

CHAPTER X: THE COSMOLOGICAL SIGNIFICANCE OF GENERATION

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Some context. I am currently working a book on Aristotle's account of the generation of substances. The central aim of the book is to examine the ways in which Aristotle's general theory of substantial generation are reflected in, and modified by, his more specific account of the generation of organic substances in the biological works, primarily, the *Generation of Animals*. My working hypothesis is that Aristotle's mature theory of animal generation is what we should expect when the more generic model developed in the foundational works (e.g. *Physics*, *Generation and Corruption*) is understood through concepts specific to the domain of living nature. This places my project within the context of a recent trend in scholarship on Aristotle's natural philosophy that stresses the importance of integrating his natural investigations into a single explanatory project. This paper will form the basis for the final chapter of that study, which explores the relation between Aristotle's mature theory of animal generation and his broader cosmology.

INTRODUCTION: TWO PERSPECTIVES

David Sedley is perhaps the most well-known defender of the cosmological interpretation of Aristotle's teleology. According to Sedley, Aristotle thinks of the universe as an organized whole whose parts (elements, animals, and plants) are all coordinated in such a way that their mutual interactions contribute to the good of the cosmos and, ultimately, the good of man (Sedley 1991, 180; 2010, 24). On this reading, Aristotle's natural teleology cannot be fully grasped in isolation of his cosmological theory. In opposition to this, many modern scholars defend what I will call the "organism-centred" view of Aristotle's natural teleology. This reading treats the individual organism as the final end for the sake of which all its features exist, so that all final causation in biology can be understood exclusively from the perspective of the individual organism itself.¹ On this reading, each individual has the features it does because, and only because, those features are good for that individual.² I count myself among those who accept some version of the organism-centred view. Most of the time Aristotle treats the survival and well-being of each individual organism as the final end for the sake of which its features ultimately exist. And while those features might also benefit things outside the individual organism, those benefits are not part of the causal story that explains why they are present in the first place. At the same time I think there is value in considering Sedley's interpretation insofar as it forces one to recognize that there are connections between Aristotle's natural teleology and his broader cosmology. In my view the collective reaction to Sedley's reading has had the effect of swinging the pendulum too far in the opposite direction. As a consequence, scholars have tended to ignore, or at least downplay, the cosmological

¹ For a classic statement of this view see Balme (1992, 96-7). It is defended by Lennox (##), Judson (2005, 348, 359-60), Gotthelf (##), and Leunissen (##). *Physics* II 7, 198b5-9 is among the main passages cited in defence of the view that, for Aristotle, each organism's nature aims at its *own* good. Lennox (2001, 341) calls this Aristotle's "basic teleological axiom".

² Not everyone who rejects cosmic teleology accepts the *organism*-centred view. For example, Johnson (2005) argues that each particular substance is the final end for the sake of which all its features exist, so that all final causation can be understood exclusively from the perspective of the particular substance itself (e.g. p. 278: "the good which teleological explanations make reference to is specific to the natural kind being explained"). It just turns out that, on his reading, organisms are not the only natural substances subject to teleological explanation; Aristotle extends his doctrine to the elements and their natural motions.

features of Aristotle's biology. To be sure Sedley grossly overestimates his case. For, as far as I can tell, there are only two places in Aristotle's biological works where the explanation for some feature of a living thing is linked to his broader cosmological theory. In this final chapter I want to focus one of those places, namely, the beginning of *GA* II where Aristotle attempts to give an account of sexual differentiation. But before turning to that, let me begin by drawing attention to the other passage to give a sense of what I mean by "the cosmological aspects" of Aristotle's biology.

Gestation, development, and natural biorhythms. In *GC* II 10 (a chapter to which we shall return) Aristotle discusses how the sun's annual motion around the earth causes generation and destruction in the sublunary world as it approaches and retreats. Part of that story includes an account of how this motion influences the life-cycles of living things:

This explains why it is not the primary motion that causes generation and destruction but the motion along the inclined circle [sc. the sun's annual motion in the ecliptic]. ...the approaching and retreating of the moving body are caused by the inclination; for the consequence of the inclination is that the body becomes alternately remote and near. ...Therefore, if it generates by approaching and by its proximity, the very same body destroys by retreating and becoming remote. ...Hence, too, the times (i.e. life-cycles) of the several kinds of things have a number by which they are distinguished. For there is an order for all things, and every time (i.e. every life-cycle) is measured by a period. Not all of them, however, are measured by the same period, but some by a smaller and others by a greater one. For some of them the period that is their measure is a year, while for others it is longer and others shorter than this. (*GC* II 10, 336a33-b16; cf. *GC* II 11, 338b3-5)

In *GA* IV 10 we get an expanded account of how this works in the case of animal generation:

As is reasonable, the times of gestation, development, and life of everything strive to be measured according to natural cycles. By 'cycles' I mean day and night and month and year and the times measured by these sorts of things, and further the cycles of the moon. The cycles of the moon are full-moon, declining moon, and the bisections of these times between; for it stands in relation to the sun according to these. For the month is a common cycle between these two. And the moon is a principle owing to its communal relationship with the sun and its participating in its light; for it becomes just like another lesser sun. For this reason, the moon contributes to all processes of development and completion. For the heatings and coolings, in a certain proportion (*summetrias*), produce generation followed by destruction. And the limits of these (both their starting-points and terminating-points) are contained by the motions of the stars. For just as we observe a sea and everything that has a fluid nature being stabilized (*istamenên*) and changed according to the motion and stillness of the winds, and the air and the winds according to the cycles of the sun and moon, so too both the things that grow from these and other sorts of things necessarily follow upon them. For it is rational (*kata logon*) for the cycles of the less important things to follow upon those of the more important things. For even wind has a kind of life, a generation and destruction. And there are probably

certain other sources of the revolutions of these stars. Therefore, nature seeks to count out the processes of development and completion by the numbers of these. But it is not precise owing to the indeterminacy of the matter and because of the many principles that impede the natural processes of generation and destruction and frequently cause things that happen contrary to nature. (*GA* IV 10, 777b16-778a9)

The phenomenon Aristotle has in mind is the fact that the stages of an animal's life-cycle are causally dependent on the changes of the seasons, which are accompanied by changes in temperature and light. The efficient causal story follows Aristotle's account of the way meteorological phenomena are caused by the motion of the sun in *Meteorologica* I 9 (e.g. 346b20-36, 347a9-10). In a similar way, Aristotle thinks the heatings and coolings in the atmosphere trigger events in the organism associated with the phases of its life cycle (e.g. in the fall as the days get shorter there is a decrease in light and temperature that triggers the hibernation instinct in certain animals). But Aristotle also thinks that the phenomenon in question can be given a teleological explanation. Now, Aristotle is not suggesting that the cosmic cycles occur *for the sake of* regulating the phases of an animal's life or vice versa. Rather, his point is that the formal nature of each animal *uses* the motions of the stars and the changes that follow upon them to measure out the stages of its life-cycle. And being used for the sake of something is one kind of teleological relation.³

The point here is that, obviously, the full significance of this aspect of animal generation cannot be fully grasped in isolation of Aristotle's broader cosmology. For it is part of his broader theory in *GC* II 10 about the causal dependence of changes in the sublunary world on the eternal motions of the heavens. To be sure, this is compatible with an organism-centred interpretation. For the appeal to teleology in this case does not involve relating these feature of the organism's life to some broader cosmic good. But the same cannot be said for the *GA* II 1 passage (or so I shall argue). And this will force us to adopt a rather weaker version of the organism-centred view than has traditionally been advocated by commentators on Aristotle's biology. Before turning to that passage, let me be clear about the position I wish to defend.

It is true that *in most cases* Aristotle treats the organism's own good as the final end for the sake of which its adaptations ultimately exist. But I want to stop short of the claim that he thinks *all* features of the living world can be understood *exclusively* from the organism's perspective. Instead, I shall attempt to show that there is at least one feature of the living world, namely the continuation of biological generation itself, that cannot be understood from the perspective of the individual organism alone. Instead this feature must be explained (at least in part) by the contribution it makes to the good of the universe as a whole. As far as I can tell this is the only exception, and so it hardly vindicates the Cosmic Teleology reading. For it is not part of any systematic attempt on Aristotle's part to adopt a more global perspective of the sort defended in *Laws* X.

³ Leunissen refers to this pattern as "secondary", as opposed to "primary", teleology. While I agree with Leunissen that Aristotle thinks there are different patterns of teleological causation, I remain skeptical that these differences can be neatly captured by her distinctions. As I see it, such discrete and mutually exclusive categories impose artificial boundaries on something that is ultimately rather continuous. For a fuller discussion of this point see Henry 2011.

PART 1: *GENERATION OF ANIMALS* II 1

One of the major puzzles driving Aristotle's *Generation of Animals* is why there are sexes. Of particular importance to the case of animal generation is why animal species are *divided* into separate sexes.⁴ *GA* II 1 opens by introducing two modes of explanation for this, one that refers to the embryological mechanisms responsible for sexual differentiation (efficient causation), and one that refers to the advantage that comes from having separate sexes (final causation).⁵ The opening of Book II provides the teleological explanation, while the efficient cause explanation is postponed until Book IV. The teleological explanation proceeds in two steps: [1] first we get an argument for why the sexes exist at all (731b24-732a3); [2] Aristotle then goes on to show why animals are *separated* into sexes, that is, why some individuals are male and others female (732a3-10). In what follows I shall focus exclusively on the first part. The text reads as follows **[handout]**:

[A] Of the things that are, some are eternal and divine, while others are capable of being and not-being, and the beautiful and divine is always a natural cause (*aition aei kata tēn hautou phusin*) of what is better in things that admit it. And what is not eternal is capable of being <and not being> and admits of the better and worse. And soul is better than body, and what is ensouled is better than what is not owing to the possession of soul, and being is better than not being, and living is better than non-living. These are the causes owing to which the generation of animals exists. [B] For, since it is not possible for the nature of this kind of thing to be eternal, what comes into being is eternal in the only way possible for it. While it is not possible to be eternal *in number* (for the substance of existing things is in the particular; if it was of this sort, then it would be eternal), it is possible to be so *in form*. That is why there is always a continuous generation⁶ of humans, animals, and plants. [C] Since the principle of these is the male and female, it is for the sake of generation that the sexes are present in those that possess them. (*GA* II 1, 731b24-732a3)

In text [A] Aristotle first divides existing things into those that are everlasting and enjoy eternal being (god and the heavenly bodies) and those are only capable of temporary being (the elements, animals, and plants). The latter alone are subject to generation and destruction since they contain matter, which is the seat of a thing's capacity to be and not be (*GC* II 9, 335a33-4, *Metaphysics* VII 7, ##). He next invokes a series of axiological principles (e.g. being is better than non-being, living is better than non-living), which are said to provide "the causes owing to which the generation of animals exists". Section [B] then expands on this point: since no sublunary organisms are capable of existing indefinitely — each one is composed of matter and so eventually decays — they can become "eternal in form", which is achieved through reproduction. The upshot of this, Aristotle says, is that, while there cannot be eternal *organisms* in the sublunary realm, there can be eternal *lineages*: "For this reason there

⁴ Aristotle thinks that plants have male and female principles but that these are co-present in the same individual.

⁵ The formal and material causes of the sexes themselves are found in *GA* I 2.

⁶ I follow Lennox in taking *genos* here to have the sense given at *Metaphysics* V 28, 1024a29-30: "the continuous generation of things having the same form" (in modern biological terms, an ancestor-descendent lineage).

is always a continuous generation of humans, animals, and plants.” [C] This, in turn, provides the final cause for the existence of males and females: male and female are “principles” of generation (*GA* ##) and so are conditionally necessary for reproduction.

Traditionally, this passage has been read in the context of a similar argument from *DA* II 4. There Aristotle argues that reproduction exists for the sake of the individual insofar as it provides individuals with a means for partaking in the divine:

For this is the most natural among the functions for living things... namely, to produce another like itself, an animal producing an animal, and a plant producing a plant, in order that it may partake in the everlasting and divine insofar as it is possible. For every living thing desires this and performs all of its natural activities for the sake of it. ...Since, then, they cannot share in the immortal and divine by continuous existence, for no perishable thing can remain numerically one and the same, they share in these in the only way they can, some more and some less. What persists is not the individual itself but something like it, not numerically one but one in form. (*DA* 415a26-b7)

Most scholars take it for granted that our passage from *GA* II 1 simply reiterates this argument. When read in that context, *GA* II 1 is understood, again, as arguing that reproduction exists for the sake of the *individual* insofar as it provides a means for achieving *personal* immortality[†]. On this reading, the perpetuation of the lineage is not the end for the sake of which reproduction exists. Rather, it is a mere consequence of the fact that, when every individual strives after its own good, what you get is a continuous generation of things of the same form. We can call this the “organism-centred reading” of *GA* II 1, since it treats personal immortality as the final cause of animal generation and eternal lineages as a by-product.⁷

Against this trend I want to suggest an alternative interpretation of *GA* II 1 that emphasizes the cosmological significance of the process. According to this interpretation *GA* II 1 is not just echoing the *DA* II 4 argument. Rather, it is a specific application of a more general argument Aristotle makes in *GC* II 10 that seeks to explain why coming to be and passing away occur continuously and without fail. What is at stake between these two readings, we shall see, is how to understand the teleological significance of generation according to the *Generation of Animals*. If I am right, then what Aristotle is arguing in *GA* II 1 is that continuous animal generation exists not (or not only) because of the contribution it makes to the

[†] Verity objected to my use of “personal” immortality, since she took this to imply the eternal existence of numerically the same material composite. Her objection: What the individual is after is ‘a share in the divine’ (she said something about a relay race that I didn’t quite get), and the way it does this is by replicating its form. So the goal is having a share in the divine, and the means is formal replication. I need to think about this. When I use “personal immortality” I just mean that the individual itself is trying to become immortal, i.e. “partake in the everlasting and divine”, insofar as it is possible. And the only way it is possible to do that is by replicating its form. As I see it, this counts as an attenuated form of personal immortality. At any rate, what I mean to contrast is the view that Aristotle thinks animals reproduce for the sake of preserving the species so that the goal is species survival not individual survival.

⁷ See Balme (1972, [repr. 1991, 96]), followed by Gotthelf (##) and Lennox (1985). See also Kullman (1985, 172): “The idea is, once again, that the circle of procreation is the way in which animals, inasmuch as they are sexual, partake of the everlasting and the divine, which in this respect functions as the final cause.”

individual's own good but because of the contribution it makes to the good of the universe as a whole.^{8‡} To see this, we need to turn to *Generation and Corruption* II 10.

GENERATION AND CORRUPTION II 10: WHY IS GENERATION CONTINUOUS?

In *GC* II 10 Aristotle asks: What is the cause responsible for the fact that generation and corruption are continuous? He has already provided the material cause of the phenomenon back in *GC* I 3.⁹ *GC* II 10 offers the efficient and final causes.

(1) The efficient cause explanation (336a15-336b24). In the *Physics* Aristotle established that locomotion is the primary form of change and that this is what causes generation and destruction. In *GC* II 10 he argues, more specifically, that this is the sun's annual movement in the ecliptic as it approaches and retreats from the earth's surface (cf. *Meteor.* 346b20-2). This, Aristotle says, can be supported by appealing to the observable facts: "for we see (*horômen*) that generation occurs as the sun approaches and things decay as it retreats" (336b16-24). Since the sun's motion is eternal, it follows that generation and destruction must themselves occur continuously and without fail.

(2) The teleological explanation[†] (336b25-337a7). Aristotle next gives us a teleological explanation for the continuity of generation and destruction in the sublunary realm, which appeals to the notion of what is best. The main text of the argument runs as follows:

As we have said, coming to be and passing away will be everlasting and continuous and will never fail owing to the reason stated. This conclusion also follows rationally (*eulogôs*). For, since we say that in all cases nature strives after (*oregesthai*) what is better, and that being is better than not being..., but not all

⁸ I am not the first to defend this reading. For example, Cooper argues that in *GA* II 1 Aristotle treats the continued existence of living things as an important good and not just the existence of the individual organism. However, Cooper does not connect the argument to *GC* II 10, which (we shall see) adds important evidence for this reading. Gottlieb (2012, 58) and Johnson (2005) both notice a connection between *GA* II 1 and *GC* II 10, but they each treat our passage as if it were simply repeating the *DA* claim that reproduction is aimed at *self*-preservation.

[‡] One thing that came out in discussion is that I need to avoid committing myself to the view that continuous generation exists *for the sake of* the universe, if that is taken to imply that the universe can be *benefited* by something. I need avoid language that suggests this. All I want to commit to is the view that (a) there is a best way for the universe to be (its good) and (b) continuous generation exists because it contributes to that. I don't want to say that anything is thereby *benefited* by it.

⁹ See 319a18-22.

[†] One of the questions raised in Sean Kelsey's commentary was whether or not this counts as a "teleological" explanation. Susan also asked about this. I need to make more explicit that I take optimality explanations ('x is F because F is the best way for x to be') to be a sub-species of teleology. Although these typically do not involve "for the sake of" language, Aristotle does say elsewhere that nature acts 'for the sake of something and because it is better'. My 2013 OSAP paper does most of the work here (see note below). I should also stress that in the *Phaedo* and in other passages in Aristotle the appeal to optimization is taken to be explanatory, i.e. it is said to be part of the *aitia* for why something is the way it is.

things can possess <eternal existence>¹⁰ because they are too far removed from the first principle, it follows that the god adopted the remaining alternative and filled up the whole completely (*suneplêrôse to holon*) by making generation perpetual. For that way existence would be most connected (*malista suneiroito*) because the fact that coming to be should itself come to be perpetually is the closest approximation it has to being. (*GC II 10, 336b25-35*)

I'll set to one side the fact Aristotle here seems to suggest the universe was created by a providential god who deliberated about what is best for the world. One possibility is that Aristotle is here invoking the popular idea of a creator god simply as a *heuristic* device.¹¹ Reasoning *as if* the universe was designed by a providential god who aims at some optimal state of affairs is a useful heuristic device because it helps us identify the final cause of continuous generation.¹² Aristotle, like Plato, takes it as a basic fact, not explicable in terms of anything more fundamental, that the universe is an ordered system and that this order is good. It follows that everything that contributes to this order is itself good. But that does not commit him to the claim that there must have been some Divine Craftsman who organized the parts of the universe in order to make it so.[§]

The conclusion of the argument is fairly clear. Continuous generation exists in the sublunary world *because* that is the best possible way to maximize the level of being in the universe as a whole, given the constraints on sublunary being. Aristotle deduces this conclusion from two universal principles, both of which are taken as basic:

- (i) Nature always strives after what is better.
- (ii) Being is better than non-being.

The first of these (or some version of it) is identified as a first principle of natural science in *IA 2*. There Aristotle tells us that nature does nothing in vain but always what is best given the range of possibilities (704b14-15). This assumption is supposed to license a certain pattern of explanation that appeals to the concept of what is best (what we call *optimality* reasoning). According to this pattern of reasoning, we explain why something is the way it is by showing how being in that state is *the best possible* way for it to be. As Aristotle puts it, “if it is better this way, then it is that way and being in that state is in accordance with nature” (*IA 704b17-18*).¹³

¹⁰ The point of the argument seems to be, not that some things are incapable of existing at all (e.g. square triangles), but that some things are not capable of *eternal* existence. This is shared premise of both the *GA II 1* and *DA II 4* arguments.

¹¹ This was suggested to me by Sean Coughlin.

¹² See [Leunissen \(2010, Ch. #\)](#).

[§] Some of the discussion at the Princeton colloquium suggests that I might have to do more here. Some feel this passage is “too weird” to be considered sufficiently Aristotelian and that we should thereby not take it too seriously. Mariska pointed to a parallel passage in *DC* as a way to counter this.

¹³ I examine the use of optimality reasoning in Plato and Aristotle in [Henry \(2013\)](#). I argue that this type of explanation has its origins in *Phaedo* 97b8-98a2, a passage that serves as the intellectual ancestor of Aristotle’s own optimality principle. On my interpretation, optimality reasoning is a sub-category of teleological explanation that appeals to some optimal state of affairs.

The teleological argument in *GC II 10* exhibits this same pattern of reasoning. Since being is better than non-being, the ideal universe would be one that contained only eternal substances that never passed out of existence. That way the universe would be completely filled up with being with no traces of non-being. But since the actual universe contains a sublunary realm of material composites, and since all material composites must come to be and pass away (*GC II 9*, 335a32-b5), this state of affairs is not possible. The alternative, Aristotle reasons, is to have an everlasting cycle of generation that guarantees an endless supply of generated beings: “That way,” he says, “existence would be most connected, because the fact that coming to be should itself come to be perpetually is the closest approximation it has to eternal being.” The key to this is the idea that continuous generation ensures sublunary being is “most connected” (*malista suneiroito*). If the generation of sublunary beings were intermittent rather than continuous, so that there were periods in the earth’s history when no sublunary beings existed, that would decrease the overall amount of being in the world. The world would contain existential gaps, as it were.¹⁴ Perpetual generation avoids this by linking individuals together in a continuous (gap-less) chain, so that, although each individual must pass out of existence, there will always be some sublunary beings around.

My suggestion is that the *GA II 1* passage considered earlier is meant to be read as a more specific application of this general argument to the case of animal generation. When read in that context, the argument can be reconstructed as follows:

- 1) Nature always strives after what is better given the range of possibilities. (Implicit premise.)
- 2) Being is better than non-being, living (which is being for an organism) is better than not living, etc.
- 3) Among living things, some are eternal (God, the heavenly bodies), while others come to be and pass away (sublunary material composites).
- 4) Since no sublunary organism is capable of eternal being, the god filled up this part of the world (the world of living things) by adopted the only alternative remaining, namely, by making biological generation perpetual.
- 5) This is why there a continuous generation of living things.*

The key here is the idea that, since there cannot be *eternal organisms* in the sublunary world (for they contain matter), the next best thing is to make their generation continuous. For having *eternal lineages* — a continuous generation of things of the same form — is the best way to maximize the amount of being in the living world (to “fill up the universe completely” as he puts it in *GC II 10*), given the constraints imposed on living things by their material natures. For that way life will be “most connected” with no existential gaps.

¹⁴ I owe this expression to Chris Frey.

* Sean raised a question about the explanandum of *GA II 1*: Is the question why there is *continuous* generation or why animals generate at all? I need to offer some arguments for the former. Briefly: (i) this is the standard way of reading the passage; (ii) the conclusion (marked by *diō*) of the argument is that there will always be a continuous generation (or *genoi*) of human, animal, and plant and that the sexes exist for the sake of ensuring that; (iii) in *GA IV 3* Aristotle explicitly states that females exist in order “to preserve the species” (##).

Let me offer some reasons for treating our *GA* passage as an extension of the *GC* II 10 argument rather merely repeating the argument from *DA* II 4. First, text [B] is a shared premise between the *GA* and *DA* arguments, which is the primary reason scholars have tended to see the two passages as attempting to establish the same point. But [B] is also a premise in the *GC* II 10 argument and so cannot help to decide between the two readings. By contrast, the *GC* and *GA* arguments both draw on the same axiological principles expressed in [A], which do not figure at all into the *DA* argument. While it may be conceded that these same principles are in the background of the *DA* argument, the fact that Aristotle makes explicit use of them in the *GA* passage creates a strong presumption in favour of my reading. For it suggests that Aristotle had *GC* II 10 clearly in mind when he composed that passage (cf. *GC* 336b28-9). Finally, the *DA* and *GA* arguments appear to be concerned with different aspects of generation. In the *DA* argument Aristotle is interested in the individual's biological imperative to reproduce, which he takes to be an expression of its desire for immortality. The *GA* argument makes no mention of this; there is no reference to individuals engaging in generation in order that they may "partake in the everlasting and divine". In fact, the *GA* argument does not mention the individual at all. Instead, the focus is on the continuity of generation itself and ultimately on why there are sexes.¹⁵ On my reading, texts [A] and [B] constitute a single argument whose conclusion is given at 731b24-35: "This is why there is always a *genos* of humans, animals, and plants." Following Lennox I take *genos* here to have the sense given at *Metaphysics* V 28, 1024a29-30, where a *genos* is described as "a continuous generation of things having the same form" (ἡ γένεσις συνεχῆς τῶν τὸ εἶδος ἔχόντων τὸ αὐτό). This way of understanding the passage makes it clear that the explanandum of the argument all along was the continuity of generation (the fact that the process will continue eternally and without fail). While it may be true that the *DA* argument presupposes this idea insofar as my ability to partake in the everlasting and divine is directly bound up with the continuity of generation, that is not the stated conclusion of that argument.

PART 3. COSMIC TELEOLOGY REVISITED

In this chapter I have examined two different interpretations of the *GA* II 1 argument, which give quite different accounts of how we understand the teleological significance of animal generation. According to the organism-centred interpretation, the *GA* passage merely echoes the point of *DA* II 4. Animal generation exists because it contributes to the individual's own good (formal replication allows the individual to partake of the everlasting and divine). The fact that there is a continuous succession of living things is simply a consequence of each individual trying to maximize its personal good; it is certainly not the end for the sake of which reproduction takes place (Balme 1992, 97; Gotthelf 2012, 58). By contrast, I take our *GA* passage to be focused on the existence of eternal lineages themselves. On this reading, eternal lineages are treated as the best possible means of increasing the level of being in the

¹⁵ This is the standard reading of the *GA* II 1 argument (e.g. Cooper ##). Even Gotthelf, who defends the organism-centred reading, takes the passage to be "explaining the unendingness of sexual generation" (##). It is also worth noting that *DA* II 4 is not concerned at all with the existence of sexes but only with the individual's desire to reproduce. And in *GA* IV 3 Aristotle is explicit that females exist for the sake of preserving each sexually-differentiated *genos* (767b8-10). However we translate *genos* in this passage, Aristotle is clearly concerned with the continued existence of something more inclusive than the individual, whether this is the species or some wider kind.

universe, given what is possible in the realm of living things. In other words, *continuous* biological generation is to be explained, not by reference to the individual's own good, but by the contribution it makes to the good of the universe as a whole. And since males and females exist for the sake of that, this gives the sexes a more cosmological significance than has traditionally been acknowledged.

[Need to integrate above and below...]

Although this chapter has stressed the cosmological significance of Aristotle's theory of animal generation, the overall interpretation advanced in this book should be seen not as a stripped-down version of the "cosmic teleology" reading but a (slightly!) weaker version of what I am calling the organism-centred reading.

[...]

Aristotle starts the teleological explanation in *GA* II 1 by stating that the final cause of sexual differentiation has its origin "in a higher principle". My reading makes good sense of that. As I interpret the phrase, Aristotle is drawing attention to the cosmological significance of sexual difference (it is ultimately rooted in his cosmology).¹⁶ On this reading, continuous biological generation exists, not (or not only) because it contributes to the good of the individual, but because it contributes to the good of the cosmos as a whole.¹⁷

Having said that, it would go too far to treat this as evidence for Sedley's Cosmic Teleology reading. On Sedley's reading, Aristotle thinks of the universe as an organized whole endowed with a nature of its own. This "cosmic nature", Sedley argues, is something over-and-above the natures of its individual parts (animals, plants, etc.). Sedley's main evidence for this reading comes from the controversial passage at the start of *Metaphysics* XII 10. There Aristotle considers the way in which "the nature of the whole (ἡ τοῦ ὅλου φύσις) contains the good and the best, whether as something separated and by itself, or as its arrangement" (see *Metaphysics* XII 10, 1075a11-25). Sedley takes the reference to "the nature of the whole" to pick out a cosmic nature that belongs to the universe *as a whole* and embodies its good. This cosmic nature, Sedley argues, is prior (and thus irreducible) to the natures of the individual organisms, since the latter are parts of the former. — I am not unsympathetic to Sedley's claim that Aristotle recognized more inclusive individuals above the level of particular organisms and that these more inclusive individuals might have natures of their own. ...What I find objectionable about Sedley's interpretation is the idea that Aristotle thinks of the parts of the universe as somehow being adjusted to one another in such a way that their

¹⁶ Balme's reading of *anôthen* as a reference to "a more universal principle" (cf. *APo.* 97a33) is plausible. Those universal principles might be the various axiological claims about the relative value of soul, life, and being. But this is consistent with my reading, since the *GC* II 10 argument also derives its conclusion from universal principles of the same sort.

¹⁷ This raises a question about how to reconcile Aristotle's two perspectives (*GC* II 10 and *DA* II 4). One answer is to point to Aristotle's distinction in *NE* between things that exist both for their own sake and for the sake of something else (e.g. virtue), and those that are present purely for their own sake (e.g. happiness). *Laws* 903b5-d1 appeals to this distinction by saying that each part of the universe is present both for its own sake and for the sake of the universe as a whole. While I think that Aristotle denies this for the most part, generation would be one of those things that exists both for the sake of the individual (*DA* II 4) and for the sake of the universe as a whole (*GC* II 10).

mutual interactions contribute to the cosmic good and, ultimately, the good of man. There is so little evidence for this interactive dimension in Aristotle's natural teleology that I find it hard to believe this was a core feature of his theory. If it were, then we should have expected Aristotle's biology to be driven by a deep interest in ecology and ecological relations. Yet, we find no traces of the concept of an ecosystem, no sign of the idea of "the web of life", and very little attention to the ubiquitous co-adaptations that exist between living things. (This lies in stark contrast to the ecologically-rich perspective of Darwin's *Origin of Species*.)

Sedley's main response to this objection is to say that, while Aristotle's biology is "squarely focused on individual bodily functioning" the global teleology is supplied by metaphysics. I have two replies to this. First, it is not that the biological works lack examples of such "coordination" between species (see, e.g., *PA* IV 13, 696b24-35, *GA* III 760a31-b1, *GA* IV 10, 777b16-778a9). The problem is that there are so few of them. If Aristotle really did view nature through the lens of Sedley's interactive teleology, then we would expect his biological works to be full of such examples. Second, it is not clear to me why a study of the coordination and interactions between the parts of nature should belong to metaphysics and not to the science of nature itself. For that is essentially the science of ecology. — The absence of anything like an ecological perspective from Aristotle's science of nature and the fact that his biology is so 'squarely focused on individual bodily functioning' makes much better sense if we assume that he rejected Plato's cosmic teleology.

PART 4. NECESSITY AND CONTINUITY

To close this chapter, I want to turn to *GC* II 11 and consider the relation between necessity and the continuity of biological generation. Aristotle's discussion is extremely challenging and its arguments are not easy to decipher. But hopefully I can say enough to get some discussion going.

Aristotle begins the chapter by saying that: "Since in the case of things that are moved continuously... we observe things coming to be in a sequence (i.e. this comes to be after that), we must investigate whether there is anything that exists necessarily or whether all things are such that it is possible for them *not* to come into being." While he introduces this question with regard to being, the focus quickly shifts to coming to be: "The question is whether all <generated> things are of this sort [sc. contingent], or whether it is necessary for some to come into being in the unqualified sense (ἀναγκαῖον ἀπλῶς). Is it the case that, just as in the sphere of being (ἐπὶ τοῦ εἶναι) some things cannot possibly fail to exist (τὰ μὲν ἀδύνατα μὴ εἶναι τὰ δὲ δυνατά), so too concerning generation [sc. some things are such that they cannot fail to come to be]? For example, is it necessary that the solstices will occur in the sense that it is not possible for them to be incapable of occurring?" (##)

Joachim calls *GC* II 11 an "appendix" because he thinks the main task of *GC* is completed in II 10 and that the discussion of necessity in the final chapter adds nothing to this. I think this is wrong: the discussion of necessity is clearly connected to *GC* II 10 and the theme of continuous generation. As I shall try to show, Aristotle is worried about the possibility that biological generation is not eternal but could cease at some point. If no sublunary organisms are necessary in the sense that they cannot fail to come into being, then what is to prevent biological generation from ceasing at some point in the future? What is the source of the necessity that makes the generation of sublunary organisms itself eternal? In a nutshell, I think Aristotle is worried about extinction.

Aristotle begins the chapter by presenting a series of arguments to show that all things that come to be are contingent so that none of them are necessary in the absolute sense: their coming to be is only “conditionally” necessary, as he put it. (1) First, he argues that in any rectilinear causal sequence, what is prior must come to be *if* the posterior will be but that the reverse is not true. It is not the case that if the prior has come to be the posterior *must* come to be. The only exception is if the posterior is itself absolutely necessary, in which case, Aristotle says, “the necessity is convertible (ἀντιστρέφει), that is, when the prior has come to be the posterior must always come to be as well” (337b24).¹⁸ But in this case the posterior is not necessary *because* of the prior but *ex hypothesi* (it was already assumed to be necessary). (2) He then argues (in two stages) that in no case is the final outcome of a rectilinear causal sequence absolutely necessary, with the consequence that each member of the series will always only be conditionally necessary (337b25-338a2). He concludes¹⁹:

But if the generation [of the final product] is necessary [in the strict sense], then it must be such that it is always coming to be. For what is necessary and what is eternal coincide (for that which is necessary cannot *not* be). Hence, if a thing is necessary, then it is eternal, and if it is eternal, it is necessary. And if, therefore, the generation of a thing is necessary, it must come to be eternally, and if eternal, then necessarily. It follows that the generation of anything, if it is absolutely necessary, must be cyclical (i.e. it must return upon itself). ...Therefore, it is in circular motion, and in cyclical generation in particular, that absolute necessity is to be found. In other words, if the generation of anything is cyclical, it is necessary that each of them is coming to be and has come to be, and if it is necessary, then their generation is cyclical.

According to Aristotle, then, what is necessary in the strict sense occurs eternally and without fail and what occurs eternally and without fail is necessary in the strict sense. Now, back in *GC* II 10, Aristotle argued that only continuous motion is properly eternal and that only circular motion is genuinely continuous. At the end of the passage just quoted Aristotle connects all this together: “It is in circular motion, and in cyclical generation, that absolute necessity is to be found.”

But Aristotle is worried that the generation of living things is not cyclical in the right way and so does not exhibit the sort of necessity that he connects with being eternal. This is a problem for him because it means that biological generation might cease at some point in the future and all life go extinct (which I take it is obviously contrary to his settled views). Let me flesh this out a bit, since this is not the typical way of reading the chapter.

Scholars often take Aristotle to hold that the generation of living things is *only* necessary the conditional sense. Leunissen, for example, following Kurpreeva, argues that unqualified necessity holds only for eternal things (such as the movement of the heavens) while “conditional necessity holds for the generation of animals, which is a sublunary natural process that is rectilinear and that concerns beings whose substance is perishable” (2010,

¹⁸ I take it that this discussion is what Aristotle is referring to at the end of *PA* 639b29-640a9 when he says, “these matters have been determined elsewhere, namely, in what sorts of things <this kind of necessity> is present, what kinds of process convert (ἀντιστρέφει), and for what reasons”.

¹⁹ With the following see Charles (1988, 14-17).

105). But this seems like an interim conclusion of *GC* II 11, not Aristotle final conclusion.²⁰ It is important to distinguish here between the claim that the generation of *some individual* organism is only conditionally necessary and the claim that *biological generation itself* is only conditionally necessary. I think Aristotle holds the former but not the latter. As we saw in the passage from *GA* II 1, Aristotle thinks that “there will always be a continuous generation of humans, animals, and plants”. And according to *GC* II 11, what is eternal is also necessary *haplôs*. So Aristotle does think the continued generation of animals is necessary in the strict sense, even though he thinks the generation of any particular animal is not. Herein lies the rub. No *individual* organism is absolutely necessary such that it could not have failed to come into being; the generation of any given organism is merely contingent. But if so, then it could turn out that the generation of living things ceases at some point. So what keeps the process reoccurring eternally? What Aristotle needs to show is how the process of biological generation can be necessary in the absolute sense (since what is necessary *haplôs* cannot fail to occur and so continues eternally) while respecting the fact that the generation of any individual organism is only *conditionally* necessary. In a word: How can *eternal* lineages be composed of a series of *contingent* beings?

As we have seen, Aristotle thinks that only continuous motion is properly eternal and that only circular motion is genuinely continuous. But he also holds that rectilinear motion can *imitate* circular motion by being cyclical (reverting back on itself). It is in *cyclical* generation that absolute necessity is to be found. At first glance, it appears that biological generation is not cyclical in the right way; for “animals do not return upon themselves so that *the same individual* comes to be a second time” (##). Once a particular animal passes out of existence, it is gone forever. By contrast, it is numerically the same sun that returns again and again to the same position every time it revolves around the earth. This is where I think many commentators leave the argument. But Aristotle continues by distinguishing between two different ways in which a rectilinear causal process might be cyclical and so imitate circular motion:

Why do some things apparently come to be in this way (as, for instance, rain and air come to be cyclically so that it must rain if there is a cloud and, conversely there must be a cloud if it is to rain — while humans and animals do not return upon themselves so that the same individual comes to be for a second time (for although your coming to be presupposes your father’s, his coming to be does not presuppose yours)? Why, on the contrary, does this sort of generation seem to constitute a rectilinear sequence? In discussing this, we must begin by inquiring into whether all things return upon themselves in the same way or whether, though in some sequences what recurs is *numerically* the same, in others it is only *the same in form*. Of those moving substances that are imperishable, it is clear that <what returns upon itself> will be numerically the same (for the motion is consequent upon that which is being moved). But those things that are perishable must return upon themselves formally but not numerically. This is why, when water comes to be from air and air from water, the air <that returns> is the same in form not the same in number. And even if these are numerically the

²⁰ Leunissen takes it as Aristotle’s settled position that animal generation is a rectilinear process. But at 338b11 Aristotle only says that it *seems to be* (ἔοικεν) a rectilinear process. Immediately he points out that animal generation is, in fact, cyclical - as I go on to say.

same, this, at any rate, is not the case with those things whose substance comes into being, being the sort of thing that is capable of being otherwise. (338b6-19)

Aristotle thinks biological generation is an instance of formal replication where what returns is not numerically the same individual but something that is the same in form. Therefore, biological generation qualifies as a *cyclical* change. And since all cyclical processes are necessary in the strict sense, it follows that biological generation occurs eternally and without fail.