Part II

Teleology

Chapter 5

"And These Things Follow":

Teleology, Necessity, and Explanation in Aristotle's Meteorologica

Aristotle's *Meteorologica* seems to be completely free of teleology, offering solely mechanistic explanations for meteorological phenomena.[1] In fact, Aristotle uses no teleological language in the entire treatise. In this paper, I argue that there is nonetheless an important explanatory role for teleological processes to play in the treatise, and I detail this role on analogy with the biological works.

Section I offers *prima facie* evidence that the explanations found in the *Meteorologica* should fit into *De Partibus Animalium*'s model of explanation in natural science. Section II begins to fill out the model of explanation by showing that the ultimate *explanantia* in meteorology – the elemental cycles of generation – are the inorganic analogues of the ultimate *explanantia* in biology, which are the organic generative processes including "man generates man." Not only do the inorganic and organic generative processes play analogous roles as ultimate *explanantia* within their subfields of natural science, but when they are viewed as *exaplananda* from the cosmic perspective taken up in the *Metaphysics*, we can observe their common causal etiology grounded in their relationship to the prime mover. Section III, nonetheless, reveals an important disanalogy between the inorganic and organic generative processes that plays out in the way the inorganic and organic subfields of natural science fill out the model of

---

[1] For a recent example of this interpretation, see Wilson (2014, Ch. 5).

explanation in natural science. This difference explains why the biological works such as *De Partibus Animalium* use teleological language, while the *Meteorologica* does not. Finally, Section IV shows the explanations found in the *Meteorologica* to fit the inorganic schema of natural scientific explanation suggested in Section III, thereby explaining why teleological processes play an important role in meteorological explanation despite the fact that no teleological language is used in the treatise.

Section I. Three Kinds of Explanation in Natural Science

This section offers *prima facie* evidence that the explanations found in the *Meteorologica* fit *De Partibus Animalium*'s model of explanation in natural science. Not only does the *Meteorologica* locate itself within natural science and claim to share a method (τὸν τρόπον; 339a7) with the biological works, *De Partibus Animalium* claims its method (τὸν τρόπον; 640b3–4) of natural scientific explanation should apply to all natural things (πάντων τῶν φύσεισυνισταμένων; 640b4). This would include the natural elements (*Phys.* II.1, 192b9–11) whose generations and movements are the subject of the *Meteorologica*. With this *prima facie* evidence in hand, the rest of my paper argues that the model of natural scientific explanation set out in *De Partibus Animalium* is indeed the model followed in the *Meteorologica*.

Let us begin with the *Meteorologica*. Situated squarely within the science of nature – commenced in *Physics*, followed by *De Caelo*, *De Generatione et Corruptione* and carried through the biological works – the *Meteorologica* concerns *ordered*, *natural* phenomena, albeit ones that fall short of the order of the heavenly bodies. Aristotle highlights the unity among all the natural scientific investigations, and asserts, in particular, that the method (τὸν τρόπον; 339a7) followed in the *Meteorologica* will be used in the biological works:

> We have already discussed [in *Phys.*] the first causes of nature, and all natural motion, also [in *DC* I and II] the stars ordered in the motion of the heavens, and [in *DC* III and IV and *GC*] the corporeal elements – enumerating and specifying them and showing how they change into one another – and becoming and perishing in general. There remains for consideration a part of this inquiry which all our predecessors called meteorology. It is concerned with events that are natural (κατὰ φύσιν), though their order is less perfect than (ἀτακτοτέραν) that of the first of the elements of bodies. … When the inquiry into these matters is concluded let us consider what account we can give, in accordance with the method (τρόπον) we have followed, of animals and plants, both generally and in detail. When that has been done we may say that the whole of our original undertaking will have been carried out (τῆς ἐξ ἀρχῆς ἡμῖν προαιρέσεως πάσης) (I.1 338a20-b4, 339a6–9).[2]

Here, Aristotle clearly indicates his "method" (τρόπον) is applied in consistent manner to all the subjects of natural science. Since *De Partibus Animalium* illuminates Aristotle's approach to natural scientific subjects in greater detail than the *Meteorologica*, we will examine this text to gain a greater understanding of the particularities of his method. *De Partibus Animalium* explicitly states that its explanatory method (τὸν τρόπον; 640b3–4) applies to *all natural things*, reassuring us that this method applies to the investigation of meteorological phenomena as well. Aristotle's general approach to natural science is detailed in the following passage from *De Partibus Animalium* I.1. Beginning with the claim that in nature, as in house-building, the coming-to-be of parts should be explained by reference to the form that is being realized, Aristotle continues:

---

[2] All translations are from Barnes (1984), unless otherwise noted.

> [P]ropagation implies a creative seed endowed with certain powers. … For (γὰρ) man is generated from man; and thus (ὥστε) it is because the parent is such and such that the generation of the child is thus and so. … Hence [*a*] it would be best to say that, since (ἐπειδὴ) this is what it is to be a human being, on account of (διὰ) this it has these things; for it cannot be without these parts. [*b*] If one cannot say this, one should say the next best thing, i.e. either that in general it cannot be otherwise, or that at least it is good thus. [*c*] And these things follow (ταῦτα δ᾽ ἕπεται). And since it is such, its generation necessarily happens in this way and is such as it is. (This is why this part comes to be first, then that one.) And in like manner one should speak in precisely this way about all of the things constituted by nature (καὶ τοῦτον δὴ τὸν τρόπον ὁμο ί ως ἐπὶ πάντων τῶν φύσει συνισταμένων) (640a23-b4).[3]

The approach is teleological: the empirical fact that "man generates man" *implies* (signaled by his use of "for" (γὰρ) and "thus" (ὥστε) (640a25–26)) that the (male) parent animal has a creative seed with the power to produce an offspring of the same form. The parts of humans are explained teleologically by reference to this form (signaled by the use of "since" (ἐπειδὴ) and "on account of" (διὰ) (640a34–35)); thus, Aristotle's teleological explanation of the parts of animals takes the fact that "man is generated from man" as the ultimate *explanans*: given that man generates man, we can understand every step of that generative process by reference to the fact that another man is being generated.

Aristotle's approach identifies three different forms of explanation, marked in the passage as [*a*], [*b*] and [*c*]. Drawing on examples throughout *De Partibus Animalium*, Mariska Leunissen illuminates the nature of the explanations distinguished here in I.1.[4] "Primary teleological explanation" (labeled as

---

[3] Trans. Lennox (2001), modified.

[4] Leunissen (2010, 81–99).

[*a*] in the passage) explains the presence of a part as being necessary for there being something of that form ("it cannot be without these parts"). Paradigmatic examples include the heart and liver, which are vital for blooded animals (*PA* II.1, 647a35-b8; III.4, 665b10–15; IV.3, 677a36-b5), and fins, which are essential to fish, given that it is "in accordance with their essential substance they are swimming animals … and since they are made for swimming they have fins" (*PA* IV.13, 695b17–26).[5] What she calls "secondary teleological explanation" ([*b*] in the passage) is that which explains the presence of "subsidiary" parts, which are necessary ("cannot be otherwise") and support the functioning of the primary parts (for instance, the kidneys support the bladder (*PA* III.7, 670b23–27)), and of "luxury" parts such as nails, hair, hoofs, horns, beaks, and spurs of cocks (*GA* II.6, 745a1–2), which are neither primary parts nor support the functioning of the primary parts, but are "at least … good thus" insofar as they contribute to the well-being of the animal.

Drawing on *De Generatione Animalium* II.6, Leunissen argues[6] that the primary parts are made first out of the best nutriment, the secondary subsidiary parts are made second out of the inferior nutriment (745a3), and the secondary luxury parts are made third out of the residues leftover from the process of making these other parts. The formal nature of the animal, like a good housekeeper, "is not in the habit of throwing away anything from which it is possible to make anything useful" (744b16–17), and makes the best use of the nutriment as well as the leftovers from the part-making processes. Nonetheless, the formal nature cannot make use of every bit of material, and dregs remain after the formal nature has picked through the leftovers. As necessary byproducts of the formation of the primary and secondary parts, these dregs have no teleological explanation. All Aristotle can offer by way of explanation is that "these things follow (ταῦτα δ᾽ ἕπεται)" ([*c*] in the passage), which Leunissen

---

[5] These and other examples are cited by Leunissen (2010, 85ff).

[6] Leunissen (2010, 81–84).

thinks "could refer to a third form of explanation in which references to teleology are completely absent."[7]

I think we should be confident that this is indeed a third form of explanation, since it alone fits Aristotle's explanation of biological byproducts, such as the spleen, bile, and residues of the gut and bladder (III.7, 670a30ff.), but this is where I will part from Leunissen's theory. Aristotle's explanations concerning these byproducts support the claim that "and these things follow" explanations are not *themselves* teleological, and yet, the text casts doubt on Leunissen's suggestion that such explanations do not even *reference* teleology. On my interpretation, "and these things follow" explanations *must* refer to teleology: These things follow … what precisely? They follow from teleological processes. Bile is a case in point:

> When [bile] is present in the region of the liver it is a residue and not for the sake of anything; just as is the case with the excretions of the stomach and intestines. For though even the residua are occasionally used by nature for some useful purpose … we must not in all cases expect to find such a final cause; for granted the existence of this or that constituent, with such and such properties, many results must ensue as necessary consequences of these properties (*PA* IV.2, 677a14–19).

After explicitly denying that bile has a teleological explanation, because the formal nature can make no "useful purpose" of such dregs, Aristotle goes on to *reference* the teleological functioning of the liver in order to explain the location and production of bile. Given that blood is sometimes "less pure in composition," there must be an organ in blooded animals to purify the blood by excreting bile (677a26). There are only two vital organs that all blooded animals share – the liver and heart – and the

---

[7] Leunissen (2010, 98).

heart is "unable to stand any violent affection [and] would be entirely intolerant of the proximity of such a fluid," so Aristotle concludes that the liver is the organ to serve this purification function ("none other should have an excretion as the bile") (*PA* IV.3, 677a19-b10). Thus bile is where it is (next to the liver, instead of next to the heart), because the liver serves the function of purifying the blood. And the liver, as a primary part, serves this function so that the animal can live. Indeed the animal's length of life depends on the well-functioning of the liver (677b1–2). Thus, Aristotle's explanation of bile seems to fit the "and these thing follow" form of explanation: although bile does not itself have a function, its production and location are explained by an indispensable reference to the liver's teleological operations.

As indicated above, the significance of this explanatory approach extends beyond *De Partibus Animalium.* Although the discussion above takes as its immediate concern *biological* explanations, Aristotle concludes the passage by insisting that "in like manner one should speak in precisely this way about all of the things constituted by nature (καὶ τοῦτον δὴ τὸν τρόπον ὁμο ί ως ἐπὶ τάντων τῶν φύσει συνισταμένων)" (*PA* 640b3–4).[8] Given that these explanations apply to *all natural things*, I therefore propose naming these "three forms of natural scientific explanation" to signal their intended broad scope. *Prima facie*, then, they provide the explanatory schema for the *explananda* of the natural scientific treatises. In what follows I show the *Meteorologica* to be such a treatise.

Section II: "Man Generates Man" and Its Meteorological Analogues

The previous section provides at least *prima facie* evidence that the explanations found in the *Meteorologica* should fit into *De Partibus Animalium*'s model of explanation. This section will begin to

---

[8] Trans. Lennox (2001).

fill out the explanatory schema for the *Meteorologica* by arguing that the elemental cycles of generation are the analogues of "man generates man." The analogy can be drawn from two perspectives. First, within the natural scientific subfield of meteorology, the elemental cycles are introduced as ultimate *explanantia*, just as within the natural scientific subfield of biology organic generative processes (such as "man generates man") serve as the ultimate *explanantia*. Second, from the cosmic perspective adopted by texts such as the *Metaphysics*, the inorganic (the elemental cycles) and organic generative processes (such as "man generates man") come into view as *explananda* that take the prime mover as their efficient and final cause. I thereby suggest that the ultimate *explanantia* in the subfields of natural science are the teleological, generative processes that are themselves explained by their relation to the prime mover, a relationship we comprehend only from the cosmic perspective.

Let us begin with the first perspective from within the subfield of the natural science of meteorology. The cycles of elemental transformation (or in my terminology, "originative cycles") are introduced when Aristotle takes up his first subjects of meteorological explanation in I.4:

> The origin (ἀρχὴ) of these and many other phenomena is this. When the sun warms the earth the exhalation (ἀναθυμ ί ασιν) which takes place is necessarily of two kinds, not of one only as some think … That which rises from the moisture contained in the earth and on its surface is vapour (ἀτμ ί δα), while that rising from the earth itself, which is dry, is like smoke (καπνώδη) … [T]he windy exhalation, being warm, rises above the moister vapour, which is heavy and sinks below the other.
>
> Hence the world surrounding the earth is ordered as follows. First below the circular motion comes the warm and dry element, which we call fire, for there is no word fully adequate to every state of the smoky evaporation; but we must use this terminology since this element is the most inflammable of all bodies. Below this comes air. We must think of what we just called fire as being spread round the terrestrial sphere on the

> outside like a kind of fuel (ὑπέκκαυμα), so that a little motion often makes it burst into flame just as smoke does; for flame (φλὸξ) is the ebullition of a dry exhalation. So whenever the circular motion stirs this stuff (σύστασις) up in any way, it catches fire at the point at which it is most inflammable (I.4 341b6–24).

In this passage, Aristotle seeks to identify the origin (ἀρχὴ) of meteorological phenomena in two "originative" cycles of elemental transformation. The sun warms the earth (cold and dry) and transforms it into a dry exhalation (hot and dry), which rises to the top and is ignited by the movement of the celestial bodies. As I will argue, earth's transformation into fire can be seen to compose one leg of an earth-fire cycle. But, more clearly, Aristotle understands air and water to form an originative cycle: the summer sun warms the water (cold and wet) and transforms it into a wet exhalation (hot and wet). When the sun recedes in the winter and the exhalation is thereby cooled, it transforms back into water (cold and wet) and falls back to the ground, thereby forming a water-air cycle:

> For the sun as it approaches or recedes, obviously causes dissipation and condensation and so gives rise to generation and destruction. … So we get a circular process that follows the course of the sun. For according as the sun moves to this side or that, the moisture in this process rises or falls. We must think of it as a river flowing up and down in a circle made up partly of air, partly of water. When the sun is near, the stream of vapour flows upwards; when it recedes, the stream of water flows down; the order of sequence, at all events, in this process always remains the same (I.9, 346b21–347a6).

The other originative cycle of earth-dry exhalation-fire (hereafter called simply the "earth-fire cycle") is less obviously cyclical. Aristotle only details one leg (the upward direction) of this originative cycle: the sun transforms earth into dry exhalation that rises to the top and bursts into flames by the friction

caused by the superlunary motion. Given that the sun and other heavenly bodies regulate these transformations, the process is regular: the dry exhalation is "continually and ceaselessly (συνεχῶς καὶ ἀεὶ)" collecting in the upper region (I.8, 346a 23) and "at each revolution of the heavens (καθ᾽ ἑκάστην περ ί οδον)," it is ignited (I.8, 346b8–10). Although Aristotle does not focus on the downward progression of this cycle (fire to earth), there is at least some evidence that he thinks this downward direction exists: in II.3 he includes fire, along with air and water, as that which is "involved in a process of perishing and becoming which yet affects them all in a regular course" (II.3, 357b27–358a7). In the case of water and air, Aristotle is certain that "all that is carried up is returned" (355a23–4) since "we always plainly see the water that has been carried up coming down again" (355a25–6). So perhaps Aristotle does not detail the downward leg of the earth/fire cycle since, unlike in the case of the water-air cycle, we do not have observational data to rely on. Perhaps the downward leg is not a meteorological phenomenon.

But neither is a defense of the downward leg of the cycle dialectically required. Aristotle details one cycle of water-air in response to two groups of predecessors who shared a non-cyclical, linear conception of elemental change: the first group thought that rivers and winds issued forth from a reservoir of ready-made material, and the second group, the entropists, thought that the earth was undergoing an irreversible process of desiccation. By contrast, when Aristotle describes the process of earth's transformation into fire, instead of arguing against predecessors who insist the process is linear, here, as Malcolm Wilson points out,[9] his target is Anaxagoras. Anaxagoras's theory of meteors contradicts the paradigm example in *Physics* II.1 of natural elemental movement – that of fire moving upwards (193a1). To preserve the natural movement of fire upwards in the face of fire's apparent horizontal movement in the form of meteors and comets, Aristotle argues that the apparent horizontal

---

[9] Wilson (2014)).

movement of a comet is actually like fire sweeping across a field of stubble, the sequential production and ignition of dense heaps of exhalation by the moving planets and stars. Hence, the details of the downward arm of the earth-fire cycle are not dialectically required, because the importance of the question at hand is not the cyclical nature of the process. Although more could be said, I will regard it as established that there are at least two originative cycles within Aristotle's account of the origins of meteorological phenomena, and will refer to the plural, "originative cycles."

The movement of the sun is said to regulate both of the cycles I have described. The claim in *Meteorologica* I.2 that "this world" derives "all its power" from the superlunary motions (339a20–33) applies this point more broadly, and refers to the claim in *Physics* VIII that the prime mover is the ultimate efficient cause of all things. Identifying the sun as the immediate efficient cause of elemental transformation, Aristotle shows that the orderliness of the superlunary processes is translated down *via* the circle of the sun into to the regularity of the sublunary originative cycles: "The efficient and chief and first of the principles is the circle in which the sun moves" (I.9, 346b20–21).

The *Meteorologica* affords us only a glimpse of the cosmic perspective which brings into view the causal relationship the originative cycles bear to the prime mover, for the task of the *Meteorologica* is to explain phenomena by reference to the originative cycles, not to explain the originative cycles' causal relationship to the prime mover. That is, the text introduces the originative cycles as ultimate *explanantia*, not as *explananda*. Likewise, as we have seen, "man generates man" is introduced in *De Partibus Animalium* as the ultimate *explanans*, not as an *explanandum*. The cosmic perspective adopted in texts outside the *Meteorologica* and *De Partibus Animalium* affords us a view of the generative cycles as *explananda* themselves: from the cosmic perspective we see that the non-biological originative cycles share an efficient and final causal etiology with biological generative processes such as "man generates man."

Just as *Meteorologica* I highlights the fact that the originative processes are efficiently caused by regular movement of the sun along the ecliptic, *De Generatione et Corruptione* identifies the sun as the efficient cause of "man generates man," a point Aristotle highlights several times throughout his corpus: "since the upper movement is cyclical, the sun moves in this determinate manner; and since the sun moves thus, the seasons (ὧραι) in consequence come-to-be in a cycle, i.e. return upon themselves; and since they come-to-be cyclically, so in their turn do the things whose coming-to-be the seasons initiate [e.g., plants and animals]" (*GC* II 11, 338b3–5; see also *DC* II 3, 286a13–286b2). This is the sense in which "man is begotten by man and by the sun as well" (*Phys.* II 2, 194b13): the sun is the efficient cause of the seasons, and the seasons provide living things with nutrients required for generation and growth.

It is clear that the originative cycles and the generation of man share the sun as their efficient cause. But while the argument in *Meteorologica* I.4 is concerned with this efficient causal dependence on the movement of the sun, and ultimately on the activity prime mover, we should not mistake this focus to exclude the possibility that the originative cycles are also teleological. The cosmic perspective shows that just as "man generates man" takes the sun, and ultimately the prime mover, as its (remote) efficient causes, it also takes the prime mover as its *final* cause. These same texts suggest that the originative cycles share this final causal structure with their biological analogues: the prime mover is the final cause of *both* the biological and the non-biological generative processes. In what follows, I review select passages that illuminate this point.

According to the conception of natural teleology in *Physics* II, nature acts for something and because it is better (II.8, 198b17–18). Given that plants, animals, and the elements have a nature (*Phys.* II.1, 192b9–11), they have teleological direction. Although artifacts such as beds and houses enjoy a teleology afforded to them by their creators (for example, beds are for supporting sleepers), all natural things exhibit a distinctive teleology at the level of generated wholes, a distinction Aristotle marks in

his argument in *Physics* II.1 against materialist predecessors such as Empedocles: "man is born from man but not bed from bed" (193b9–10). Thus, the teleology distinctive of natural things is that of continuous generation, for nature is distinguished from art by an *internal* principle of "production (ποιήσεως)" (*Phys.* II 1, 192b30).

The teleology of continuous generation is focused on imitating the highest good in the cosmos, the prime mover, as the "one thing" to which everything in the cosmos bears a relation, as the cosmic perspective of *Metaphysics* XII.10 reveals (1075a17–18). Individuals strive to *be* the prime mover, which is eternal, purely noetic activity. But since they can never successfully achieve this aim, the most they can do is *approximate* it through imitation. The heavenly spheres directly imitate the prime mover's activity by eternally moving in perfect circles; since each point on a circle is as much an end as any other point, circular motion imitates the self-ended activity of the prime mover (*Phys.* VIII.9 265a28-b9, referenced in *Mete.* I.2, 339a25). Plants and animals imitate the eternal actuality of the prime mover by reproducing another of their kind (*DA* II.4 415a25-b7), while the sublunary elements indirectly imitate the prime mover by being part of a cycle that imitates the superlunary circular movements: "we say coming-to-be has completed the circle, because it reverts again to the beginning. Hence (ὥστε) it is by imitating circular motion that rectilinear motion too is continuous" (*GC* II.10 337a5–7).[10] Thus, rectilinear movement is imitative only when and *because* (expressed by ὥστε) it occurs on the heels of another rectilinear movement with which it composes a cycle.

Although the relationship that the sublunary generative processes bear to the prime mover is comprehended from the cosmic perspective of the *Metaphysics*, the *Meteorologica* itself emphasizes the naturalness and regularity that the imitative teleology of *Metaphysics* XII.10 requires. For example, the diurnal and annual cycle of evaporation and condensation are described as the regular course of

---

[10] See also *GC* II 10, 336b25 and 336b32–337a1.

nature – “φύσις” (II.2 354b34), “κατά ί τὴν τάξιν” (I.9 347a6), “κατά τινα τάξιν, ὡς ἐνδέχεται μετέχειν τὰ ἐνταῦθα τάξεως” (II.3 358a26–7), “περιόδου” (I.14 352a31), and “τεταγμένως” (II.3 358a3, quoted above). In addition to the diurnal and annual cycle of evaporation and condensation, Aristotle recognizes a third form of the water-air cycle: “in determined intervals in some great period of time there comes a great winter (μέγας χειμὼν) and with it great excess of rain” (352a29–33; see also II.3 357a2), which is counter-balanced by periods of drought. Once again, the cycle is regular – “περιόδου” (I.14 352a31), “τεταγμένοις” (II.2 355a28; II.3 358a3, quoted above), “κατὰ κύκλον” (II.3 357a2), “κατὰ ί τινὰ τάξιν ί καὶ περ ί οδον” (I.14 351a26 and 352b16) – and natural (φυσικὴν I.14, 351b8–14; see also II.3, 359b23–6). This emphasis on naturalness and regularity suggests that the imitative teleology of *Metaphysics* XII.10 is at play in the background.

Thus, I have argued that the cosmic perspective shows us that the biological and non-biological generative processes are *explananda* with the same final and efficient explanations, an etiology reflected in the *Meteorologica*'s emphasis on the originative cycles' naturalness and regularity. And just as *De Partibus Animalium* shows “man generates man” as the ultimate *explanans* within the natural scientific subfield of biology, we have seen the originative cycles introduced as the ultimate *explanantia* in the natural scientific subfield of meteorology. The suggestion, then, is that the processes that serve as ultimate *explanantia* within a subfield of natural science are the generative processes explained by their teleological relationship to the prime mover from the cosmic perspective.

Section III: The Disanalogy Between Inorganic and Organic Generative Processes

Section II argued that the biological and non-biological processes of generation are the same sort of *explananda* from the cosmic perspective and, in turn, play an analogous role as ultimate *explanantia* within their respective subfields of natural science. This section points out an important disanalogy

between organic and inorganic generative processes. I first illuminate the disanalogy from the cosmic perspective and then return to the subfields of biology and meteorology to show how the disanalogy plays out in the particular ways each subfield fills out the model of natural scientific explanation examined in Section I.

Let us begin, then, with the cosmic perspective. As we have seen, all sublunary generation aims to imitate the activity of the prime mover, however, Aristotle insists that the greater and lesser extents to which individuals partake in the divine creates a hierarchy of beings stretching from the heavenly bodies – which are "more divine" (I.2 269a32–3) since they have "a higher nature" (I.2 269b16–7) – all the way down to the sublunary elements, which *De Caelo* II.12 confirms, "share in the divine source (τυχεῖν τῆς θειοτάτης ἀρχῆς)" (292b17–25). *De Generatione Animalium* II.1 corroborates this ranking: beginning at the top of the *scala naturae*, Aristotle places the heavenly bodies (both living and eternal), then living things (living but not eternal), and finally the sublunary elements (neither living nor eternal) (731b24–732a1). The household analogy of *Metaphysics* XII.10 alternatively calibrates the hierarchy according to regularity: the heavenly bodies are to the sublunary elements as the freemen are to the slaves and beasts insofar as the heavenly bodies "have least license to act as they chance to, but all or most of what they do is arranged (τέτακται)," while the sublunary elements "can do a little towards what is communal, but act mostly as they chance to" (1075a19–22; see also *DA* II 4, 415b4–6).[11] The introduction to the *Meteorologica* confirms this contrast in regularity: the sublunary elements exhibit a "regularity less (ἀτακτοτέραν) than" the heavenly bodies moving in a circle (*Mete.* I 1, 338a20-b4). Calibrating the *scala naturae* according to regularity comes to the same thing as calibrating it according to divinity or "goodness": since the prime mover is the best thing in the cosmos,

[11] Trans. Sedley (2000, 328).

the more closely something approximates its activity, the better it is; and the more closely it approximates the prime mover, the more regular and uninterrupted its activity.

This difference in degree of regularity exhibited by the generation of elements and living things can explained by the difference in formal natures involved in each generative process. *Physics* II.1 defines nature as a "source of movement" (ἀρχή κινήσεως), and maintains that both living things and sublunary elements have a nature (II.1, 192b9–11). However, *Physics* VIII.4 goes on to suggest that "movement" (κινήσεως) is ambiguous between the active (κινεῖν) and passive (κινεῖσθαι) senses. While self-moving living things have a source of moving (an ἀρχή τοῦ κινεῖν), sublunary elements' nature is a source of suffering (an ἀρχή τοῦ πάσχειν 255b31), which can be understood as a source of being moved (ἀρχή τοῦ κινεῖσθαι), in keeping with the II.1 definition.

Physics VIII.4 further maintains that the elements are passive not only with respect to their transformation into one another, but also with respect to their movement into natural place. Their generator is responsible for both their generation and their movement. Aristotle arrives at this claim in the course of arguing for the conclusion that everything that moves is moved by something (255a1–6). Initially puzzled by what moves the elements since they have no parts and thus cannot move themselves, Aristotle traces the confusion to the failure to recognize that "potentiality is said in various ways" (255a30). Once we distinguish the two sorts of potentiality – the second potential to move into natural place and the first potential to come to be – we see that movement is the *second* phase of a single two-phase process (of which coming to be is the first stage). Once we realize that the two phases compose a single process, it is clear that the generator is the efficient cause of elemental movement into natural place: the chapter concludes, "[t]he light and the heavy... [are moved] by the thing that has generated and has made them light or heavy" (256a1–3). While we had trouble identifying the efficient cause of elemental movement into natural place (the second phase), it is clear that the efficient cause of the first phase is the generator of the elements. Although Aristotle does not mention what this

generator is (since all that matters for his purposes here is that there is one), the *Meteorologica* is clear that at least *a* generator is the sun moving along the ecliptic (I.9 346b22 and *GC* II.10 336b6–7).

Although our analysis at the beginning of this section suggested that living things and elements share an efficient causal etiology traced back to the sun as their generator, this *Physics* VIII.4 distinction between active and passive natures explains the difference registered by their respective places on the *scala naturae*, where the living ranks above the not living (*GA* II.1 731b24–732a1). As we saw in Section I, *De Generatione Animalium* II.6 personifies the formal nature of a living thing as a good housekeeper that does its best to make use of the materials at hand. Although the offspring takes the father, and (remotely) the sun, as its generator, the offspring's active formal nature continues to make use of nutriment and leftovers to form and grow parts even after birth and into old age (*GA* II.6, 744b31–745a18). Making use of such materials, an animal can not only live, but live well and ever better, thereby actualizing its nature to higher degrees, the apex of which is generating another of its own kind in imitation of the prime mover. Living things' active natures are, moreover, able to refashion their initial byproducts into teleologically-directed subsidiary and luxury parts. For example, hair comes to be as a materially-necessitated byproduct of the development of vital organs. Instead of letting that hair go to waste, the organism actively co-opts the hair for the sake of protection against heat and cold.[12] This refashioning requires the kind of active nature unique to self-moving living things.

By contrast, the elements are utterly passive with regard to the timing and location of their generation and are unable even to stop themselves from moving (*Phys.* VIII.4, 255a8–11). The elements cannot have the active nature of self-movers precisely because they have no parts: "[N]one of these things move themselves – for they are naturally unified (συμφυῆ) – nor does anything else that is continuous" (255a15–16). Insofar as the elements enjoy a more immediate relation to the superlunary

---

[12] See Leunissen's description of secondary teleology (2010, 81–99).

order of the sun than living things do, the elements' passivity is an asset: the sun's orderly approach and retreat ensures that air's upward rectilinear movement will be preceded and followed by water's downward rectilinear movement to form an imitative cycle (*GC* II.10 337a5–7; *Mete.* I.9 346b16–347a6), while the sun's orderly movement has a more indirect influence on living things insofar as it must be mediated through organisms' use of the food that the seasons provide (*GC* II 11, 338b3–5). However, much of the meteorological phenomena that occur simply follow from the originative cycles as byproducts, which the passive natures of the elements are unable to refashion into anything useful for the purpose of imitating of the prime mover.

Now we are in a position to see how this difference in active and passive natures, rooted in the difference between being an entity composed of parts and an element that is a partless whole, impacts the kinds of explanations that can be given in the biological and non-biological subfields of natural science. Recall the three forms of natural scientific explanation as they apply to organic things: man generates man (its teleology in view only when seen as itself an *explanandum* from the cosmic perspective), therefore he has (1) these vital and necessary parts (primary teleological explanation), and (2) these subsidiary and luxury parts (secondary teleological explanation), and (3) "and these things follow" (the third, non-teleological explanation). But as utterly passive and without parts, the elements have no parts to be explained by primary and secondary teleology, and thus the explanatory schema can have no analogue of the first and second sort of explanation, but could only have an analogue of the third, filling out the explanatory schema as follows: originative cycles (its teleology in view only when seen as *explananda* from the cosmic perspective) "and these things follow" (the third, non-teleological explanation). Given that the originative cycles are themselves teleological, we can make sense of Section I's suggestion that although "and these things follow" explanations are not *themselves* teleological, these explanations nonetheless *must* refer to teleology: These things follow … what precisely? They follow from teleological processes. As teleological processes, the originative

cycles can explain the phenomena that result from them, even though those phenomena are not themselves teleologically directed. At the same time, filling out the schema in this way would make sense of the fact that the *Meteorologica* uses no teleological language: "and these things follow" explanations are not themselves teleological, and thus we should expect no teleological language to be used in describing them. Interestingly, neither should we expect to find teleological language used to describe the originative cycles from which they follow, for the teleology of the originative cycles is not established within of the subfield of meteorology, but only in texts that take on the cosmic perspective from which these cycles are themselves viewed as *explananda*. We saw the teleology of organic generative processes ("man generates man") to be established by the cosmic perspective, not within the subfield of biology set out in *De Partibus Animalium*. Insofar as *De Partibus Animalium* uses teleological language, then, it is used in primary and secondary teleological explanations that have no counterpart in the subfield of meteorology.

Thus, establishing the details of imitation based on the activity of the prime mover seems to be out of place in both the *Meteorologica* and *De Partibus Animalium*, and we might even suggest that it is out of place in natural science more generally, despite some notable exceptions.[13] It seems that Aristotle's usual practice conforms to his proposal in the *Physics*: the "student of nature" needs to know the form "up to the point" of knowing that "man is begotten by man." Beyond that, knowledge of the prime mover as form is "the business of first philosophy to define" (I.2, 194b10–15).[14] In keeping with this suggestion, perhaps just as it is outside the purview of the natural science of *De Partibus*

---

[13] For example, see *DG* II.1.

[14] Through a close reading of *Physics* VIII, *De Motu*, and *GC* I-II, Andrea Falcon argues persuasively that Aristotle "enforc[es] the division of labor between physics and metaphysics" (forthcoming).

Animalium to consider form beyond the point of "man generates man," it is outside the purview of the natural science of meteorology to consider form beyond the point of the originative cycles.

In summary, I suggest that we should fill out the picture of natural scientific explanation as it applies in the fields of biology and meteorology as follows:

Table 1

Three Forms of Natural Scientific Explanation Applied to Biology and Meteorology

Forms of Explanation	Text: *PA* I.1, 640a25-b1	Biological Explanation	Biological *Explananda*	Meteorological Explanation	Meteorological *Explananda*

Primary Teleological Explanation	"For (γὰρ) man is generated from man; and thus (ὥστε) it is because the parent is such and such that the generation of the child is thus and so. Hence it would be best to say that, since (ἐπειδὴ) this is what it is to be a human being, on account of (διὰ) this it has these things; for it cannot be without these parts."	1. Man generates man. (Or its equivalent). The ultimate explanans. 2. The (male) parent animal has a creative seed with the power to produce an offspring of the same form (implied by 1). 3. The offspring's parts come to be out of the best nutriment for the sake of realizing this form.	Vital and essential parts (e.g., the heart and liver are vital parts in blooded animals, and fins are essential parts in fish).	1. Originative cycles of a) fire-earth and b) air-water. The ultimate meteorological explanantia. 2. The elements have passive natures and are thereby such as to be transformed in due season by the sun in its circular course. 3. There is no analogue to primary teleological explanation because the elements have no parts to explain.	None

Secondary Teleological Explanation	"If one cannot say this, one should say the next best thing, i.e., either that in general it cannot be otherwise, or that at least it is good thus."	4.1. The formal nature uses inferior nutriment to make subsidiary parts that support the vital and essential parts produced according to 3, stated above. 4.2. The formal nature also co-opts the leftovers from processes 3 and 4.1, above, to make luxury parts for the sake of living well by providing further protection or support.	Subsidiary parts (e.g., kidneys, which support the functioning of the bladder). Luxury parts (e.g., nails, hair, hoofs, horns, beaks, and spurs of cocks).	4. There is no analogue to secondary teleological explanation because the elements have no parts to explain.	None
A Third, Non-Teleological Explanation	"And these things follow (ταῦτα δ᾽ ἕπεται)."	5. Dregs remain as the byproducts of the processes described in 3 and/or 4 above.	Parts or residues that do not perform any function (e.g., spleen, bile, and other residues of the gut and bladder).	5. There are byproducts from the processes described in 1a) and b) above.	All meteorological phenomena besides the originative cycles themselves. (See chart II below for examples).

It remains to be seen whether this schema tracks the actual explanations offered in the *Meteorologica* (the task of Section IV). All I have argued so far is that the disanalogy between inorganic and organic generative processes – the difference in their passive and active natures that takes root in their being partless wholes versus wholes of parts – should play out in the kinds of explanations we can expect to find in the biological and non-biological subfields of natural science. Whereas explanations in biology fill out the entire three-part schema of natural scientific explanation, explanations in meteorology are

able to fit only the third "and these things follow" form of explanation. In the next section, I argue that the *Meteorologica* indeed lives up to these expectations.

Section IV: "And These Things Follow" from the Originative Cycles

In this section, I argue that the *Meteorologica* takes the teleology of the originative cycles as given, and shows other meteorological phenomena to follow, as necessary byproducts, from one or both of these cycles. So understood, Aristotle does indeed offer the "and this follows" third type of teleological explanation. Although I only have space to offer a sketch of my position, not a full detailed account, I chart the explanations of phenomena discussed in *Meteorologica* I-III according to my schema as follows:

Table 2

The Phenomena of Meteorologica I-III Indexed by Originative Cycles

Originative Cycle	Meteorological phenomena that are part of the originative cycle and thereby imitative and teleological:	Meteorological phenomena that non-teleologically "follow from" one originative cycle:	Meteorological phenomena that non-teleologically "follow from" the accidental confluence of multiple originative cycles:
Earth/Dry Exhalation/Fire Cycle	Burning flames, torches, goats, shooting stars produced by combustion (I.5, 341b24–35), the Milky Way (I.8, 341b36).	1. Chasms, trenches, blood-red colors (I.6). 2. Shape of the flame (in the form of burning flames, torches, goats, and shooting stars produced by combustion (I.5) and the Milky Way (I.8)), which is determined by the length, breadth and depth of the exhalation. 3. Oblique movement of the winds (II.4, 361a23–5).	1. Shooting stars and thunderbolts "produced not by combustion, but by projection under pressure" (I.5, 342a15–7, see also II.9 370a26–35). 2. Hurricanes (II.9 369a17–25 and III.1 370b5–10). 3. The frequent appearance of comets within the zodiac circle (I.7, 344b28–345a10), due to unusually "excessive" winds (I.7, 344b19–32). 4. Dew formed in Pontus produced by recoil

Water/Vaporous Exhalation/Air Cycle	Three kinds: 1. Diurnal: Nighttime dew and frost (I.10). 2. Annual: Winter rain and snow (I.11). 3. Great cycle: Rivers (I.14) and sea (I.14, 353a23–4, II.1–2).	1. Reflections of vapor, haloes, rainbows and sundogs (III.2–6). 2. Rivers formed by trapped water that then forces its way out (ἀποβιαζομένου 351a7–8).	(ἀντιπερίστασις) (347a35-b7). 5. Hail and summer rain produced by recoil (ἀντιπερίστασις) (I.12). 6. Salinity of the Sea (given its organic analog as a residuum in II.2, 356a36-b3 and II.3, 358a17–27). 7. Earthquakes (II.8, 366a4–5), which are a violent movement of the exhalation (σφοδρότατον 365b32, b33, σφοδρὸν 366a33, ἀποβιάζεσθαι 366b11) because the sun has less power (δύναται) over earthquake winds (II.8, 368b20). Earthquakes' organic analogs are pathological impulses in the body (II.8, 366b15–30). 8. Perhaps also minerals produced by the compression of exhalations enclosed in the earth (III.6 378a15-b6).

As my previous section showed from the cosmic perspective, the meteorological phenomena that compose the originative cycles are teleologically directed at imitating the prime mover. In this section, I aim to show that the other phenomena follow from these originative cycles according to the third, non-teleological, "and these things follow" mode of natural scientific explanation presented in *De Partibus Animalium* I.1. Although I will not be able to detail all of the examples presented above, I illustrate my point by examining two sets of paradigmatic cases.

Let us begin with Aristotle's explanation of winter rain and of summer rain. Winter rain composes an originative cycle with summer evaporation: when the sun recedes in the winter, air transforms into water, which moves downwards, and when the sun approaches in the summer, water transforms into air, which moves upwards. The sun ensures that these rectilinear movements occur on the heels of one another to form an imitative cycle. Summer rain, however, is not generated by the regular cooling due to the sun's annual winter recession, but rather by warmth due to the sun's

proximity (perhaps also conjoined with the heat generated by the ignition of the fires as part of the earth-fire cycle (I.9 346b24)): "in the warmer seasons the cold is concentrated by the surrounding heat and causes the cloud to go over into water suddenly" (I.12 348b6–8). Aristotle's explanation of summer rain relies on details of the originative water-air cycle: *regularly* in the summer the sun generates air, which rises and forms clouds, which *regularly* do not condense back into water until the sun recedes in the winter. However, this time something unusual happened: the heat of the summer sun surrounded the cloud and forced it to cool and condense into water out of season. Without reference to the originative cycle, Aristotle could not explain when and why this phenomenon took place, for the originative cycle explains the presence and location of the cloud and the heat in the first place. (Recall Aristotle's explanation of bile in Section I.) Summer rain, then, simply follows from the unusual interaction between factors that usually contribute to an imitative cycle of elemental transformation. Since summer rain is generated as a result of this unusual confluence of factors, it has no generator to ensure its downward rectilinear movement will occur on the heels of the upward rectilinear movement of air. Thus, summer rain is a non-imitative rectilinear dead-end, what Aristotle calls "violent rain" ("ὗδατα λαβρότερα," 348b11, 348b23 or "ῥαγδαῖα" 349a7), thereby contrasting it with its teleologically-imitative counterpart, winter rain.[15]

Just as Aristotle sharply contrasts the production of winter rain and summer rain, he distinguishes shooting stars produced as part of the originative cycle from shooting stars produced by ejection occasioned by the accidental confluence of the water-air with the earth-fire cycles. Regularly, as part of the originative earth-fire cycle, the superlunary bodies cause shooting stars to be "formed in

---

[15] As previous papers of mine argue in depth, the best reading of *Physics* II.8 shows Aristotle committed to winter rain and summer heatwaves being teleological (on their own and independent of biological processes) and to summer rain and winter heatwaves being accidental (Scharle 2005; forthcoming 2014). My reading is also supported by the Arab commentary tradition on the *Meteorologica.* See Lettinck (1999, 97–119).

the upper region... due to the combustion of the [dry] exhalation" (342a16). However, sometimes shooting stars result ("these things follow") as an accidental byproduct of the confluence of the water-air cycle with the earth-fire cycle:

> When it takes place at a lower level it is due to the ejection of the exhalation by the condensing and cooling of the moister exhalation; for this latter as it condenses and inclines downwards contracts, and thrusts out the hot element and causes it to be thrown downwards (342a16–21).[16]

Once again, Aristotle explains this occurrence by way of a "these things follow" explanation that traces the phenomena back to the originative cycles: as we have seen above, the cooling and condensation of the moist exhalation is a regular part of the water-air cycle, but in this instance the upward movement of earth's dry exhalation, which usually gets combusted and transformed into fire by the superlunary motions, gets caught up in the water-air cycle, thereby taking "a course more like that of a projectile than of a fire" (I.5, 342a2–3). This unnatural direction of fire's movement under ejection, which has no immediate superlunary origin, stands in sharp contrast to the natural upward movement of fire as shooting stars produced by combustion caused by the superlunary motions. Just like summer rain, such accidentally-produced shooting stars are non-imitative rectilinear dead-ends.

This section illustrates that Aristotle does indeed offer the "and this follows" third type of teleological explanation in the *Meteorologica*: he takes the teleology of the originative cycles as given, and shows other meteorological phenomena to follow, as necessary byproducts, from one or both of these cycles. Although I do not have the space to demonstrate this for all of phenomena catalogued

---

[16] See also II.9 370a26–35; and hurricanes at II.9 369a17–25 and III.1 370b5–10.

above, it is a significant finding that at least some can be traced back to these two cycles. This shows that teleology can indeed play a role in meteorological explanation.

Section V: Conclusion

This paper suggests a unified theory of Aristotle's treatises. This theory illuminates subtle patterns in the focus and explanatory approach to each subject and explains the lack of teleological language in *Meteorologica.* Scholars have disagreed about the philosophical issue at stake in Aristotle's introduction of formal and final causation on the organic level: one side claims Aristotle's reason was to explain the organic phenomena his opponents tried but failed to explain via elemental material and efficient causation, and the other side claims his reason was to refute a theory on which organic phenomena would fail to be *explananda*.[17] Despite this disagreement, scholars on both sides have been united in assuming that Aristotle's defense of natural teleology solely targets his predecessors' conception of organic phenomena: scholars have believed that while Aristotle agrees with his predecessors that the four elements operate solely by efficient and material causes, he held that the generation of living things requires, in addition, formal and final causes.[18]

My new reading of the *Meteorologica* questions this common assumption. If I am right, my reading of the *Meteorologica* supports Sarah Broadie's suggestion that "natural change is ontologically

---

[17] Anti-reductivist interpreters include Gotthelf (1987; 1997), Charlton (1992), Waterlow (Broadie) (1982), Cohen (1989), Cooper (1982), Charles (1991), Bradie and Miller (1984), and Balme (1987). See Gotthelf (1997) for a useful taxonomy of these views. Anti-eliminativist interpreters include Sauvé Meyer (1992), Irwin (1988), and Johnson (2005).

[18] The following commentators explicitly accept the claim: Cooper (1982, 202); Bradie and Miller (1984, 141); Charles (1988); Lewis (1988, 55); Nussbaum (1978, 55); and Gill (1997, 147). See also Waterlow (Broadie) (1982, 92).

and conceptually presupposed by change of all other types."[19] In the *Meteorologica* we have traced meteorological phenomena back to one or both of the natural, teleological originative cycles. We might go a step further, then, to suggest that *teleological* change – even at the level of the elements – is ontologically and conceptually presupposed by change of all other types. This would show that Aristotle's dispute with his materialist predecessors runs much deeper than scholars have thought.

My interpretation of the *Meteorologica* explains why some scholars might have missed the crucial role teleology plays on the elemental level[20] and why this role is so easy to miss. The *Meteorologica* describes only two teleological cycles by contrast with the many, many teleological processes found in the biological treatises. These two proportions may perhaps be explained by the household analogy of *Metaphysics* XII.10, which suggests that the heavenly bodies "have least license to act as they chance to, but all or most of what they do is arranged (τέτακται)," while the sublunary elements "can do a little towards what is communal, but act mostly as they chance to" (1075a19–22).[21] Living things are able to coopt and refashion byproducts into teleologically-directed subsidiary and luxury parts – something which the elements are denied, possessing solely passive natures. Without this ability, the elements mostly operate as they chance to, which is just what the household analogy suggests. I have argued that what they mostly chance to do – as byproducts – follows from the little

---

[19] Waterlow (Broadie) (1982, 38).

[20] Scholars often think that Aristotle's natural teleology applies exclusively to biological things (plants and animals) and that the elements (earth, air, fire, and water) either are not teleological, or are teleological only insofar as they play a role in biological processes. Gotthelf and Lennox (1987) and Lennox (2001) are paradigmatic examples of the former approach, while Sedley (1991) is of the latter. Notable exceptions include Johnson (2005), Quarantotto (2005), and Leunissen (2010)).

[21] Trans. Sedley (2000, 328). For a fuller discussion of this passage, see Scharle (2008).

they do toward what is communal – as participants in originative cycles – and this fact is significant in showing the priority Aristotle affords teleology even at the level of the elements.[22]

chapter-bibliography

Bibliography

Balme, David. 1987. "Teleology and Necessity." In *Philosophical Issues in Aristotle's Biology*, ed. Alan Gotthelf and James G. Lennox, 9–20. Cambridge, UK: Cambridge University Press.

Barnes, J. (ed.) 1984. *Revised Oxford Translation: The Complete Works of Aristotle*. Princeton: Princeton University Press.

Bradie, Michael and Miller, Fred. 1984. "Teleology and Natural Necessity in Aristotle." *History of Philosophy Quarterly* 1: 133–145.

Charles, David. 1991. "Teleological Causation in the Physics." In *Aristotle's Physics: A Collection of Essays*, ed. L. Judson, 101–128. Oxford, UK: Oxford University Press.

Charles, David. 1988. "Aristotle on Hypothetical Necessity and Irreducibility." *Pacific Philosophical Quarterly* 69: 133–145.

Charlton, William. 1992. *Aristotle's Physics. Books 1 & 2; Translated [from the Greek] with Introduction and Notes*. Oxford, UK: Clarendon Press.

Cohen, Sheldon. 1989. "Aristotle on Hot, Cold, and Teleological Explanation." *Ancient Philosophy* 9: 255–270.

---

[22] I thank the participants in the Northwestern Theory and Practice workshop, and especially David Ebrey for his written comments on the penultimate draft. I also thank Kellyn Bardeen for her excellent editorial assistance and philosophical insight.

Cooper, John. 1982. "Aristotle on Natural Teleology." In *Language and Logos*, ed. Malcolm Schofield and Martha Nussbaum, 197–222. Cambridge, UK: Cambridge University Press.

Falcon, Andrea. Forthcoming. "Aristotle's Integrated Study of Motion." In *Reading Aristotle*, ed. Ron Polansky and William Wians.

Gill, Mary Louise. 1997. "Material Necessity and *Meteorology* VI 12." In *Aristotelische Biologie: Intentionen, Methoden, Ergebnisse*, ed. Wolfgang Kullmann and Sabine Follinger, 145–162. Stuttgart: Franz Steiner Verlag.

Gotthelf, Allan. 1997. "Understanding Aristotle's Teleology." In *Final Causality in Nature and Human Affairs*, ed. Richard F. Hassing, 71–82. Washington DC: Catholic University of America Press.

Gotthelf, Allan. 1987. "Aristotle's Conception of Final Causality: With Postscript." In *Philosophical Issues in Aristotle's Biology*, ed. A. Gotthelf and J. B. Lennox, 204–242. Cambridge, UK: Cambridge University Press.

Gotthelf, Allan and Lennox, James. 1987. *Philosophical Issues in Aristotle's Biology*. Cambridge, UK: Cambridge University Press.

Lennox, James. 2001. *Aristotle: On the Parts of Animals I-IV*. Oxford, UK: Oxford University Press.

Irwin, Terence. 1988. *Aristotle's First Principles*. Oxford, UK: Oxford University Press.

Johnson, Monte. 2005. *Aristotle on Teleology*. Oxford, UK: Oxford University Press.

Leunissen, Mariska. 2010. *Explanation and Teleology in Aristotle's Science and Nature*. Cambridge: Cambridge University Press.

Lettinck, Paul. 1999. *Aristotle's Meteorology and its Reception in the Arab World*. Leiden: Brill Academic Publishers.

Lewis, Frank. 1988. "Teleology and Material/Efficient Causes in Aristotle." *Pacific Philosophical Quarterly* 69: 54–98.

Nussbaum, Martha. 1978. *Aristotle's De Motu Animalium: Text with Translation, Commentary, and Interpretive Essays*. Princeton, MA: Princeton University Press.

Quarantotto, Diana. 2005. *Causa Finale, Sostanza, Essenza in Aristotele: Saggi Sulla Struttura dei Processi Teleologici Naturali e Sulla Funzione dei Telos*. Naples, Italy: Bibliopolis.

Sauvé Meyer, Susan. 1992. "Aristotle, Teleology, and Reduction." *Philosophical Review* 101: 791–825.

Scharle, Margaret. 2014 (forthcoming). "Man from Man, not Bed from Bed: Nature, Art and Chance in *Physics* II." In *Aristotle's Physics: A Critical Guide*. Cambridge, UK: Cambridge University Press.

Scharle, Margaret. 2008. "Elemental Teleology in *Physics* II.8." *Oxford Studies in Ancient Philosophy* vol. XXXIV: 147–183.

Sedley, David. 1991. "Is Aristotle's Teleology Anthropocentric?" *Phronesis* 36: 179–197.

Sedley, David. 2000. "*Metaphysics* L.10." In *Aristotle's Metaphysics Lambda, Symposium Aristotelicum*, ed. Michael Frede and David Charles, 327–350. Oxford: Oxford University Press.

Waterlow [Broadie], Sarah. 1982. *Nature, Change, and Agency in Aristotle's Physics*. Oxford, UK: Oxford University Press.

Wilson, Malcom. 2014. *Structure and Method in Aristotle's Meteorologica*. Cambridge, UK: Cambridge University Press.