially if art imitates nature" (*On the Causes of Plants,* 2.18.2).[71] In the spontaneous cases, as opposed to the agricultural ones, Theophrastus is not saying there is a teleological relationship among the plants, such that, for example, deciduous trees lose their leaves for the sake of the good feeding this provides for evergreens. One plant can benefit the other, but it is not for the sake of the evergreen that the deciduous loses its leaves. Art imitates this process, however, in the sense that, having observed and understood it, farmers repeat the process in order to produce the same result.

Finally, that reliable methods of production in the arts are grounded in regular natural processes is also found in Aristotle. In the *Protrepticus*, Aristotle says that "the best tools [in the arts] are discovered (εὕρηται) by craftsman from nature (e.g., in construction, the plumb-line, the straight-edge and the compass: some are grasped from water, others from light and the rays of the sun) relative to which, when judging according to our perception what is sufficiently straight and smooth, we test" (*Protrepticus* fr. 47.1-7).[72] And in his discussion of concoction in the *Meteorology*, he claims:

> Broiling is concoction by dry foreign heat. Hence if a man were to boil a thing but the change and concoction in it were due, not to the heat of the liquid but to that of the fire, the thing will have been broiled and not boiled when the process has been carried to completion: if the process has gone too far we use the word "charred" to describe it. [...] Now broiling and boiling are artificial processes (γίγνονται μὲν τέχνῃ), but the same general kind of thing (τὰ εἴδη καθόλου), as we said, also [occurs] by nature

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[71] Οἴεσθαι γὰρ χρὴ τοιαῦτα καὶ ἐν τοῖς αὐτομάτοις τῆς φύσεως ὑπάρχειν ἄλλως τε καὶ εἰ ἡ τέχνη μιμεῖται τὴν φύσιν.

[72] Καθάπερ γὰρ ἐν ταῖς ἄλλαις τέχναις ταῖς δημιουργικαῖς ἀπὸ τῆς φύσεως εὕρηται τὰ βέλτιστα τῶν ὀργάνων, οἷον ἐν τεκτονικῇ στάθμη καὶ κανὼν καὶ τόρνος – τὰ μὲν ὕδατι τὰ δὲ φωτὶ καὶ ταῖς αὐγαῖς τῶν ἀκτίνων ληφθέντων – πρὸς ἃ κρίνοντες τὸ κατὰ τὴν αἴσθησιν ἱκανῶς εὐθὺ καὶ λεῖον βασανίζομεν.

> (φύσει). The affections produced (τὰ γιγνόμενα πάθη) are similar though they lack a name, since art imitates nature (μιμεῖται γὰρ ἡ τέχνη τὴν φύσιν). For instance, the concoction of food in the body is like boiling, for it takes place in a hot and moist medium and the agent is the heat of the body. So, too certain forms of indigestion are like parboiling. (*Meteorology* IV 3, 381a24-381b10, tr. Webster, modified)[73]

If Aristotle thought "art imitates nature" meant the ends of art were subordinate to natural ones, his point would be that cooking and digestion have the same end, namely producing nutrition for the body. What he says, however, is that concoction in both natural and artificial contexts produces similar qualities in the matter (their effects are the same). There is no suggestion that concoction of food in the body and cooking are both for the same end. But it does suggest that Aristotle thinks the processes in both cases are instrumental. Aristotle asserts this in a parallel passage: "there is no difference in artificial and natural *instruments* [οὐδὲν διαφέρει ἐν ὀργάνοις τεχνικοῖς καὶ φυσικοῖς] should something come to be, since they all will exist because of the same cause" (*Meteorology* IV 3, 381a9-12). "The same cause" is the heat acting on the moist, which is only instrumental to the production of the ends either of nature or of art. And this is what we would expect if a science of nature was being modeled on a science of art. They are both conceived of as instruments for an end, even though they do not have the same ends.

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[73] At *Meteorology* IV 3, 380a11-17, Aristotle calls this extension of a term 'metaphorical': "Ripening is a sort of concoction (πέψις τις); for we call it ripening when there is a concoction of the nutriment in fruit. [...] This is what ripening means when the word is applied to fruit. However, many other things that have undergone concoction are said to be ripe, the general character of the process being the same, though the word is used metaphorically [μεταφοραῖς]" (tr. Webster, modified). For more on this use of metaphor, see Chapter One, "Metaphor in Aristotle's Science."

As we have seen, the claim that humans imitate nature was used as part of a larger debate about the status of medicine as an art (τέχνη). Some Hippocratic doctors invoked this idea in arguing against those who claimed their results were due to luck (τύχη). They conducted investigations into the first principles medicine to prove that their art was a reliable cause of order in the body, and they did this by grounding medicine's ability to order the body in the intelligible order already present in nature. This order can be revealed by observation, but only because nature itself is already intelligible. Aristotle finds this model useful in the study of nature for the same reason the Hippocratic doctors did in their study of medicine: if the methods of art are successful, then it is because nature is ordered, and that order must be immanent in nature. Aristotle takes the further step by saying that, if nature is ordered, then the cause of that order cannot be the matter itself. Instead, it must be something that explains the order in matter the same way an art does.[74] Physics, therefore, can be a single science if, as Aristotle thinks, the formal nature is the source of order in the matter. Whatever Aristotle's reasons might be for conceiving of nature in this way, it is not because the arts act for the sake of natural ends that art imitates nature; rather, the reliability of artistic methods presupposes regularity in nature. The arts give Aristotle a model for explaining this order because they, too, are a source of order in matter. The model, however, assumes

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[74] So, Alexander *In Metaphysica* A 103,31-104-19, "For all natural things come to be according to a certain order and certain determinate numbers, and not by chance or spontaneity, but surely this does not mean that they also come to be by reference to a model. For it is not by reflecting (*ennoein*) that nature produces what it does (for it is an irrational power), but it is responsible for the fact that [generation] takes place in an orderly progression of movements, so that a first movement is followed in orderly sequence by a second, although not as the result of any reasoning process, and this second movement is followed in turn by a third, until the movements have progressed to the end for the sake of which they occurred. *It is this order that art imitates, for it puts things together in a rational way and [thus] produces its object.* [...] Again, it is possible to discover [this] regular order even in evil things and in those that come to be in a way contrary to nature, such as abscesses, wounds, boils, and periodic illnesses. But the generations of certain living things too are in fact orderly, but not by reference to an Idea, those e.g. of worms, gnats, and grubs" (tr. Dooley, emphasis mine).

the source of order is something achieving its end through matter, both as substrate and as instruments, and so it is no surprise that in Aristotle's physics, nature manifests the same instrumental structure we observe in the arts.

Aristotle argues that nature manifests this instrumental structure in *Physics* II 8. There, he uses arguments similar to the ones employed by the Hippocratic doctors—which they used to show that the outcomes of their procedures were not due to chance—to show that regular natural outcomes cannot be due to chance either, but must occur because nature is a cause that acts for the sake of an end. He argues for this conclusion in what has come to be called the "rainfall example" (198b17-199a8). I will not discuss this controversial passage here.[75] Instead, I want to look at what follows from this argument, namely, Aristotle's argument that, if nature acts for an end, then it will exhibit an instrumental structure. He argues for this conclusion at 199a9-19, by appealing to certain similarities between how things come about κατὰ τέχνην and how they come about κατὰ φύσιν:

> ἔτι ἐν ὅσοις τέλος ἔστι τι, τούτου ἕνεκα πράττεται τὸ πρότερον καὶ τὸ ἐφεξῆς. οὐκοῦν ὡς πράττεται, οὕτω πέφυκε, καὶ ὡς πέφυκεν, οὕτω πράττεται ἕκαστον, ἂν μή τι ἐμποδίζῃ. πράττεται δ' ἕνεκά του· καὶ πέφυκεν ἄρα ἕνεκά του. οἷον εἰ οἰκία τῶν φύσει γιγνομένων ἦν, οὕτως ἂν ἐγίγνετο ὡς νῦν ὑπὸ τῆς τέχνης· εἰ δὲ τὰ φύσει μὴ μόνον φύσει ἀλλὰ καὶ τέχνῃ γίγνοιτο, ὡσαύτως ἂν γίγνοιτο ἢ

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[75] The controversy is about what the "rainfall example" implies about the scope of natural teleology. I will avoid any discussion of these issues, since any interpretation of the beginning of *Physics* II 8 will have to be consistent with the argument I examine. For a discussion of the issues, see Furley (1985), "The Rainfall Example in Physics Ii.8"; Cooper (1987), "Hypothetical Necessity and Natural Teleology"; Sauve Meyer (1992), "Aristotle, Teleology, and Reduction"; Sedley (1991), "Is Aristotle's Teleology Anthropocentric?", *Phronesis* 36(2); Johnson (2005), *Aristotle on Teleology*; Judson (2005), *Aristotelian Teleology*; Bodnár (2005), "Teleology across Natures", *Rhizai: A Journal for Ancient Philosophy and Science* 2(1); and Sedley (2007), *Creationism and Its Critics in Antiquity*, Chapter 6. Good surveys of the literature can be found in Leunissen (2010), *Explanation and Teleology in Aristotle's Science of Nature*, 22-49 and Gotthelf (2012), *Teleology, First Principles and Scientific Method in Aristotle's Biology*, Chapter 2.

> πέφυκεν. ἕνεκα ἄρα θατέρου θάτερον. ὅλως δὲ ἡ τέχνη τὰ μὲν ἐπιτελεῖ ἃ ἡ φύσις ἀδυνατεῖ ἀπεργάσασθαι, τὰ δὲ μιμεῖται. εἰ οὖν τὰ κατὰ τέχνην ἕνεκά του, δῆλον ὅτι καὶ τὰ κατὰ φύσιν· ὁμοίως γὰρ ἔχει πρὸς ἄλληλα ἐν τοῖς κατὰ τέχνην καὶ ἐν τοῖς κατὰ φύσιν τὰ ὕστερα πρὸς τὰ πρότερα.
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> Further, where there is an end, what is prior is done [πράττεται] for the sake of that. Now surely as in action [πράττεται], so in nature [πέφυκε]; and as in nature, so it is in each action, if nothing interferes. Now action is for the sake of an end; therefore what has come about naturally is also for the sake of something. Thus if a house, e.g., had been a thing made by nature, it would have been made in the same way as it is now by art; and if things made by nature were made not only by nature but also by art, they would come to be in the same way as by nature. The one, then, is for the sake of the other; and generally art in some cases completes what nature cannot bring to a finish, and in others imitates nature. If, therefore, artificial products are for the sake of an end, so clearly also are natural products. The relation of the later to the earlier items is the same in both. (*Physics* II 8, 199a9-199a19, tr. Hardie and Gaye, modified)

The question I am concerned with is the nature of the inference from human action and art to nature: "surely as in action [πράττεται], so in nature [πέφυκε]; and as in nature, so it is in each action, if nothing interferes" (198b17-199a8, tr. Hardie and Gaye).[76] Not only does Aristotle think action and nature are similar insofar as they have ends, he also takes it for granted that there is a similarity between artistic production and natural processes: in both cases, the later stages come after earlier stages in a definite order. But why should he think that, if a house comes into existence by nature, the process by which it comes into existence will follow some sequence of steps as it does by art? And why think that if what results naturally were also to be produced by art, it would come

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[76] One question discussed in the literature is the role this passage plays in Aristotle's overall defense of natural teleology in Physics II 8. For discussions, see Charles (1984), *Aristotle's Philosophy of Action* and Granger (1993), "Aristotle on the Analogy between Action and Nature"

about in the same way?[77] His answer is that "art sometimes completes what nature cannot bring to a finish, and sometimes imitates nature" (199a16-7). The claim that "art completes nature" is compatible with the claim that ends in nature are prior to artistic ones, and so it is consistent with the claim that natural ends are ontologically prior to artistic ones. Medicine exists *because* health exists; and agriculture exists *because* plants exist and sometimes require human aid for growth.

He also claims, "if a house, e.g., had been a thing made by nature, it would have been made in the same way as it is now by art" (199a13). If Aristotle were using the ontological sense of "art imitates nature," then, as Simplicius points out, the argument would be question-begging.[78] And Aristotle has not said explicitly why he thinks if nature built houses it would build them the same way we do and this argument seems to add almost nothing to the overall defense of teleology except to say that ends determine means. He makes the same claim a few lines later, where he says "if the art of ship-building were in the wood, it would produce the same results by nature. If, therefore,

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[77] The implication here is quite severe, since could suggest that Aristotle denies art can improve upon nature, but at best imitate it.

[78] Simplicius*, In physicam* 374.30-375,14 wonders why Alexander thought the argument was not question-begging. According to Simplicius, Alexander interpreted it as follows: "He [Aristotle] has shown [in the immediately preceding argument] that the products of nature are for some purpose (for they possess an end 'for the sake of which'). He adds the following statement as a consequence, that where there is an end in view, the previous stages in the process are done for the sake of it; it follows from this that the previous stages happen for the sake of the end even in the products of nature." Commenting on Alexander's interpretation, Simplicius writes, "I do not think that I grasp his point, since he [Aristotle] seems to me to be saying nothing more than that, in understanding that the products of nature are for some purpose, he concludes that the products of nature are for some purpose. For what do the words 'the previous stages happen for the sake of the end even in the products of nature' mean other than that?" The question both Simplicius and Alexander seem to be interested in is why, having established nature to be a cause that acts for the sake of its end and not by necessity, he needs to go on to say that *not only* is nature a cause for producing its results, but also the means by which it produces its results are also for the sake of its results. This would be like wondering whether, assuming doctor acts for the sake of producing health, the doctor also mixes up medicines and administers them for the sake of producing health.

purpose is present in art, it is also present in nature. The best illustration is a doctor doctoring. Nature is like [ἔοικεν] that" (199a28-31 tr. Hardie and Gaye).[79] The argument seems as question-begging as the previous one, and the simile or metaphor, that nature is art-like, may help us to conceive of what he means, but it certainly is not convincing.

Is it more convincing if we assume the epistemological sense of "art imitates nature"? If this sense is in play, then Aristotle is claiming, "if houses were made by nature, then the way nature makes houses would be the same way we do, because (hypothetically) we would have learned how to produce houses by observing how nature produces them." If Aristotle thought his audience was already committed to the epistemological claim, this argument is less puzzling. If we already believe that productive knowledge, art, is learned from observing ordered natural processes, and if Aristotle thought he had already convincingly established that order in nature required final causes, then the argument seems quite reasonable. The epistemological claim that "art imitates nature" requires the existence of order in nature. If Aristotle is claiming that order requires final causes, he may have made his case.

Someone might object that Aristotle's next statement suggests he cannot have the epistemological sense in mind. Aristotle goes on to say, "if things made by nature were made not only by nature but also by art, they would come to be in the same way as by nature" (199a13-14). If art imitates nature means the arts learn their method from nature, then why have we not learned how to produce them? But this suggestion reflects a much more optimistic view of our ability to learn than Aristotle would admit. He

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[79] καὶ εἰ ἐνῆν ἐν τῷ ξύλῳ ἡ ναυπηγική, ὁμοίως ἂν τῇ φύσει ἐποίει· ὥστ' εἰ ἐν τῇ τέχνῃ ἔνεστι τὸ ἕνεκά του, καὶ ἐν τῇ φύσει. Μάλιστα δὲ δῆλον, ὅταν τις ἰατρεύῃ αὐτὸς ἑαυτόν· τούτῳ γὰρ ἔοικεν ἡ φύσις.

thinks the arts progress, and so Aristotle would think there is some time at which human art does not yet know how to produce something it will know how to produce. This does not suggest nature is not our teacher. It simply suggests we are slow learners. Before medicine existed, health may have seemed to be something that only nature could produce, or something that simply came about by luck or by chance. But the Hippocratics observed that there was an order and regularity, not only to instances of health, but even to disease. Medicine had discovered its methods by imitating this order—by inquiring into what health is and into how and when it comes about naturally. Imitating this process meant learning how it worked, and they were able to "complete what nature cannot bring to a finish" because they came to understand the causes that produced it.

4.5 Conclusion

I want to make two brief remarks about what this study suggests regarding Aristotle's approach to method in natural science. First, it suggests one way Aristotle was trying to respond to Plato's view that art and reason were prior to things in the natural world, but also the sources of our knowledge about the natural world. Aristotle, instead, wants to maintain that nature can be the subject of a science, and so is, in virtue of itself, knowable. He also maintains Plato's conclusions that nature exhibits a teleological order. But Plato believed that understanding this order required understanding the model that the demiurge looked to in creating it. Aristotle, however, thinks we do not need to posit a separately existing model to ground our understanding of the natural world (*Physics* II 2, 194b10-15). Aristotle thinks if we admit that "art imitates nature," then this is sufficient to show that nature is sufficiently intelligible without needing to posit or consider external causes or sources of its intelligibility.

In addition, this study suggests that Aristotle, in trying to respond to Plato, found it useful to adopt arguments from a different tradition. He also needed to adopt a method of inquiry in natural science, and he adopted one that Plato himself used to motivate a scientific art of rhetoric. And this, in turn was the method the Hippocratic authors used in order to motivate a scientific art medicine. The method involves, as the author of *On the Sacred Disease* asserts, that we can discover the nature (φύσις) and causes (προφασείς) of things with sufficient experience. Aristotle suggests that, since art imitates natural processes, we can use artistic processes like cooking to understand natural processes: "there is no difference in artificial and natural *instruments* [οὐδὲν διαφέρει ἐν ὀργάνοις τεχνικοῖς καὶ φυσικοῖς] whenever something comes to be, since they all will exist because of the same cause" (*Meteorology* IV 3, 381a9-12). The ends of art and nature may be different, but Aristotle thinks the instruments with which they produce their effects will be similar, since we acquired understanding of how to use those instruments by observing nature in the first place. And it seems that Aristotle is willing to use artistic means to inquire into natural phenomena, since he uses concoction or cooking as a metaphor to speak about a whole range of physical processes in both art and nature.[80] A study of how Aristotle uses the analogy of art as a way of inquiring into nature, of "reverse-engineering" processes in nature that are hidden from observation, is the subject for further study. But here lies Aristotle's insight into the relation between art and physics as sciences: our knowledge of either depends on the other.

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[80] Lloyd (1996), *Aristotelian Explorations*, especially chapter 4, "The Master Cook", 83-103.

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