



‘What’s Teleology Got To Do With It?’ A Reinterpretation of Aristotle’s *Generation of Animals V**

Mariska Leunissen^a and Allan Gotthelf^b

^a) Department of Philosophy, Washington University in St. Louis, USA
mleuniss@artsci.wustl.edu

^b) Department of History and Philosophy of Science, University of Pittsburgh, USA
gotthelf@pitt.edu

Abstract

Despite the renewed interest in Aristotle’s *Generation of Animals* in recent years, the subject matter of *GA V*, its preferred mode(s) of explanation, and its place in the treatise as a whole remain misunderstood. Scholars focus on *GA I-IV*, which explain animal generation in terms of efficient-final causation, but dismiss *GA V* as a mere appendix, thinking it to concern (a) individual, accidental differences among animals, which are (b) purely materially necessitated, and (c) are only tangentially related to the topics discussed in the earlier books. In this paper, we defend an alternative and more integrated account of *GA V* by closely examining Aristotle’s methodological introduction in *GA V.1 778a16-b19* and his teleological explanation of the differences of teeth in *GA V.8*. We argue for the unity of both *GA V* and of *GA* as a whole and present a more nuanced theory of teleological explanation in Aristotle’s biology.

Keywords

Aristotle, *Generation of Animals*, teleology, material necessity, explanation, biology

*) The fourth Pittsburgh/London (Ont.) Workshop on Aristotle’s *Generation of Animals*, organized by Allan Gotthelf and Devin Henry, and held at the University of Pittsburgh, April 26-27, 2008, was devoted to *GA Book V*. At this workshop we each separately offered new readings of (i) the general statement in the book’s first chapter of the mode(s) of explanation appropriate to the attributes under discussion in the book as a whole (Gotthelf) and (ii) the manner in which, in the book’s last chapter, the explanations pertaining to teeth appeal both to material-efficient and teleological causation (Leunissen). Both of us noticed the light each of our accounts shed on the other’s, and how the two together

Introduction: The Problem of *Generation of Animals* Book V

Despite the renewed scholarly interest in Aristotle's *Generation of Animals* (*GA*) in recent years,¹ the subject matter of *Generation of Animals* book V, its preferred mode(s) of explanation, and its place in the treatise as a whole remain misunderstood.

Scholars typically focus on the first four books of *GA*, which contain Aristotle's key theories of reproduction, embryogenesis and heredity; by contrast, they treat book V as a mere appendix,² since it discusses 'the attributes by which the parts of animals differ' (*GA* V.1 778a16-17), such as differences in eye-color and pitch of voice. Whereas the first four books explain the coming to be of entire organisms and their parts in terms of efficient-final causation, book V is thought to concern (a) *individual, accidental differences* among animals, which are (b) purely *materially necessitated* and thus have nothing to do with the operation of teleology, and (c) are only *tangentially related* to the topics discussed in the earlier books.³ Within book V, scholars consider Aristotle's discussion of the differences of teeth in chapter 8 to be especially problematic. There, Aristotle 'paradoxically' combines references to material necessity with teleology, which has led a recent commentator to postulate that chapter 8 does not belong

pointed the direction to a new interpretation of the aims and the unity of *GA* V, and the continuity of its investigation with the investigation of animal generation in the first four books of *GA*. We were helped in these reflections by outstanding, sometimes electric, discussion at the workshop, most especially with Alan Code, Devin Henry, and Jim Lennox, but with other participants as well. We are grateful to all who participated in the workshop, and to Devin for his role in its organization. Following the workshop, Leunissen did a draft of the bulk of the paper, to which Gotthelf added the section on the V.1 passage discussing the modes of explanation and the Appendix. Extensive revision by the two of us in concert, followed by incorporation of useful written comments provided by Devin Henry and Robin Smith on an earlier version, has resulted in the paper you have before you.

¹ See in particular Balme (1987a); Bolton (1987); Code (1987); Coles (1995); Henry (2006a, 2006b, 2007, 2009); Liatsi (2000); and Witt (1985).

² See Liatsi (2000), 13, 25 and Morsink (1982), 148.

³ Interpretations that restrict the scope of book V to accidental, non-teleological differences at the sub-species level are defended by Balme (1987a), 11; (1987b), 305-306, 312; and (1992), 51; Cooper (1990), 81-83; Johnson (2005), 59 and 197; Liatsi (2000), 14-19, 23, 25; Lloyd (1990), 20-21, 23-24; and Pellegrin (1986), 157.

to book V properly speaking, but that it is instead a second, separate appendix to the first four books.⁴

The purpose of this paper is to defend an alternative and more integrated account of the subject matter of book V, its preferred mode(s) of explanation, and its relation to the first four books by closely examining two key passages: Aristotle's methodological introduction in chapter 1 and his discussion of the differences of teeth in chapter 8.

Our argument consists of two parts. In section one, we shall offer a detailed interpretation of Aristotle's introduction to the project of book V in *GA* V.1 778a16-b19. First, we show that what unifies the differences singled out for discussion in book V, and characterized in 778a16-29, is that they are all 'differences of the more and the less' that come to be due to changes during the development of the animal *after its birth*. Under this interpretation, book V continues the investigation of the first four books into the causes of animal generation operative during embryogenesis and surrounding the animal's birth. Second, we give a reading of *GA* V.1 778a29-b19 according to which the passage's careful distinction between teleological and material-efficient modes of explanation does not require *either* that (i) everything universal to a subject must be explained teleologically *or* that (ii) the subject matter of book V is not in any way subject to teleological explanation. We offer a short analysis of the explanations in use in *GA* V.1-7 in further support of this reading.

In section two, we turn to Aristotle's explanation of the differences of teeth in chapter 8. Though we grant that the primary cause of the generation of all the differences studied in book V, including the ones of teeth in *GA* V.8, is material necessity, we argue that this mode of explanation is fully compatible with *secondary* forms of teleology. The differences of teeth, as do teeth themselves according to Aristotle's explanation in *GA* II.6, come to be of material necessity after the animal's birth, from the residues of matter produced for the growth of bones. The developing animal's formal nature then uses what has come to be of material necessity for something good, e.g., to enhance the function of nutrition. We use this notion of secondary teleology to show that there is a continuity not only in theme but also in the modes of explanation used, both within book V as a whole and between that book and the first four books of *GA*.

⁴ Liatsi (2000), 19, 195.

If our interpretation is right, book V forms an intrinsic part of Aristotle's investigation into the generation of animals.

1. The Scope and Nature of Book V

The Nature of 'The Attributes by which the Parts of Animals Differ'

The methodological introduction to book V consists of two parts: Aristotle first introduces the subject matter of the investigation to be undertaken (in *GA* V.1 778a16-28) as 'the attributes by which the parts of animals differ' and then explicates which mode(s) of explanation he deems appropriate for these attributes (in 778a29-b19). In our discussion below, we shall closely follow Aristotle's text.

In his introduction of the subject matter, Aristotle provides two sets of specifications from which we might glean the nature of these 'attributes'. First, he gives examples:

I mean such attributes of parts as blueness or blackness of eyes, and height and depth of voice, and differences of color in hairs and feathers.⁵ (778a17-20)

We take it that the group of attributes Aristotle is singling out for discussion here by means of these examples is a subset of the category of 'differences of the more and the less', a category of difference which Aristotle carefully distinguishes in the delineation of types of sameness and difference of animal parts at the opening of *History of Animals* (among other places).⁶ He there includes in this category differences of parts (i) 'by oppositions of their attributes, e.g., color and shape,' and then (expanding

⁵ λέγω δὲ τὰ τοιαῦτα παθήματα τῶν μορίων οἷον γλαυκότητα ὀμμάτων καὶ μελανίαν, καὶ φωνῆς ὄξύτητα καὶ βαρύτητα, καὶ χρώματος [ἢ σώματος] καὶ τριχῶν ἢ πτερῶν διαφοράς.

⁶ *HA* I.1 486a25-b8; cf. *PA* I.4 644a16-21, b8-15, and *Meta.* VIII.2 1042b29-35. While the account at the opening of *HA* illustrates the different types of sameness and difference by reference to animal parts, later, at the start of book VII(VIII), Aristotle explicitly applies that account to differences in ἦθη, 'characters' (which include (i) animal traits such as fierceness and timidity, (ii) enmities between animals and (iii) degrees of φρόνησις, intelligence, all discussed in VIII(IX)). Differences of the more and the less are clearly to be found in every category of animal 'difference' (or attribute). See *HA* VII(VIII).1 588a18-b3. On differences of the more and the less in general, cf. Lennox (2001a), 160-181.

the category to include all ‘differences by excess and defect’) (ii) ‘by <the parts> being more or fewer, and larger and smaller’. These differences always belong to animals that are part of one and the same kind (γένος), as opposed to differences (and samenesses) by analogy, which are found across different animal kinds.⁷

In the methodologically prior *Parts of Animals*, Aristotle had already discussed many differences of the more and the less. The reason why he singles out *these particular differences* of the more and the less (such as in color and pitch) for discussion here in *GA* V is made clear in the subsequent section of his introduction, where he notes the distinctive features of this group of attributes that make them worthy of study in the current context:

It turns out that *some* of such [attributes] belong to whole kinds, but to *some* [kinds] they belong at random, such as happens especially with regard to human beings. In addition, following the changes of life *some* [changes] belong equally to all living beings, while *others* [belong] in the opposite way, such as [the changes] concerning voice and the color of hair. For *some* do not grow grey visibly in old age, while man suffers from this most among all animals. And *some* immediately follow coming into being, *others* become plain as age advances or in old age.⁸ (778a20-28)

The reason for discussing this group of attributes separately in the final book of the *Generation of Animals* is obviously not because Aristotle thinks these are all non-generic, individual features (by contrast with the ones

⁷ See the previous note. It is unclear in which type of sameness and difference Aristotle places differences in the position of the same part (his example is the mammarys), a type which he tacks on at the end of this passage. The word παθήματα is standardly used in all these contexts to pick out the qualities of parts by which they differ in the more and the less (cf. *PA* I.4 644b13: τοῖς σωματικοῖς πάθεσιν; *Meta.* VIII.2 1042b21-22: τοῖς τῶν αἰσθητῶν πάθεσιν), and color is explicitly mentioned as such a difference (*HA* I.1 486b6; *GA* V.1 779b33-34: τὰ δὲ μεταξὺ τῶν ὀμμάτων τούτων τῷ μᾶλλον ἤδη διαφέρει καὶ ἥττον). Differences in the pitch of voice are to our knowledge nowhere explicitly mentioned as differences of the more and the less, but see *HA* IV.9 for Aristotle’s discussion of differences in pitch of voice due to locality and *PA* II.17 660a14-b4 for his explanation of differences of the more and the less in vocalization.

⁸ τυγχάνει δὲ τῶν τοιούτων ἓνια μὲν ὅλοις ὑπάρχοντα τοῖς γένεσιν, ἐνίοις δ’ ὅπως ἔτυχεν, οἷον μάλιστα ἐπὶ τῶν ἀνθρώπων τοῦτο συμβέβηκεν. ἔτι δὲ κατὰ τὰς τῶν ἡλικιῶν μεταβολὰς τὰ μὲν ὁμοίως πᾶσιν ὑπάρχει τοῖς ζώοις τὰ δ’ ὑπεναντίως, ὡσπερ περὶ τὴν φωνὰς καὶ περὶ τριχῶν χροῶς: τὰ μὲν γὰρ οὐ πολιοῦται πρὸς τὸ γήρας ἐπιδήλωσ, ὁ δ’ ἄνθρωπος μάλιστα τοῦτο πάσχει τῶν ἄλλων ζῴων. καὶ τὰ μὲν εὐθὺς ἀκολουθεῖ γυνομένης, τὰ δὲ προϊούσης τῆς ἡλικίας γίνεταί δῆλα καὶ γηρασκόντων.

discussed in *Parts of Animals*, which all belong to entire species, or even wider kinds). What makes these attributes listed here interesting is exactly the fact that for some species the attributes are possessed unvaryingly as well as universally, whereas in others, and particularly in human beings, the attributes are variable and occur randomly. In other words, the attributes of eyes, hair, and voice are *not realized uniformly* in all living beings that possess them and sometimes not even within one and the same species. A second characteristic is that these attributes come to be not during embryogenesis, but as a result of changes during the *later development* of the animal, either immediately after its birth, or in later life, or in old age. Again, some of these changes belong in the same way to all living beings that possess them, while others do not. A third point of interest in Aristotle's characterization of these differences is their *prominence in human beings*: for reasons to be specified in the remainder of book V, differences in eyes, hair, and pitch of voice are most visible in human beings.

What unites these attributes, then, is that their changes are especially variable and noticeable in the maturation and aging of human beings: as often in the biological works, Aristotle takes the human (male) body as a starting point of explanation and as a guide for the organization of his exposition (see, e.g., *HA* I.6 491a19-26, *PA* II.10 656a9-14, and *GA* II.4 737b25-27). The change of eye-color in babies, the growing grey or bald in men, and the changes in pitch of voice of humans (who have voice more than any other kind of animal) are the primary explananda in this book, which in their turn prompt the discussions of the (often different and very variable) causes of the changes of similar attributes in other animals.

Aristotle's subsequent accounts of these attributes in the remainder of chapters 1-7 follow this programmatic introduction rather closely (we postpone the question of how chapter 8 fits into the larger structure of book V to section two below). First of all, Aristotle's concern with attributes that come to be due to changes *after* the birth of an animal explains why the starting point of his discussion is the moment of birth (778b19-21).⁹ Before turning to the attributes, Aristotle first needs to solve some problems that pertain to the first development of animals (778b23-779a26; cf. b23-24: ἔχει δ' ἀπορίαν περὶ τῆς ἐξ ἀρχῆς γενέσεως). From then on, he explains the causes of the coming to be of the three kinds of

⁹ Pace Liatsi (2000), 19.

attributes mentioned in the introduction: changes in eye-color in human beings are the topic of the remainder of the first chapter (followed by a general discussion of differences in eyes in 779b12ff. and of hearing and smell in chapter 2); changes and differences in the structure and color of hair and feathers are discussed in chapters 3-6 (starting off with discussions of baldness and grayness in men); and differences in voice are explained in chapter 7.

Second, preceding his explanations, Aristotle states whether an attribute belongs to a whole γένος or not; whether the attribute is a result of a later change and if so, when exactly during the later development after an animal's birth the attribute comes to be; and finally, how the occurrence and distribution of the attribute is different in human beings as opposed to its realization in other animals.¹⁰

And third, the actual explanations Aristotle provides in the first seven chapters (about which we shall say more below) are sometimes remarkably precise in classifying both the nature of the attribute to be explained and the kinds of causes that are responsible for the coming to be of that attribute.¹¹ In doing so, Aristotle provides detailed accounts – not just for why a particular difference of the more or the less belongs to or comes to be in a particular kind of animal – but also for why one and the same attribute can be realized so differently among different species, and especially among human beings.

The focus on generation we find both in the introduction and in the actual explanations of book V is of course typical for the whole of *GA* (see especially *GA* I.1 715a1-18 and *GA* II.1 731b20-22). This perhaps also explains why Aristotle does not discuss these differences in the *Parts of Animals*, in which the focus is primarily on the *being* of animals, and on their generation so far as it is controlled primarily by teleological causes; in those cases the complete, mature animal is taken as a starting point of

¹⁰ See in particular *GA* V.1 778b20-779b6, V.3 781b30-782a19, V.4 784a22-25, V.6 785b16-26, V.7 786b6-22.

¹¹ For instance, in his explanation of balding, Aristotle specifies that even though balding is most visible in human beings, it is a generally occurring attribute that also holds of some plants and birds (*GA* V.3 783b8-13; b9-10: ἔστι δέ τι καθόλου τὸ τοιοῦτον πάθος; cf. V.1 779b12-13). Many explanations differentiate explicitly between natural causes and affections such as diseases, aging, or environmental influences (see, e.g., *GA* V.5 785b1-2, V.6 785b30-34, and 786a8-14), and one even differentiates between per se causes and accidental ones (see V.3 783a33-b2).

explanation. Differences that are not realized uniformly within a whole species and/or that change over the animal's life-time do not appear as explananda in that context.

These facts about the focus of book V already make clear the book's close relationship to the first four books of *GA*. Books I-III discuss the mechanisms of reproduction and embryogenesis and the natural order of the generation of parts. An appropriate next step might well be a discussion of the coming to be of *differences* of parts – especially of those that occur after birth (cf. *GA* V.1 778b20). What is arguably needed first, however, is an account of the mechanisms of heredity and other phenomena related to pregnancy and birth itself, and this book IV provides.¹² The concluding words of book IV and the opening of book V suggest that book V is in fact an immediate follow-up from the preceding discussion:

We have spoken about the nourishment of animals within [the mother] and of their birth into the outside [world], both of each kind separately and of all in common. || We must now investigate the attributes by which the parts of animals differ.¹³ (*GA* IV.10 778a10-V.1 778a16-17)

The δέ in the opening sentence of book V picks up the μέν in the concluding remarks of book IV: where book IV concludes with a discussion of phenomena related to the growth of animals within the womb and to their birth, book V continues 'chronologically' with a discussion of the attributes by which their parts differ that arise during their development after birth.

Under this interpretation, Aristotle continues his investigation of the coming to be of animals by shifting from identifying the causes of what happens during embryogenesis and surrounding pregnancy to identifying the causes of what happens to some particularly variable parts of animals after their birth. Thematically speaking, there is no reason to treat book V as an appendix.

¹² For instance, in book IV, Aristotle already briefly touched upon attributes such as excessive hair-growth in animals rich in semen (*GA* IV.5 774a30-b4), the re-growth of eyes in very young birds (*GA* IV.6 774b27-34), and changes of voice during sexual maturation in male animals and most prominently in humans (*GA* IV.8 776b13-25): these are all differences that are immediately related to gestation and reproduction.

¹³ Περὶ μὲν οὖν τῆς ἔσωθεν τροφῆς τῶν ζώων καὶ τῆς θύραζε γενέσεως εἴρηται, καὶ χωρὶς περὶ ἐκάστου καὶ κοινῆ περὶ πάντων. || Περὶ δὲ τῶν παθημάτων οἷς διαφέρουσι τὰ μέρη τῶν ζώων θεωρητέον νῦν.

The Appropriate Mode of Explanation of the Attributes in GA V: The General Statement in GA V.1 778a29-b19

Although the broad outlines of Aristotle's discussion, in *GA* V.1 778a29-b19, of the mode(s) of causation operative in the generation of the attributes which are the subject matter of book V are clear enough, much in it is difficult to understand, not least its opening sentence. The discussion starts as follows:

About these [attributes] and all the things of this sort, one must no longer think that there is the same manner of explanation. For all those which are neither the products of a nature in common nor a distinctive feature of each kind – of those sorts of things, none either is or comes to be for the sake of something. For, while an eye is for the sake of something, its being blue is not for the sake of something – unless this attribute is a distinctive feature of the kind. In some cases [the attribute] does not reach to the definition of the substantial being, but the explanations must be referred back to the matter and the source of motion as coming to be from necessity.¹⁴ (778a29-b1)

The expression, 'one must no longer think that there is the same manner of explanation' (τὸν αὐτὸν τρόπον... τῆς αἰτίας), might mean either (a) 'one must no longer think that there is here the same manner of explanation as we used previously' or (b) 'one must no longer think that there is one and the same manner of explanation for every type of attribute, as one might have thought previously'. We will argue for a certain version of (a).

Whatever is meant by the first sentence is explained in the next sentence by reference to a contrast between two manners of explanation, one that refers to teleological causation and one that refers to a non-teleological one. The contrast is first given in just those terms (in one set of attributes, 'none... for the sake of something') and then exemplified (eyes, when present, are for the sake of something, blue eyes normally are not). Attributes not possessed in common across some wider or narrower kind are said not to be present for the sake of something. Presumably, those

¹⁴ Περὶ δὲ τούτων καὶ τῶν τοιούτων πάντων οὐκέτι τὸν αὐτὸν τρόπον δεῖ νομίζειν εἶναι τῆς αἰτίας. ὅσα γὰρ μὴ τῆς φύσεως ἔργα κοινῇ μὴδ' ἴδια τοῦ γένους ἐκάστου, τούτων οὐθέν ἔνεκά του τοιούτου οὔτ' ἐστὶν οὔτε γίγνεται. ὀφθαλμὸς μὲν γὰρ ἔνεκά του, γλαυκὸς δ' οὐχ ἔνεκά του πλην ἂν ἴδιον ἢ τοῦ γένους τοῦτο τὸ πάθος. οὔτε δ' ἐπ' ἐνίων πρὸς τὸν λόγον συντείνει τὸν τῆς οὐσίας, ἀλλ' ὡς ἐξ ἀνάγκης γιγνομένων εἰς τὴν ὕλην καὶ τὴν κινήσασαν ἀρχὴν ἀνακτέον τὰς αἰτίας.

that are common in one of those ways *may* be present for the sake of something.¹⁵

Only in the fourth sentence is the non-teleological mode of causation described positively (though still by contrast with a corresponding feature of the teleological case): the explanation of an attribute will not start from the definition of the substantial being (λόγος τῆς οὐσίας) of its possessor, but from its ‘matter and the source of motion’ showing the attribute ‘as coming to be from necessity.’

This is a non-teleological, non-conditional necessity, as the last sentence of the methodological discussion makes clear: ‘For while <an animal> will have an eye from necessity (for an animal is posited as being this sort of thing),¹⁶ it will have a particular sort of eye from necessity, though not that sort of necessity but another kind, because it is its nature to act and be acted upon in this or that way’ (778b16-19).¹⁷ As the sentence just prior to this one says, in regard to differences such as the blueness of an eye, (in most cases) ‘the cause must be sought in the motion and in the generation as having acquired these differences during its process of constitution (ἐν αὐτῇ τῇ συστάσει)’ (778b14-15).

In the methodological passage under discussion, then, we are told first that, in the case of the attributes which are the subject of book V, we should no longer think that the manner of explanation is the same. Then we are introduced, from various angles, to a distinction between two manners of explanation, one that refers to (an apparently less familiar) non-teleological material-efficient causation, the other that refers to (the apparently more familiar) teleological mode of causation.

¹⁵ Though interpreters regularly take the sentence to make the stronger claim, that universality is sufficient for the causation to be teleological, the sentence actually commits Aristotle only to the view that universality is *necessary* for the causation to be teleological. Likewise in the example which follows (b33-34), Aristotle’s point may well be that blue eyes are non-teleologically caused, unless they are characteristic of the entire kind in question, in which case they *may* be teleologically caused (rather than *must be* teleologically caused).

¹⁶ Cf. *PA* I.1 640a33-b1, and note that the lines in *PA* I that Aristotle refers to in the course of our *GA* V.1 passage (at 778b2), appear just before this, at 640a16-19.

¹⁷ ὅτι τοιονδὶ ἢ τοιονδὶ ποιεῖν πέφυκε καὶ πάσχειν. Note the similar wording at *PA* I.1 642a34-35: where it is explained that when one says that ‘*this* comes to be of necessity because of *those*’, ‘necessity’ signifies not conditional necessity but that ἔστιν οὕτως ἔχοντα καὶ πεφυκότα (‘this is their state and nature’; tr. Balme 1992).

The traditional reading of this passage takes the opening sentence to be saying, in effect, that one mode of explanation has been used in books I-IV, but that a different mode will be needed here in book V.¹⁸ The balance of the passage is then understood to be introducing the non-teleological mode by carefully contrasting it with the teleological mode used in the previous books. We think this cannot be right for several reasons.

First, and most important, it is simply not true either that books I-IV make no use, in the explanations they provide, of material-efficient causation operating on its own *or* that book V makes no use of teleological causation. For instance, material-efficient causation operating on its own is appealed to several times in book IV.¹⁹ And, second, as we will show below, teleological causation, quite apart from its appearance in chapter 8 of book V, is never excluded as a possible mode of explanation of the attributes under discussion in the first seven chapters, even though its actual use in those chapters is entirely marginal.

This leaves us, we think, with a different reading. The opening sentence is to be taken as saying that in previous books the *dominant* (not necessarily *only*) mode of explanation was the teleological one, while in the present book the *dominant* (and not necessarily *only*) mode of explanation is a non-teleological one appealing primarily to material-efficient causes.

In favor of our reading is the fact, already mentioned, that distinct modes of explanation have already been used in book IV, and will be used, as we will show, in book V. Nowhere in his introduction does Aristotle claim that we should rely exclusively on just one mode of explanation for all of the attributes at hand. For instance, as the example concerning eye-

¹⁸) This reading, which focuses on the difference between books I-IV and book V in the modes of explanation that are used, goes back to Michael of Ephesus, *CAG* 14.3 (ed. Hayduck), p.211.14-212.28 (see especially p.211.19-20: καὶ ἐπὶ τῶν ὁμοίων τὸ μὲν ὑλικὸν καὶ ποιητικὸν αἴτιον ζητητέον καὶ ἀποδοτέον, τὸ δὲ ἕνεκά του οὐ ζητητέον), and has been defended explicitly most recently by Liatsi (2000), 22. This reading is often asserted without argument, e.g., in Peck (1942), lxxv and Louis (1961), *ad* 778a20 (176 n. 1). Others have pointed to a break in thematic continuity between books I-IV and V, and argued that since book V is only concerned with the non-teleological generation of non-functional features, it must be treated as an appendix: see, e.g., St.-Hilaire (1887), CCLIX-CCLXVI, 418, and 424-5; Zeller (1897), p.92 n.2; and Morsink (1982), 148. On both aspects (or variants) of the traditional reading, see also note 3 above.

¹⁹) For example, in *GA* IV Aristotle explains monstrosities solely as a result of material necessity (see IV.3-4, especially IV.4 770a6-7) and the production of milk as being due to a combination of material necessity and teleology (see IV.8 776a15-b3).

color indicates, Aristotle believes that if an attribute is proper to an animal kind, it may well have to be explained teleologically.²⁰ Similarly, the use of ‘in some cases’ in *GA* V.1 778a34 may suggest that in *other* cases attributes by which parts of animals differ do ‘reach to the definition of the substantial being’ and are thus essential to, or at least *per se* of, those animals. (These attributes, we would submit, are the ones already explained teleologically in the *Parts of Animals*; see, e.g., *PA* II.2 648a13-19, II.13 657b22-27, and IV.12 693b28-694a9). And, a few lines later, at 778b7-10, Aristotle criticizes his predecessors for not seeing that natural phenomena, including the attributes under discussion, might involve formal-final causation *as well as* material-efficient causation. It is wrong, he says, to explain all such phenomena in terms of (not very well distinguished) material-efficient causation *alone* (778b8).

However, Aristotle’s delineation of the two distinct modes of explanation that follow presents the material-efficient mode as less familiar (to Aristotle’s audience if not to his predecessors) than the teleological one; so it is natural to take it as introducing a mode which is now to be used more than previously. The new subject-matter at hand makes it no longer (οὐκέτι) right to think what one had been right to think regarding the prior subject matter, namely that the biological phenomena in question are to be explained predominantly (although not exclusively) by reference to teleology.²¹

Our reading thus differs from the traditional reading in taking Aristotle to be saying, not that teleological explanation is present *only* in books I-IV and explanation via material-efficient causes present *only* in book V. It takes him to be speaking rather of the type of explanation that is *dominant* in the two places, and dominant in two senses. In the first sense (as we will explain further below when we distinguish ‘secondary teleology’ from

²⁰ This point is already well made by Lennox (2001b), 176. Based on our reading of the text at b30-32 (and 32-34) we are a bit more cautious: though Lennox may indeed be right that Aristotle thinks that the appropriate sort of universality provides ‘prima facie evidence’ that teleological explanation is in order, we don’t think the passage quite says that, as we explained in note 15 above. (It is no part of Aristotle’s claim here, incidentally, that *having eyes* is among the attributes that *GA* V is meant to provide explanations of; surely it is not, even though *having blue eyes* of course is. Its point is simply to exemplify, strikingly in this context, a mode of explanation which *some* attributes that are the subject of *GA* V may require.)

²¹ The γάρ (‘For’) immediately following the first sentence (778a20) might be thought to provide further support for this reading.

‘primary teleology’), while both teleological and material-efficient causes may be at work together in each of the two places, in explanations in books I-IV, even if material-efficient causes are involved, the teleological cause is primary; but in explanations in book V the material-efficient cause is primary, even if (as we show is indeed sometimes the case) teleological causation is involved. In a second sense of ‘dominant’, our reading acknowledges that there may be exceptions to its claims about the modes of explanation present in the different books;²² its claim is rather that explanations in which material-efficient causes play the only or the primary role are *rare* in books I-IV and that explanations in which teleological causes are primary are rare in book V.

In the section below, we shall provide further support for this reading of the primary methodological passage in *GA* V, showing that Aristotle does not from the outset restrict the explanations he provides in V.1-7 to material-efficient causation alone. Then we will turn to V.8.²³

The Appropriate Mode of Explanation of the Attributes in GA V: The Explanations in Use in GA V.1-7

The explanations in use in *GA* V.1-7 (which discuss the specific kinds of attributes listed in *GA* V.1 778a17-20) offer further support for our readings.

As should be expected from Aristotle’s methodological remarks (cf. also V.3 782a20-24 and V.7 786b23-25), the vast majority of the explanations offered in V.1-7 are of a material nature. The most common type of explanation refers to the material constitution of a part and its specific potentials in each kind of animal. For example, differences in degrees of the liquidity of the eye (where medium liquidity is optimal for sight) determine what particular eye-color animals have (see *GA* V.1 779b7-12, 779b14-33, and 780b3-11) as well as how discriminative their eye-sight is (V.1 779b33-80a13, 780b12-781a11; cf. V.3 782a24-b11 and V.7 787a6-8). (Occasionally, Aristotle also picks out the location of a part or its size as the cause for a particular difference.)²⁴ Others pick out external

²² For example, in the joint explanation of milk in *GA* IV (above, note 19), material necessity plays the primary role: its genesis is an example of what, in sec. 2 below, we call ‘secondary teleology’.

²³ For a detailed outline-analysis of our reading of the whole of 778a29-b19, see the Appendix below.

²⁴ See *GA* V.1 780b12-781a11, V.2 781b5-16, and V.3 783b35-784a3.

or internal efficient causes that affect the material constitution of parts and thereby bring about certain changes (that are not for the sake of something). Such causes are: (a) aging;²⁵ (b) diseases;²⁶ (c) the material potentials of the environment;²⁷ and (d) the kind of food an animal digests.²⁸ And finally, Aristotle sometimes refers more generally to what may be the material nature of the whole animal kind.²⁹

Teleology is mostly absent in these chapters, but Aristotle does on occasion seem to entertain the possibility that some of these attributes might need to be explained teleologically. For instance, there are a few times where Aristotle refers to the goal-directed actions of formal natures,³⁰

²⁵ Aging is a form of decay that causes a deficiency of heat and moisture, which makes the body go cold and dry, which then causes the coming to be of various attributes; see, e.g., *GA* V.1 780a30-32, V.3 783b2-7 and V.4 784a26-34.

²⁶ Diseases are a (temporary) deficiency of natural heat (just as aging is), which can cause the coming to be of attributes; see e.g. *GA* V.1 780a14-21 and V.4 784a25-30.

²⁷ E.g., rainy weather or a damp climate affects the movement of air in the ears and deteriorates hearing (*GA* V.2 781a33-34), and moist environments cause hair to grow straight whereas hot and dry environments cause curly hair (V.3 782b32-783a1); see also *GA* V.3 783a11-32, 784a12-20, V.6 786a30-34, and V.7 788a16-20.

²⁸ E.g., more omnivorous animals are more vari-colored, because 'if foods are the causes of change (εἰ γὰρ αἱ τροφαὶ αἴτιαι τῆς μεταβολῆς), it is reasonable that more varied foods make the motions and the residues of the food more varied, from which hairs and feathers and skins come into being' (*GA* V.6 786a34-b4); see also V.6 786a2-20 and IV.2 767a28-35.

²⁹ E.g., some animals are multi-colored 'because not having a single color belongs to the nature of the whole kind' (*GA* V.6 785b16-786a2; cf. V.1 779b2, V.3 784a4-5, and V.6 786a2-4). Aristotle nowhere offers a teleological explanation for the specific colorations of hairs, but refers its causes in all non-human animals back to the material nature of the skin (V.4 784a23-24: τῶν δὲ χρωμάτων αἴτιον τοῖς μὲν ἄλλοις ζώοις καὶ τοῦ μονόχρου εἶναι καὶ τοῦ ποικίλου ἢ τοῦ δέρματος φύσις), which seems to suggest that the references to nature must be to the animal's *material* nature, rather than to its formal nature. For an alternative understanding of 'the nature of the whole kind' in this passage, however, see Henry (2008), 67-70.

³⁰ For instance, in *GA* V.1 780b9-12 Aristotle explains differently colored eyes within one individual by reference to the formal nature of the animal *falling* (ὅταν οὖν μὴ δύνηται ἀπαρτίσαι ἢ φύσις...) to make the eyes correspond by concoction. There are two other references in *GA* V.1-7 to the goal-directed actions of the formal nature: in *GA* V.3 782a20-22 Aristotle states that he has explained earlier for the sake of what nature has made hairs, but he nowhere provides a teleological explanation of the attributes of hair; in *GA* V.7 786b19-22 he explains why the difference in pitch of voice between male and female is especially clear in human beings, by stating that 'nature has given this faculty to

which suggests that he must have assumed there to be a potential role for teleology to play in the explanation of the attributes under discussion, even though in practice this role turns out to be marginal at the least. For instance, in discussing the attributes of the organs of sight, smell, and hearing (in V.1-2) Aristotle indicates what effects the presence of these attributes has on the performance of the functions of perception (e.g. in V.1 779b33-80a13), although he never embeds this into a teleological explanation or even uses teleological language. It seems that, even though the attributes under discussion here change the sense-organs for the better or the worse, Aristotle does not believe that they come to be for the sake of this functional difference (as he does in the case of the more-and-less differences in sense organs he considers in the *Parts of Animals*: e.g., *PA* II.2 648a13-19, II.13 657a30-b4, 657b30-658a10, and IV.11 691a19-27).

Within *GA* V.1-7, there is only one example of an explanation that is unequivocally teleological in nature (V.2 781b22-28):

Nature acts reasonably also with regard to the things concerning the seal. For, although it is four-footed and live-bearing, it does not have ears but only passages. The cause is that its way of life is in the water. For the part [that is] the ears is attached to the passages for preserving the motion of air from afar: now this is not useful for it, but it would accomplish the opposite by receiving a great amount of water in them [i.e. in the passages].³¹

This explanation of the absence of outer ears in seals follows a discussion of how longer passages in ears and noses produce greater accuracy in perception from afar. It is not clear what the passage is doing here. It is possible to read the absence of outer ears in seals as another example of a difference ‘of the less’, but one would rather expect to find such a teleological explanation of why a type of animal lacks an entire (type of) part

them in the highest degree, because they alone of animals make use of speech, and voice is the material of speech.’ The difference is thus especially audible as a result of there being more voice in human beings than there is in other animals, but this in itself is not for the sake of something.

³¹) Εὐλόγως δ’ ἀπείργασται ἡ φύσις καὶ τὰ περὶ τὴν φώκην· τετράπουν γὰρ ὄν καὶ ζωτόκον οὐκ ἔχει ὠτα ἀλλὰ πόρους μόνον. αἴτιον δ’ ὅτι ἐν ὑγρῷ αὐτῇ ὁ βίος· τὸ γὰρ τῶν ὠτων μόνιον πρόσκειται τοῖς πόροις πρὸς τὸ σώζειν τὴν τοῦ πόρρωθεν ἀέρος κίνησιν· οὐθὲν οὖν χρήσιμόν ἐστιν αὐτῇ, ἀλλὰ καὶ τούναντίον ἀπεργάζοιτ’ ἂν δεχόμενα εἰς αὐτὰ ὑγροῦ πλῆθος.

in the *Parts of Animals*. In fact, the explanation given here complements the short remark about the absence of outer ears in seals that Aristotle makes in *PA* II.12 657a23-25 rather well: contrasting seals with birds and egg-laying four-footers who lack outer ears because of a lack of the kinds of materials from which outer ears are typically formed, Aristotle states that seals lack outer ears because they are 'a deformed four-footed animal' (on the deformity of seals, cf. *HA* II.1 498a32-b4 and *IA* 19 714b12-13). Seals are 'dualizers,' and like other dualizers, they lack the features that are universally present in one of the natures to which they tend (here: outer ears in four-footed animals) if the presence of those features would be harmful or useless to them (cf. *PA* IV.10, 689b31-34, IV.11, 690b19-24, IV.13, 697b1-13 and IV.14). Due to the seal's aquatic way of life the presence of outer ears would impair rather than improve their hearing from afar, and – since 'nature does nothing in vain' – this is why these outer ears are absent. The seal-passage in *GA* V.2 thus elaborates on the rather elliptical remark in the *Parts of Animals*, and so the passage might well be an interpolation.

It is not until Aristotle's discussion of the differences of teeth in *GA* V.8, that we find actual, fully-fledged teleological explanations for the *presence* of attributes, and, as we shall show below, these explanations go hand in hand with references to material necessity.

2. The Appropriate Mode of Explanation of the Differences of Teeth in *GA* V.8

The Connection between GA V.8 and GA II.6

Having treated in *GA* V.1-7 the three sorts of attribute mentioned at the opening of chapter 1 as examples of the book's subject matter (differences of eyes, voice, and color of hair and feathers), Aristotle turns in the book's final chapter, chapter 8, to a fourth sort: differences of teeth (*GA* V.8 788b3-9):

About teeth, it has been stated previously that animals do not have them for one thing, nor [do they have them] all for the sake of the same thing, but some because of nutrition, others also for defense and for speech in sound. Why the front teeth come to be earlier and the grinders later, and [why] the latter do not fall out, but the

former fall out and grow back again – we should consider the explanation [of this] to be of a similar kind to the accounts concerning [their] generation.³²

The explananda of *GA* V.8 are thus (a) why front teeth come to be first and the grinders later, which is a difference in the *timing* of their growth; and (b) why front teeth fall out and grow back again, whereas grinders do not fall out, which is a difference in *shedding*.

The attributes at stake here are similar to the ones explained in *GA* V.1-7 in that the differences of teeth also come to be during the later development of animals and are especially visible in human beings (see *HA* II.1 501a8-II.5 and *HA* IX(VII).10 587b13-16). Aristotle did not mention these differences in his introduction in chapter 1, but the reference to his account of teeth in *Parts of Animals* (in which he identifies the final causes of their presence)³³ is similar to the start of the explanations of the attributes of hair and voice in *GA* V.3 782a20-24 and 786b23-25. Additionally, he explicitly links the present investigation to the accounts about generation in the earlier chapters of *GA*, because it is ‘congenial’³⁴ to them.

In fact, the question Aristotle sets out to answer in *GA* V.8 was already announced in *GA* II.6 (745b13-15: ‘The explanation for why some teeth come to be and fall out but others do not fall out, *will be stated later*’), following an account of the causes of the coming to be of teeth. Since this account forms the background of the causal explanation of the difference of teeth in chapter 8, we shall discuss this first.

³² Περὶ δὲ ὀδόντων, ὅτι μὲν οὐχ ἑνὸς χάριν οὐδὲ πάντα τοῦ αὐτοῦ ἕνεκα τὰ ζῶα ἔχουσιν ἀλλὰ τὰ μὲν διὰ τὴν τροφήν τὰ δὲ καὶ πρὸς ἀλκίην καὶ πρὸς τὸν ἐν τῇ φωνῇ λόγον, εἴρηται πρότερον· διότι δ’ οἱ μὲν πρόσθιοι γίνονται πρότερον οἱ δὲ γόμφιοι ὕστερον, καὶ οὗτοι μὲν οὐκ ἐκπίπτουσιν ἐκεῖνοι δ’ ἐκπίπτουσι καὶ φύονται πάλιν, τοῖς περὶ γενέσεως λόγοις τὴν αἰτίαν συγγενῆ δεῖ νομίζειν.

³³ Teeth are present for the sake of nutrition, and sometimes also for defense and speech; see *PA* II.9 655b2-15, III.1 661a34-662a15, and IV.5 678b6-26.

³⁴ For the use of συγγενῆ as referring to things that belong to the same scientific genus, cf. *APo* I.9 76a1, a9, a30, I.28 87b4, and I.32 88b24. Cf. also Aristotle’s introduction to the *Generation of Animals* in *GA* I.1 715a11-18.

Aristotle's Account of the Coming to be of Teeth in GA II.6

The context of the account of teeth in *GA* II.6 is Aristotle's attempt to track and explain the natural order of generation of the various animal parts within the embryo (see *GA* II.1 733a32, 734a16-34, and II.4 740a2-16). In II.6 744b11-27, he uses an analogy comparing a nature to 'a good housekeeper',³⁵ to illustrate this order: in the allocation of resources, a nature first creates the most important parts from the best materials, and then – provided that there are enough leftovers to spare – uses the extra materials to make parts that perform subsidiary or luxury functions.

We believe that these two categories of parts are the result of two different patterns of causation. Parts that are of vital or essential importance to the animal in question are all the result of what we call *primary teleology*: these parts are the necessary realizations of a pre-existing, internal potential for form, specified by the definition of the substantial being of the animal.³⁶ Because of their importance to the animal for living, these parts come to be first and are generated by that form, or formal nature, through conditional necessity: if there is to be an animal of that form, it *must* have these very parts. Parts that serve subsidiary functions are the result of what we call *secondary teleology*: the materials constitutive of these parts come to be as materially necessary by-products of prior teleological processes and are then *used* by the animal's formal nature, which acts as 'a good housekeeper',³⁷ for the production of parts that while they are not

³⁵ For a discussion of this image of nature as 'a good housekeeper', the hierarchy of parts, and the distinction between primary and secondary teleology, see Leunissen (2010), chapter 3 and (forthcoming). (Gotthelf would like it stressed that the account we develop here of the primary/secondary teleology distinction was originated by Leunissen).

³⁶ This characterization of 'primary teleology' builds on the understanding of teleological causation in the case of animal generation provided in Gotthelf (1987).

³⁷ In a fuller study of what we are calling 'secondary teleology' we would include those cases where a nature uses already formed parts for a second function, without incorporating any additional material. A familiar case is an elephant-nature's use of its already flexible trunk for grasping (*PA* II.16 659a20-36; cf. a21-2: ἡ φύσις παρακαταχρηται, καθάπερ εἴωθεν, ἐπὶ πλείονα τοῖς αὐτοῖς μορίοις). Two more cases are the use in some animals of (i) the air they already breathe for voice as well as respiration and (ii) the tongue already there for taste for articulation. See *DA* II.8 420b13-22 (Aristotle refers to his account of voice in *De Anima* in *GA* V.7 786b24-26): '... it is reasonable that the only creatures to have voice should be those which take in air. For nature then uses the air already breathed in for two functions (καταχρηται ἡ φύσις ἐπὶ δύο ἔργα); just as it uses the tongue for

directly necessary for the form, are necessary for an animal of that form to live or serve the animal's well-being.³⁸ This second category of parts comes into being *after* the first category, since the nature produces parts of the second category only if there is enough residue available from productions of the first category *or* if those productions result in the formation, by material necessity alone, as by-products, of extra materials. If this is not the case, the nature will not be able to produce (all of the) subsidiary parts. Every animal will still have all the parts that are the necessary prerequisites for the performance of its necessary functions (for instance, as Aristotle points out in *GA* I.4 717a11-31 *all* sexually reproducing males need ducts for semen; without this part, reproduction would be impossible for them), but it might lack other features which merely perform subsidiary functions (for instance, not all sexually reproducing males will have testes, but only those in which having testes is possible and in which their presence is 'for the better'). Subsidiary parts are parts an animal – hypothetically speaking – could do without (i.e., the animal *could have been* designed in a way such that it would not rely on the presence of subsidiary parts for its survival); they are not conditionally necessary given the animal's form.³⁹

Both types of parts are present because of the function they perform, so both are caused teleologically. But whereas the causation of first category of parts – the vital and essential ones – is *wholly* due to form (for even the material used in that process is produced of conditional necessity by the organism's – or its mother's – form), the causation of the subsidiary parts *begins* from material by-products of the former process, which are formed at a later stage and then act according to their own natures. The function is imposed on these materials only secondarily to their independent production. That is, the nature did not produce these materials for the sake of (ἐνεκά) realizing a necessary function as in the case of primary teleology, but uses (καταχρηῆται) what is available of material necessity in a way that is (a) consistent with the potentials the available material has of necessity and (b) adds to the well-being of the animal. Aristotle characterizes the resulting part as being 'for the better' or 'for' (πρὸς, εἰς) something.

both tasting and articulation...'. See further n. 35. In the present context, however, the form of secondary teleology specified in our text here is what is at work.

³⁸) Cf. *PA* I.1 640a33-b1.

³⁹) Cf. Gotthelf (1997), 90.

To sharpen further this distinction between primary and secondary teleology, we would like to offer a *non-metaphorical* characterization of secondary teleology, along the lines of the non-metaphorical account we draw on of primary teleology, as the realization of an internal pre-existent potential for form (see note 36). We start from two premises: (i) that there is, throughout the generation of an animal, *one* formal nature, i.e., one 'potential for form', in operation, and (ii) that material by-products of the primary operation of that nature are not part of what that formal nature or potential is a potential to produce, in just the way that the aim (and desire) of the carpenter is not to produce a table *plus* (e.g.) the excess shavings. However, just as the art of woodworking includes the capacity to make good use of leftovers or unexpected extra materials, so too we think it is the case for Aristotle that the one nature, the one potential for form, *includes* the potential to act for the best on (excess) material of a certain sort (should such material happen to be around), at some point in the process *later* than the initial activation of that potential.⁴⁰

In the discussion that follows the analogy, which largely pertains to the nature and the coming to be of bones (744b27-745a18), Aristotle suggests that there are different kinds of material building blocks and residues available to the formal nature of an animal, which all play different roles in the formation of parts. First, there is spermatic residue (S), i.e., the menses of the female, which are from the very beginning available for the development of the embryo in the body of the female. Second, there is natural food (F), of which there are two kinds: natural food that is 'nutritious' (F1) and which is used for the formation of complete parts, and there is natural food that is 'conductive to growth' (F2) and which is used for the quantitative increase of parts that are already complete (i.e. they are fully developed, but may still grow in size). Finally, there are residues of these two kinds of materials (RS, RF1, RF2). Aristotle uses these distinctions among the available materials to differentiate between bones and sinews on the one hand, which come to be in the first formation of parts and are made from the spermatic residue (RS), and parts such as 'nails, hair, hoofs, horns, beaks, the spurs of birds, and any other such part' (745a1-3), on the other hand, as being made 'from the food that is

⁴⁰ We provide a fuller picture of this non-metaphorical account of secondary teleology in Gotthelf (forthcoming), ch. 5, n. 40.

taken in later and is concerned with growth (F2), which is acquired from the mother and from the outer world' (745a3).

Teeth are not mentioned until after Aristotle completes his discussion of the distinction between these two groups of subsidiary parts, apparently because teeth present a problem (745a18: Περὶ δ' ὀδόντων ἀπορήσειεν ἄν τις). The problem pertains to the categorization of teeth (745a19; 745b2-4): are teeth like bones (and sinews) or not? That teeth are subsidiary parts (they are either present for the preparation of food or for defense, or both: see note 33 above),⁴¹ rather than vital or essential ones, is already implied in an explanation of the coming to be of horns Aristotle offers in *PA*, where he mentions teeth as being among those parts that are made from residues (*PA* III.2 663b22-35):

But we must say what the character of the necessary nature is, and, how nature according to the account *makes use* of things present of necessity for the sake of something. . . . For the residual surplus of this sort of body [i.e. earthen], being present in the larger of the animals, is *used* by nature *for* protection and advantage, and the surplus, which flows of necessity to the upper region, in some cases it *distributes* to *teeth* and tusks, in other cases to horns.⁴²

⁴¹) Strictly speaking, and at the most general level, the function of nutrition in animals requires – i.e., conditionally necessitates – only the presence of a part for the intake of nourishment and for the excretion of residues (*PA* II.10 655b29-31) and a part in which the incoming food is changed (*PA* III.14 674a12-16; cf. 674a21-22: the contributory (συντελεῖς) parts for the stomach referred to likely include teeth); teeth are not necessary in this strict sense, as is evidenced by the fact that some kinds of animals, such as birds, lack teeth entirely and are nevertheless able to perform the function of nutrition.

This subsidiary status of teeth, however, does not necessarily pose problems for Aristotle's reliance on the example of the growth of teeth in his defense of natural teleology in *Ph* II.8 198b16-199a8: the three examples (growth of crops, teeth, and entire organisms) presented by the materialist opponent represent for Aristotle *increasingly stronger cases of teleology*, starting with a kind of artificial production that is most natural (cf. ps.-Arist. *Econ* I.2 1343a24-b1), and ending with a kind of natural phenomenon that can only be explained by reference to primary teleology. The example of teeth presents a case in between, as being due to secondary teleology. For a defense of this reading, see Leunissen (2010), chapter 1.

⁴²) πῶς δὲ τῆς ἀναγκαίας φύσεως ἐχούσης τοῖς ὑπάρχουσιν ἐξ ἀνάγκης ἢ κατὰ τὸν λόγον φύσις ἕνεκά του κατακέχρηται, λέγωμεν. . . . Τὴν γοῦν τοιοῦτου σώματος περισσοματικὴν ὑπερβολὴν ἐν τοῖς μείζουσι τῶν ζῴων ὑπάρχουσαν ἐπὶ βοήθειαν καὶ τὸ συμφέρον καταχρητῆται ἢ φύσις, καὶ τὴν ῥέουσαν ἐξ ἀνάγκης εἰς τὸν ἄνω τόπον τοῖς μὲν εἰς ὀδόντας καὶ χαυλιόδοντας ἀπένειμε, τοῖς δ' εἰς κέρατα.

The image of nature using materials available of necessity indicates that teeth are a product of secondary teleology (as are, we would argue, hair and voice: on hair, see *GA* II.6 744b25 and 745a1; on voice, see note 37 above). The question Aristotle sets out to settle in *GA* II.6 745a18 is rather *what kind* of subsidiary part teeth are. As he points out in the next lines, teeth are of the same nature as bones (cf. *HA* I.11 493a2: ὀδόντες ὀστέϊνοι), and they thus belong to the first group of subsidiary parts, but not without qualification: the coming to be of teeth is intrinsically connected to the growth of bones, but in a way that makes their coming to be dependent on and secondary in time to the growth of bones (745b2-5):

And it turns out that teeth do not have the same nature as the other bones: for they all come to be in the first formation and none of them later, whereas teeth come to be later.⁴³

The explanation is that, whereas bones come to be from the spermatoc residue (RS) and take their growth from the residues of the natural food (RF1) that is not used up for the production of the ‘most important parts’ (744b27-38), teeth come to be from the bones (745a19-20). More precisely, teeth come to be from the food distributed to the bones (RF1) but that is not used up by the bones for their growth – once the bones ‘have reached their number’, teeth come to be (745b7-9). In other words, teeth come to be from the leftovers of materials that were conditionally necessitated for some other use.

The particular connection of teeth to the growth of bones also accounts for two of their distinctive features. First, unlike the other bones, teeth can keep growing throughout the animal’s lifetime (745a25), as long as there are residues available from the food distributed to the bones. (As Aristotle is quick to point out in 745a27-b2, the continuous growth of teeth also serves a final cause: they would blunt fast, if there were not some flow of materials towards them.) Second, because teeth are not grown together with bones and come to be later, they can also grow back again (only once in human beings, but repeatedly over their lifetime in some of the other animals with teeth, such as in sharks and reptiles) after they have fallen out. As we shall see shortly, Aristotle’s explanation of the

⁴³ συμβαίνει δὲ μηδὲ τὴν αὐτὴν ἔχειν φύσιν τοῖς ἄλλοις ὀστοῖς τοὺς ὀδόντας: τὰ μὲν γὰρ ἐν τῇ πρώτῃ συστάσει γίνονται πάντα καὶ οὐθὲν ὕστερον, οἱ δ’ ὀδόντες ὕστερον.

differences of teeth in book V, chapter 8 builds upon these two distinctive features.

Aristotle's Account of the Differences of Teeth in GA V.8

Aristotle's explanations in book V, chapter 8 also exhibit the pattern of secondary teleology, involving references both to an initial material necessity and to a subsequent final causation. Aristotle mixes his explanations with criticisms of Democritus' account of the differences of teeth; for the sake of clarity, we shall reconstruct Aristotle's explanations separately and then turn to his critique of Democritus.

Aristotle starts his explanation of the difference in the timing of the growth of the front teeth and the grinders by applying the teleological principle that 'nature does nothing in vain, but always, given the possibilities, does what is best for the substantial being of each kind of animal' (*GA* V.8 788b20-24):⁴⁴

But since we suppose – making suppositions based on the things we observe – that nature neither falls short nor produces anything pointless among the possibilities in each case, it is necessary for animals that are to take in nourishment after suckling to have instruments for the chewing of food.⁴⁵

Usually Aristotle invokes this principle to identify the causally basic feature of some animal that explains why it has the specific part it has, when observation of the wider kind shows that there are multiple ways in which its nature could have realized the function the part in question fulfills (see, e.g., Aristotle's explanation of why humans have hands instead of forelimbs in *PA* IV.10 687a15-18). Here he uses the principle to identify the causally basic feature that explains why teeth arise *at the time* they do: among the possibilities, it is best for teeth to arise after suckling (and not when approaching maturity, as Democritus claimed: 788b25), because *that* is when animals need instruments for chewing. If teeth arose earlier, they would be pointless; if they arose later, 'nature would have failed to do

⁴⁴ For formulations of the complete principle, see *IA* 2 704b12-18, 8 708a9-12, and 12 711a18-29. See also Lennox (2001b), 205-223.

⁴⁵ ἐπεὶ δὲ τὴν φύσιν ὑποτιθέμεθα, ἐξ ὧν ὀρώμεν ὑποτιθέμενοι, οὐτ' ἐλλείπουσιν οὔτε μάταιον οὐθὲν ποιῶσαν τῶν ἐνδεχομένων περὶ ἕκαστον, ἀνάγκη δὲ τοῖς μέλλουσι λαμβάνειν τροφήν μετὰ τὴν [τοῦ γάλακτος] ἀπογαλάκτισιν ἔχειν ὄργανα πρὸς τὴν ἐργασίαν τῆς τροφῆς.

something that is among the possibilities for it' (788b25-26; cf. *GA* II.6 744a35-b1 and *DA* III.12 434a30-b8). In *GA* II.6 Aristotle explained that the growth of teeth occurs after 'the first generation of parts' when there are residues available from the food assigned to the growth of bones. The exact timing, however, of *when* formal natures use these residues for the production of teeth is determined by the animals' functional needs (including the needs of the process by which they are produced).

The full explanation of the difference in timing appeals both to teleology and material necessity (788b29-789a4): front teeth arise before grinders because their function is needed earlier than the function performed by grinders *and* because 'what is smaller – *even* when set in motion at the same time – by nature comes to be faster than the bigger'. Grinders are bigger than front teeth, because the jaw-bone is narrower towards the front of the mouth, and bigger and flat where the grinders grow, and *of necessity* there is a bigger outflow of food to the surface from what is bigger. The remark 'even when set in motion at the same time (κἀν ἅμα ὀρμηθῆ)' is significant: even if formal natures did not divert the residues first to front teeth and later to grinders, the *same* beneficial result would have occurred of material necessity alone.

The explanation of the differences of shedding also refers both to teleology and necessity (789a8-14): front teeth blunt fast, so they need to be replaced if animals are to remain able to cut food. However, there is no such functional need for grinders (they do not blunt, but get smooth): it is therefore 'for the better' (τοῦ μὲν βελτίονος χάριν) that front teeth shed, and not grinders, which do not need replacement. Front teeth also shed of material necessity (ἐξ ἀνάγκης δ'): whereas grinders are fixed firmly in the broad, strong parts of the jaws, front teeth grow in the thinnest parts and are therefore easily moved.⁴⁶

Finally, the availability of constitutive materials is given as the one and only explanation why front teeth grow back after shedding (789a14-17): they grow back 'because the shedding occurs while the bone is still growing and there is still time for teeth to grow.' This explanation builds upon Aristotle's discussion of teeth in *GA* II.6: front teeth are shed while there

⁴⁶ In the biological works, Aristotle typically provides such double-barreled explanations for subsidiary parts or differences: the 'for the better' picks out the operation of secondary teleology, the 'of necessity' the operation of material necessity. For examples, see *GA* I.4 717a12-21 and 26-31; *PA* II.14 658b2-10, III.9 672a1-21, IV.3 677b22-32, and IV.12 694a22-b11; cf. also Leunissen (2007), 173-74.

is still a supply of food assigned to the growth of bones, which leaves enough residue for a second set of front teeth to grow (and for wisdom teeth to form: *GA* V.8 789a16-20).

In both explanations of the differences of teeth, teleology and material necessity are identified as operating alongside and even as complementing each other, just as teeth themselves come to be both of material necessity and due to (secondary) teleology.

For Aristotle's views about the interaction of these two forms of causation, we need to turn to his second criticism of the explanations provided by Democritus (*GA* V.8 789b2-15):⁴⁷

Democritus, neglecting to state that for the sake of which, brings back all things of which nature makes use to necessity – they are such, but on the other hand they are for the sake of something and for the best concerning each. Thus nothing prevents [them] from coming to be this way and being shed, but it is not because of those but because of the end. For those things are causes in the sense of being the movers and the instruments and the material, since it is also likely that the operation of *pneuma* is as an instrument for many things – as for instance some [instruments] are of many uses to those involved in arts, such as the hammer and anvil in the art of the smith, so too is *pneuma* in those things which are put together by nature. It seems that to say that the causes are of necessity is similar to if somebody would think that it is only because of the surgeon's knife that the water has been drawn off in those who are dropsical, but not because of being healthy, for the sake of which the knife made the cut.⁴⁸

The basic mistake Democritus made according to Aristotle is not the fact that he explained *all* natural phenomena in terms of material necessity, but that he *failed to state* the final cause of all those things *which nature uses*. We take it that what Aristotle is saying here is that in cases where the formal nature of an animal makes use of things that have come to be of

⁴⁷ In his first critique of Democritus, Aristotle faults Democritus for providing a general explanation without having examined all cases (*GA* V.8 788b9-21).

⁴⁸ Δημόκριτος δὲ τὸ οὐδ' ἔνεκεν ἀφείξ λέγειν πάντα ἀνάγει εἰς ἀνάγκην οἷς χρῆται ἡ φύσις – οὐδὲ μὲν τοιούτοις, οὐ μὴν ἀλλ' ἔνεκά τινος οὐδὲ καὶ τοῦ περὶ ἕκαστον βελτίονος χάριν. ὥστε γίνεσθαι μὲν οὐθὲν κωλύει οὕτω καὶ ἐκπίπτειν, ἀλλ' οὐ διὰ ταῦτα ἀλλὰ διὰ τὸ τέλος· ταῦτα δ' ὡς κινουῦντα καὶ ὡς ὄργανα καὶ ὡς ὕλη αἴτια, ἐπεὶ καὶ τὸ τῷ πνεύματι ἐργάζεσθαι τὰ πολλὰ εἰκὸς ὡς ὀργάνων – οἷον γὰρ ἕνια πολὺχρηστά ἐστὶ τῶν περὶ τὰς τέχνας, ὥσπερ ἐν τῇ χαλκευτικῇ ἢ σφύρα καὶ ὁ ἄκμων, οὕτω καὶ τὸ πνεῦμα ἐν τοῖς φύσει συνεστῶσιν. ὅμοιον δ' ἔοικε τὸ λέγειν τὰ αἴτια ἐξ ἀνάγκης κἂν εἴ τις διὰ τὸ μαχαίριον οἶοιτο τὸ ὕδωρ ἐξεληλυθέναι μόνον τοῖς ὑδρωπιῶσιν, ἀλλ' οὐ διὰ τὸ ὑγιαίνειν οὐδ' ἔνεκα τὸ μαχαίριον ἔτεμεν.

material necessity, one should include a reference to the function for which those things are used in the explanation *as well*.⁴⁹ As Aristotle points out (in *GA* V.8 789b3-4): the coming to be of such things *is* materially necessitated, but that is not the whole story – they also serve a purpose in the animals that have those features because of the use nature has made of them.

In his application of this critique to the example of the shedding of teeth, Aristotle claims that front teeth come to be and are shed of material necessity, but that ultimately phenomena such as these should be explained by reference to (a form of) teleology, because it is ultimately the formal nature of an animal that is responsible for using those ‘materials’ and ‘instruments’ – such as *pneuma* – in a goal-directed way within the animal. It is usually assumed that Aristotle here offers a general defense of teleology and speaks of the operation of material necessity only within the framework of an operation of conditional necessity.⁵⁰ However, if we limit the scope of Aristotle’s critique to Democritus’ explanation of teeth and of any other such feature that is the result of nature *using* what is present of material necessity, such an interpretation might well be too strong. Aristotle’s own explanations of the differences of teeth, alongside many other examples throughout the biological works and especially the ones provided in chapters 1-7, offer sufficient evidence that material necessity can operate independently of teleology, and that formal natures often, though not always,⁵¹ make use of what happens of material necessity for something good, where this good is not already specified in the definition of the animal’s substantial being.

Aristotle refers to this distinction between the attributes of teeth that are used for something and the attributes discussed in the first seven chap-

⁴⁹ See also Aristotle’s final example of water-drawing, where he equates ‘stating that the causes are of necessity’ with believing that the water draws off *only* because of the knife’s cut, and not because of health, which is that for the sake of which the cut was made. The suggestion is again that some phenomena are due to the operation of both material necessity and (secondary) teleology, and their explanations thus need to pick out both causes.

⁵⁰ E.g., Cooper (1987), 259, 268.

⁵¹ Cf. *PA* IV.2 677a15-18: ‘Sometimes a nature makes use even of residues for some benefit (κατάχρηται μὲν οὖν ἐνίοτε ἡ φύσις εἰς τὸ ὠφέλιμον καὶ τοῖς περιττώμασιν), yet one should not on this account search for what something is for in every case; on the contrary, when certain things are such as they are, many other such things happen from necessity because of these.’

ters that do not serve any teleological purposes in his summary of book V at the end of the chapter V.8, 789b16-20:

We have thus spoken of teeth, saying why some fall out and grow again, and others not, and generally because of what cause they come to be. And we have spoken also of the other attributes of parts, as many as turn out to come to be not for the sake of something but of necessity and because of the moving cause.⁵²

Aristotle first sums up the immediately preceding account of teeth: it has now been stated (in chapter 8) why there is a difference in the shedding of teeth, and why they come to be in general (in 788b3-6, summing up the accounts provided in the *Parts of Animals*). The next section sums up the earlier accounts of book V and *contrasts* them with the account of the differences of teeth: he has also spoken of the *other* attributes (in chapters 1-7), which are characterized by the fact that they do *not* come to be for the sake of something, but arise due to material and efficient causes alone.

Aristotle thus signals a discontinuity between the first seven chapters of book V and chapter 8, but if our interpretation of chapter 8 is correct, this discontinuity does not run very deep: the dominant type of causation in the coming to be of all attributes of parts discussed in book V is material-efficient causation, but the differences of teeth discussed in chapter 8 are different in that they, unlike the others, are *also* (though secondarily) for the sake of something.

3. Concluding Remarks

The upshot of the preceding analysis of Aristotle's explanation of the differences of teeth for our assessment of the scope and nature of book V is as follows.

First of all, we found that the differences of teeth discussed in chapter 8 are similar to the particular attributes of eyes, hair, and voice discussed in chapters 1-7 in that all are differences of the more and the less that come to be due to material and efficient causes during the later development of

⁵²) Περὶ μὲν οὖν ὀδόντων, διότι οἱ μὲν ἐκπίπτουσι καὶ γίνονται πάλιν οἱ δ' οὐ, καὶ ὅλως διὰ τίν' αἰτίαν γίνονται εἴρηται. εἴρηται δὲ καὶ περὶ τῶν ἄλλων τῶν κατὰ τὰ μέρη παθημάτων ὅσα γίνεσθαι συμβαίνει μὴ ἕνεκά του ἀλλ' ἐξ ἀνάγκης καὶ διὰ τὴν αἰτίαν τὴν κινητικὴν.

the animals that have them, and most particularly human beings. The scope of book V is thus not limited to the explanation of accidental, individual differences among animals, but encompasses some of the most variable attributes that come to be, in one variant or another, in either whole species or in individuals during their later life, and that are very conspicuous in human beings. What unites all explanations of the attributes discussed in book V is that they pick out material necessity as the primary cause for the later development or changes responsible for these attributes. The differences of teeth are different, however, in that the formal natures of animals with teeth use or co-opt the differences of teeth that come to be of material necessity for something good, whereas this is evidently not (explicitly) the case for the other attributes.

Secondly, Aristotle's concern for the appropriate mode of explanation to be used for the explanation of the differences of teeth (expressed in his critique of Democritus) is consistent with his advice in his introduction in the first chapter of book V: in both cases, Aristotle warns us not to think that the manner of explanation is the same for all explananda. As is evidenced also by the actual explanations provided across book V, as we have seen, Aristotle never bans the use of teleology for the explanation of attributes in book V, but only insists that it should be applied to the appropriate phenomena.

Finally, as for the place of book V in the *Generation of Animals* as a whole, there is sufficient evidence that the particular explanations of the differences of teeth provided in chapter 8, just as the explanations of the other attributes discussed in chapters 1-7, presuppose and build upon Aristotle's earlier accounts of the coming to be of the parts themselves. Together with the explicit cross-references between book V and the earlier books, this suggests that Aristotle considered all these books as part of one and the same investigation into the coming to be of animals and their parts. Also, the continuity in content and method between chapters 1-7 and chapter 8 in our opinion outweighs its discontinuity: the hypothesis that chapter 8 is unrelated to the preceding seven chapters and forms instead a separate appendix to books I-IV, ought to be rejected.

Bibliography

- Balme, D. M. (1987a), 'The Place of Biology in Aristotle's Philosophy', in Gotthelf & Lennox, 9-20.
- . (1987b), 'Aristotle's Use of Division and Differentiae', in Gotthelf & Lennox, 69-89.
- . (1992), *Aristotle's De Partibus Animalium I and De Generatione Animalium I (with excerpts from II.1-3)*, rev. edn. with a Report on Recent Work and Additional Bibliography by Allan Gotthelf, Oxford (orig. edn. 1972).
- Bolton, R. (1987), 'Definition and Scientific Method in Aristotle's *Posterior Analytics* and *Generation of Animals*', in Gotthelf & Lennox, 120-166.
- Cho, D.-H. (2003), *Ousia und Eidos in der Metaphysik und Biologie des Aristoteles, Philosophie der Antike Band 19*, Stuttgart.
- Code, A. (1987), 'Soul as Efficient Cause in Aristotle's Embryology', *Philosophical Topics* 15, 51-59.
- Coles, A. (1995), 'Biomedical Models of Reproduction in the Fifth Century BC and Aristotle's *Generation of Animals*', *Phronesis* 40, 48-88.
- Cooper, J. M. (1990), 'Metaphysics in Aristotle's Embryology', in D. Devereux & P. Pellegrin (eds.), *Biologie, Logique et Métaphysique chez Aristote*, Paris, 55-84.
- Gotthelf, A. (1987a), 'First Principles in Aristotle's *Parts of Animals*', in Gotthelf & Lennox, 167-198.
- . (1987b), 'Aristotle's Conception of Final Causality', in Gotthelf & Lennox, 204-242.
- . (1997), 'The Elephant's Nose: Further Reflections on the Axiomatic Structure of Biological Explanation in Aristotle', in W. Kullmann and S. Föllinger (eds.), *Aristotelische Biologie: Intentionen, Methoden, Ergebnisse*, Stuttgart, 85-96.
- . (forthcoming), *Teleology, First Principles, and Scientific Method in Aristotle's Biology*. Oxford Aristotle Studies. Oxford.
- Gotthelf, A. & J. G. Lennox (eds.) (1987), *Philosophical Issues in Aristotle's Biology*, Cambridge.
- Henry, D. (2006a), 'Understanding Aristotle's Reproductive Hylomorphism', *Apeiron* 39.3, 257-287.
- . (2006b), 'Aristotle on the Mechanisms of Inheritance', *Journal of the History of Biology* 39.3, 425-455.
- . (2007), 'How Sexist is Aristotle's Developmental Biology?', *Phronesis* 52, 251-269.
- . (2008), 'Organismal Natures', in J. Mouracade (ed.), *Aristotle on Life*. Kelowna, BC, 57-74.
- . (2009), 'Generation of Animals', in: G. Anagnostopoulos (ed.), *A Companion to Aristotle*. Oxford, 368-383.
- Johnson, M. R. (2005), *Aristotle on Teleology*, Oxford.
- Lennox, J. G. (2001a). *Aristotle's Philosophy of Biology, Studies in the Origins of Life Science*, Cambridge.
- . (2001b). *Aristotle on the Parts of Animals I-IV, Translated with an Introduction and Commentary*, Oxford.

- Leunissen, M. (2007), 'The Structure of Teleological Explanations in Aristotle: Theory and Practice', *Oxford Studies in Ancient Philosophy* 33, 145-178.
- . (2010), *Explanation and Teleology in Aristotle's Science of Nature*, Cambridge.
- . (forthcoming), 'Nature as a Good Housekeeper. Secondary Teleology and Material Necessity in Aristotle's Biology', *Apeiron*.
- Liatsi, M. (2000), *Aristoteles, De Generatione Animalium, Buch V, Einleitung und Kommentar*, Trier.
- Lloyd, G. E. R. (1990), 'Aristotle's Zoology and his Metaphysics: The Status Quaestionis; A Critical Review of some Recent Theories', in D. Devereux & P. Pellegrin (eds.), *Biologie, Logique et Métaphysique chez Aristote*, Paris, 7-35; repr. in G. E. R. Lloyd, *Methods and Problems in Greek Science: Selected Papers* Cambridge 1993, 372-397.
- Louis, P. 1961, *Aristote: De la generation des animaux*, Paris.
- Michael of Ephesus see Ps.-Philoponus.
- Morsink, J. (1982), *Aristotle on the Generation of Animals: A Philosophical Study*, Washington D.C.
- Peck, A. L. (1942), *Aristotle: Generation of Animals*, London; repr. 1979.
- Pellegrin, P. (1986), *Aristotle's Classification of Animals: Biology and the Conceptual Unity of the Aristotelian Corpus*, translated by A. Preus, Berkeley.
- Ps.-Philoponus (Michael of Ephesus), *In Libros de Generatione Animalium Commentaria*, ed. M. Hayduck (1903), *Commentaria in Aristotelem Graeca* 14.3.
- St.-Hilaire, J. B. (1887), *Traité de la génération des animaux d'Aristote: Traduit en français pour la première fois et accompagné de notes perpétuelles*, Tome 1 & 2, Paris.
- Witt, C. (1985), 'Form, Reproduction, and Inherited Characteristics in Aristotle's *Generation of Animals*', *Phronesis* 30, 46-57.
- Zeller, E. (1897), *Aristotle and the Earlier Peripatetics*, 2 vols., tr. B. F. C. Costello and J. H. Muirhead, London, New York & Bombay.

**Appendix: GA V.1 778a29-b19: The Manner of Explanation
Appropriate to the Attributes Now under Study**

1. (a29-30) Introduction via a contrast: the manner of explanation is ‘no longer the same’ as was appropriate previously (i.e., in *GA* I-IV).
2. (a30-32) Distinction between two manners of explanation, the primary one to be used in *GA* V, distinguished from the primary one used previously, by reference to the dominant mode of causation employed in each case:
 - [i] The subject neither is nor comes to be for the sake of something.
[Of this sort are] things that are:
neither (α) products of a nature in common (*sc.* across several kinds)
nor (β) distinctive features ($\text{\textit{\iota}}\delta\text{\textit{\iota}}\alpha$) of any particular kind [cf. n. 15 above].
 - [ii] The subject is [and comes to be?] for the sake of something.
3. (a32-34) Examples of each of the two dominant modes of causation in 2.:
 - [ii] An eye is present for the sake of something
 - [i] Its being blue is not (unless this attribute is distinctive ($\text{\textit{\iota}}\delta\text{\textit{\iota}}\nu$) to the kind of animal its possessors belong to) [cf. n.15 above]
4. (a34-b1) Fuller statement of the first of the two manners of explanation just distinguished, the one which is appropriate to (at least the majority of) the attributes under discussion in *GA* V:
In those cases where the attribute being explained does not (as [ii] would require) reach back to ($\sigma\upsilon\nu\tau\epsilon\text{\textit{\iota}}\nu\epsilon\text{\textit{\iota}}$) the account of the substantial being ($\lambda\acute{o}\gamma\omicron\varsigma\ \tau\eta\varsigma\ \omicron\upsilon\sigma\acute{\iota}\alpha\varsigma$; *sc.* of the animal possessing it), then the attribute must (qua case of [i]) be referred to ‘the matter and the source of motion, as coming to be of necessity’.
5. (b1-10) Reminder of what we know of things explained that come to be for the sake of something (= [ii]) and critique of predecessors:
 - [a] As has been said in the opening $\lambda\acute{o}\gamma\omicron\iota$ (*sc.* *PA* I; cf. 640a10ff), in the case of ‘the ordered and determinate

products of <a> nature', coming to be follows upon and is for the sake of substantial being (οὐσία – and so it's not because a thing comes to be of a certain character that it is that character, but rather because it is of this particular character that it comes to be such as it does).

[b] Earlier natural philosophers thought the opposite, for one reason because they didn't realize that the causes are many but saw *only* the cause that belongs to the matter and the one that belongs to the motion (and did not distinguish these).

6. (b10-19) Fullest statement of the contrast between the two modes of causation (and their respective sorts of necessity) that are dominant, respectively, in the two manners of explanation of the coming to be of animal differences previously distinguished:

[ii] The teleological mode (essential to teleological explanations of the primary sort): The difference whose coming to be is being explained is formed both for the sake of the animal which is to possess it and through the other causes, and the necessity involved is *conditional necessity*. (b10-14)

[i] The non-teleological mode (essential to explanations that are primarily material-efficient): The difference being explained is formed (*sc.* not because the animal's substantial being (οὐσία) requires it, as in [ii], but) in the very constituting (συστάσις: *sc.* of the animal), as a result of the movement (κίνησις) and formation (γένεσις) going on itself, via *the (non-conditional) necessity of* 'its being its nature to act or be acted upon in this or that way'. (b14-19)