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Understanding Aristotle's Reproductive Hylomorphism

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Introduction

In *Generation of Animals* (GA) Aristotle develops a thesis about the distinctive contributions made by each parent to the process of reproduction. In its most general formulation, the thesis states that the father contributes the form (εἶδος) while the mother contributes the matter (ύλη).² I shall call this thesis 'reproductive hylomorphism'. At first glance Aristotle's reproductive hylomorphism seems straightforward. The mother provides a quantity of unformed matter which the father (or rather his semen) then forms into an individual of some determinate kind just as the sculptor forms the unsculpted bronze into a statue of Hermes. However, as we shall see, things are not as straightforward as this. Saying that the mother provides the matter certainly does mean that her contribution is used to make the parts of the offspring, and so in this

1 This paper was developed out of a chapter of my Ph.D. dissertation at Kings College London. I am grateful to Richard Sorabji, M.M. McCabe, Bob Sharples, Lindsay Judson, and Jim Lennox for their useful comments on earlier drafts.

2 E.g., GA I 20, 729a9-12; I 21, 729b18-19; II 1, 732a4-5; II 4, 738b26-8. In other places Aristotle simply says the male contributes the 'starting-point of the change' (ἀρχὴ τῆς κινήσεως: e.g., I 2, 716a4-7; I 21, 730a24-30; II 4, 740b25-6), which refers to its role as a catalyst for the process of development (cf. III 1, 750b20: τὴν ὁρμήν). Although this is not equivalent to the father's role as supplier of form, in certain contexts these two functions are bound up with one another.

sense it is analogous to unsculpted bronze.³ But it is far from obvious what Aristotle means by saying that the father provides ‘the form’.

The aim of this paper is to shed light on Aristotle’s matter-form hypothesis. I shall attempt to do this by exploring an apparent inconsistency that many commentators have identified between Aristotle’s reproductive hylomorphism, on the one hand, and his views about maternal inheritance, on the other. The problem is that in *GA* IV 3 Aristotle appears to assign a formal contribution to the mother, which many have come to see as being completely at odds with the strict hylomorphism that dominates the first three books of the *GA*. The problem is how to resolve this apparent inconsistency.

The Problem of Maternal Inheritance

According to the theory of inheritance set out in *GA* IV 3 an animal’s ability to generate a new individual resembling itself is explained by the fact that its sperma contains a set of κινήσεις or ‘movements’ whose function is to transmit the heritable properties of its bodily form.⁴ Aristotle divides these spermatic movements into three groups (*GA* IV 3, 768a11-14): those of the individual generator (τοῦ γεννῶντος); those of the universals (τῶν καθόλου); and those of the ancestors (τῶν προγόνων). For this paper I shall concentrate only on those in the first group.

The movements corresponding to the individual generator include two movements (or sets of movements): one corresponding to the generator’s sexual morphology and one corresponding to those properties that we can classify under the general heading of family resemblances (e.g., eye color, nose shape, etc.).⁵ For example, at 768a28-9 Aristotle

3 At one point Aristotle even compares menstrual fluid to prime matter (*GA* I 20, 729a32-3).

4 See, esp., *GA* 767b35-8a2: ‘there are movements present in the seeds <of animals> derived from the potentials of all of these sorts of things [e.g., male, Socrates, human, animal] ...’. The fact that these movements are derived from a set of ‘potentials’ (δυνάμεις) associated with the formal properties of the body will become important later on. For a detailed discussion of this mechanism see Henry forthcoming.

5 Aristotle does not mention which properties are matters of family resemblance, though facial features would have been the most obvious.

draws the distinction between 'the movement coming from male' (ἡ ἀπὸ τοῦ ἄρρενος κίνησις) and 'the movement coming from Socrates' (ἡ ἀπὸ τοῦ Σωκράτους κίνησις). By distinguishing the movements for sex and resemblance Aristotle was able to explain why some males resemble their mothers while females sometimes resemble their fathers: 'If the movement coming from *male* dominates but the movement from *Socrates* does not dominate, or the latter does but the former does not, then males come to be resembling their mother and females their father.' The movements in Socrates' semen are supposed to be further divisible into movements corresponding to his parts (768b2). For example, 'the movement coming from Socrates' is analyzed into a set of movements corresponding to those features that distinguish him from other human beings, such as his snub-nose and particular shade of eye color. This further analysis is important for explaining how the offspring can resemble one individual in some parts and another in other parts (767b1-2).⁶

At this point it is necessary to establish some preliminary points. It is important that when it comes to generating offspring Aristotle distinguishes between being male or female and resembling different family members. Although these are usually determined together (768a22-7), as we have seen, Aristotle thinks the distinction is critical for explaining why males sometimes resemble their mothers while females sometimes resemble their fathers. However, there is also a distinction to be made when it comes to biological sex itself. While Aristotle recognizes that being male or female depends on having certain parts, he claims that 'male' and 'female' in the primary sense ultimately refer to the ability and inability to fully concoct the nourishment and convert it to semen (γονή). A 'male' is an animal that possess this capacity while a 'female' is defined by the corresponding incapacity (the privation). Although I shall not argue for this, Aristotle thinks these two aspects of biological sex are determined by different causal mechanisms. The semen makes the embryo male or female in the functional sense by concocting the menstrual fluid, which gradually raises its temperature (since whether or not an animal has the ability in question depends on whether or not its principle of natural heat lies above a certain threshold). The inheri-

⁶ This probably only applies to family resemblances, since offspring do not have mix-matched sexual morphologies (though see *GA* IV 4, 772b27ff.).

tance of sexual morphology, on the other hand, is governed by the same mechanism that governs the inheritance of family resemblances in *GA IV 3*, which is different from (although closely connected with) the mechanism of concoction described in *GA IV 1*. Inheritance primarily involves the transmission of shape and structure, which is why Aristotle introduces specialized movements in *GA IV 3* that somehow code for the morphological features of the organism's body.⁷

The purpose of this digression was to establish two preliminary points. First, *GA IV 3* carefully distinguishes between the movements that code for the animal's sex and those that code for family resemblances (such as eye color and nose shape). This is what allows Aristotle to explain why males sometimes resemble their mothers while females sometimes resemble their fathers. Second, Aristotle distinguishes two aspects of biological sex: the sexual parts (morphology) and the capacity to produce semen (function). In *GA IV 3* 'male' and 'female' generally refer, not to the functional properties, but to the corresponding sexual parts which are present for the sake of those functions. So, for example, when Aristotle speaks of the movement of the male he is referring to the causal factor behind the inheritance of the parts that make the offspring male. In what follows I shall have nothing to say about males and females in the functional sense; like *GA IV 3*, this paper's concern with sex is limited to the inheritance of sexual morphology.

On the standard reading of *GA IV*, the movements supplied by Socrates through his semen literally fashion the material supplied by the female into an offspring resembling him in different respects. According

⁷ I argue for this in detail in Henry 2004. The need to introduce a separate mechanism in *GA IV 3* to explain resemblances, including general resemblances in sexual morphology, has to do with the nature of the properties being explained there. In *GA IV 1* Aristotle is only concerned with the functional property that ultimately defines males and females, namely the capacity (and incapacity) to concoct blood into semen. And whether or not an animal has this property, and thus whether or not it is male or female (functionally defined), depends on the level of natural heat in its heart (*GA IV 1*, 766a31-b5; cf. *I 2*, 716b3-12; *V 7*, esp. 788a13-16). Thus seminal concoction is sufficient to produce that property, since concoction has the effect of increasing heat. However, simply raising the temperature of the menstrual fluid would not adequately explain why the offspring comes to have certain parts (likewise for family resemblances). This is why we find Aristotle appealing to spermatoc 'movements' in *GA IV 3*, which I shall argue are specialized information-bearing vehicles of sorts.

to Cooper, for example, the father's semen is 'the causal agent active in generation' which possesses 'specific movements (*κινήσεις*) that are such as *to shape the material* that the female provides in her womb into a member of the same species.'⁸ Likewise, Furth takes the father's semen to be 'active and formative in character, being pre-programmed with a variety of highly intricate "motions", which "shape" and "set" the catamenia in stages as development advances.'⁹ Furth goes on to criticize Aristotle's account of reproduction for this idea:

... much of this account is factually incorrect: it is a mistake to suppose that only the male parent makes a genetically significant contribution to the specific form of the offspring ... and Aristotle's idea of the causal influence that is exercised by this genetic contribution, literally "shaping" and "forming" the matter, is by present-day lights quite crude and childlike compared to the actual mechanisms involved, which are more complicated and more indirect as between the nature of the genetic material itself and the form manifested in the eventual offspring.¹⁰

When Aristotle's reproductive hylomorphism is understood in this way it becomes extremely tempting to interpret his theory using the analogy of sculpting. Here the father is taken to be analogous to the sculptor who shapes the bronze into a statue of Hermes through the motions of his tools, while the mother's contribution is compared to the unsculpted bronze that eventually receives that shape and form.¹¹ On this interpretation, only the father makes a genetically significant contribution to the

8 Cooper 1988, 15 (emphasis added). Cooper extends this account from species- to family-resemblance.

9 Furth 1988, 118 (emphasis added).

10 Furth 1988, 119

11 This reading could be supported by *GA I 22, 730b8-23*, where Aristotle explains that the father's nature 'uses' the semen as a tool just as tools are used in art. However, that passage does not commit Aristotle to any view on what the semen actually does in generation, whether it fashions the parts directly or whether it contributes to generation in some more indirect way. His point there is simply that the father does not contribute anything material that gets used in the formation of the offspring just as no part of the carpenter is used to build the house.

offspring's form, just as the sculptor (not the bronze) directly determines the shape and form of the statue.¹²

However, when we turn to Book IV of the *GA* we find something that does not sit well with this tidy picture. As several commentators have noted, the theory of inheritance set out in *GA* IV 3 introduces a set of maternal movements to account for resemblances to the mother's side of the family. Apparently Aristotle's idea is that, like the father, the mother too contributes a set of genetic movements associated with the parts of her own phenotype as well as certain features inherited from her various ancestors. This is most explicit in a passage where Aristotle introduces the causal mechanism behind the phenomenon of atavism (resemblance to ancestors):

[Atavism occurs when] the formative movements relapse into the ones which stand closest to them. For example, if the movement of the father relapses, it passes into that of his father (the least difference) and in the second instance into that of his grandfather. Indeed in this way too, on the female side just as on the male side: the movement of the mother passes into that of her mother, and if it not into that one, then into that of her grandmother. And in the same way for the more distant ancestors.¹³ (*GA* IV 3, 768a14-21)

The passage begins by giving us a general explanation for the phenomenon of atavism. Atavism occurs when 'the formative movements relapse into the ones which stand closest to them'. Paternal-line atavism is then offered as an example (ὄϊον) of this general phenomenon. The crucial bit of text for our purposes is the next line. Aristotle says that maternal-line atavism occurs *in the same way* as paternal-line atavism. The latter occurs when the movement of the father relapses into that of his father. Likewise

12 See Cooper pp. 31-2 on how the bronze — and by analogy, the mother's contribution — can still (according to this reading) be said to *indirectly* determine the shape and form of the finished product.

13 There are several technical concepts being deployed in this passage that we can largely ignore. For example, there is an effect that Aristotle calls 'relapse' (λύσις). Although I do not have space to explore this highly specialized concept, what relapsing is supposed to do is, at least in the abstract, sufficiently clear from this passage to allow us to proceed without that analysis. I discuss this in detail in Henry forthcoming.

on the mother's side, atavism occurs when the movement of *the mother* passes into that of her mother. The most natural reading of this (and similar passages) is to see the movements contributed by the mother as being functionally equivalent to those of her male counter-part (whatever that function turns out to be).

Not surprisingly, many commentators have come to see the introduction of maternal movements in *GA IV 3* as inconsistent with the general hylomorphic theory that dominates the earlier books of the *GA*. According to that theory, the father alone supplies the offspring's form while the mother supplies the matter which receives that form. The introduction of maternal movements in *GA IV 3* thus seems to imply that Aristotle changed his mind and came to see the mother as making her own formal contribution to the process of reproduction. For whatever her maternal movements turn out to be, they clearly play some role in explaining those aspects of the offspring's bodily form that make it look like individuals on the mother's side of the family. Before turning to my own solution to this problem, it will be instructive to consider how previous scholars have responded to the charge of inconsistency.

Previous Responses to the Problem

Some commentators have simply attempted to explain away the problem by claiming that family resemblances are material accidents and thus do not qualify as 'formal' (so the mother can't be said to supply form).¹⁴ According to this interpretation, the form transmitted in the act of reproduction is universal and includes only those features which are common to the species. Those features that distinguish one member of the species from another (e.g., eye color) are accidental properties which result when the species-form is embodied in different quantities of matter. However, in contrast to this others have argued that Aristotle was committed to a much more radical notion of *individual* forms, which include features below the level of species.¹⁵

14 Witt 1985; cf. Sharples 2005, 105.

15 Balme 1987, 291-312; Cooper 1988, 32-8; Whiting 1990. Part of the worry I have with Balme's particular view is that he also treats family resemblances as material accidents that result when the species-form is embodied in different quantities of

Aristotle's remarks on inheritance certainly seem to point in the direction of individual forms. For example, at *GA IV 3*, 767b23-33 Aristotle says:

The generator is not only a male but also a particular sort of male, e.g., a Coriscus or a Socrates, and it is not only a Coriscus but also a human being. And it is in this sense that, of the characteristics that belong to the generator insofar as it is capable of reproduction and not incidentally (e.g., if it is a scholar or someone's neighbor), some belong to it more closely and others more remotely. But what is distinctive and particular (τὸ ἴδιον καὶ τὸ καθ' ἑκάστων) always exerts a stronger influence in generation.

If we take 'the generator' (τὸ γεννῶν) to be the logical subject (the primary substance in the *Categories* sense), Aristotle's point is that the predicates 'male', 'Socrates', and 'human' all belong to it insofar as it is capable of reproduction (καθὸ γεννητικόν) and not incidentally (κατὰ συμβεβηκός). The examples of genetically incidental properties are being a scholar and being someone's neighbor. Such properties are considered incidental to the generator *qua* generator precisely because they are not passed on in the act of reproduction: they are not part of its heritable form. What this passage makes perfectly clear, however, is that those features which are peculiar to an organism as an individual (e.g., its particular shade of eye color) *are* part of its heritable form. These features can even be described as essential to the organism. Of course nothing is essential and inessential *simpliciter* but only relative to this or that description. So while having a particular eye color and being someone's next-door neighbor are both incidental to Socrates *qua* human, the former is essential to him insofar as he is capable of reproduction.

So there is good reason to think that Aristotle treats family resemblances as formal differences in some sense. The problem arises because

matter. These are supposed to be part of the *actualized* form, since on Balme's reading of *Metaphysics* H6 matter and form are identical at the moment of actualization (294-5). I have a problem with the suggestion that form (in any sense of εἶδος) should include material accidents. Cooper's view is somewhat more attractive, since it treats family resemblances as purely formal in the sense that they are 'programmed into' the movements that impose form on the offspring (Cooper 1988, 37-8). However, Cooper has a strange view about what counts as a family resemblance (see pp. 36-7).

he appears to hold that some of these formal differences can be traced to the inheritance of spermatoc movements coming from the mother, which is supposed to contradict Aristotle's reproductive hylomorphism.

According to Furth, the sudden appearance of maternal movements in *GA* IV 3 is nothing short of a total collapse of the tidy matter-form theory developed in the earlier books. As Furth sees it, the last minute addition of a formal contribution coming from the mother is simply an *ad hoc* attempt on Aristotle's part to save his theory from flying in the face of the observed facts. Thus, at best Aristotle's theory of reproduction in the *GA* is internally inconsistent and at worst it all comes crashing down in *GA* IV 3 under the weight of empirical evidence.¹⁶ This is not so much a solution to the problem as it is an explanation for the apparent inconsistency. It says that Aristotle was aware of the fact that there was a tension in his theory, attempted to resolve it, but failed miserably.¹⁷ I do not have any positive arguments for rejecting this interpretation except to say that I think Furth's conclusion is too rash. As a rule it is better to attempt to find consistency in Aristotle's theory than to immediately dismiss it as incoherent.

Morsink offers a much less drastic solution to the problem which attempts to preserve the internal consistency of the *GA*.¹⁸ Like any theory, Aristotle's matter-form theory is only meant to apply to normal cases of development where everything goes according to plan. According to Morsink, this is when the father's movements successfully 'master' the matter supplied by the female. When this happens the offspring will resemble its father in every respect. In this *ideal* scenario, Morsink argues, the father alone supplies the offspring's form (a perfect reproduction of his own) while the mother supplies only matter. However sometimes the paternal movements fail. In these *deviant* cases a second set of movements coming from the mother take over and impose on the offspring resemblances to her side of the family. Thus maternal movements are only brought in later (in *GA* IV 3) to explain what happens when the process of reproduction deviates from the ideal scenario.¹⁹ In

16 Furth 1988, 141 (cf. 132n22, 133).

17 Furth refers to *GA* IV 3 as a 'rout', a 'retreat', and an 'embarrassing *dénouement*'.

18 Morsink 1982

19 Morsink 1982, 138; 171

this way, Morsink argues, the introduction of maternal movements is simply a *qualification* of the matter-form theory, not a refutation of it.

Morsink's strategy is an interesting approach to the problem. The idea is that, while Aristotle's theory of reproductive hylomorphism should be able to account for abnormal developments, it is only intended to apply to normal cases where everything works the way it is supposed to. The crucial step in Morsink's argument is the claim that Aristotle viewed offspring who look like their mothers as abnormal deviations from an ideal paternal form. In this way Morsink attempts to avoid the problem by bringing maternal inheritance under the scope of teratology (the study of abnormal developments).

Now if Aristotle really did view maternal resemblance as a kind of monstrosity (a deviation from the ideal), then we should expect the account of maternal inheritance in *GA* IV 3 to exhibit the structure of a teratological explanation. A teratological explanation for Aristotle is characterized by two important features. First, it does not introduce any new mechanisms into the theory whose proper functioning produces the monstrous form. Rather, the abnormal result is produced by the same mechanisms that are responsible for producing the normal one; it is produced by *the malfunctioning* of those mechanisms (mechanisms that would have produced the intended result had they been functioning properly). Second, although the normal and abnormal outcomes are both *produced* by the same mechanisms, the latter is *explained* by the external factors that caused them to malfunction rather than directly by the mechanisms themselves. For Aristotle, these external factors would be those primarily arising from the embryo's material nature (*GA* IV 4, 770a4-7; IV 10, 778a4-9).²⁰

20 The teratological view of maternal inheritance is an extremely popular interpretation of Aristotle's *GA*. For example, Sober (1992, 361-2) argues that Aristotle treated maternal resemblances as deviations from the organism's natural state (the paternal form) caused by 'interfering forces deflecting reproduction from its natural pattern'. On this interpretation those features that make the offspring look like its mother would be explained by the external factors that caused that interference (and thus the deviant results) rather than the proper functioning of the mechanism itself. For a similar interpretation see Pellegrin (1985, 110), Balme (1987, 292), Furth (1988, 128), Gill (1989, 33), Katayama (1999, 3), Freudenthal (1999, 24).

A quick glance at *GA* IV 3 shows that Aristotle's account of maternal resemblance does not exhibit this kind of structure. First, maternal movements are introduced into the theory as an independent source of inheritance whose proper functioning is responsible for those features that make the offspring look like its mother and/or her various ancestors. This is not true of monstrosities. Genuine monstrosities are not produced by an independent set of movements; there are no 'movements of the monster' as it were that take over when those of the generating parent fail. Rather, deformities are produced by the very same movements that would have produced a likeness to the parent under normal conditions. Monsters result when *those parental movements* get distorted so that *they produce* something deformed (see *GA* IV 3, 767b20-3, discussed below). Second, as we have already seen, Aristotle thinks the inheritance of maternal traits is explained by movements coming from the mother herself (not external, material factors) in the same way that paternal movements explain resemblances to the father's side of the family (768a14-21).

The fact that Aristotle's account of maternal inheritance does not exhibit the essential features of a teratological explanation shows that he did not treat resemblance to the mother or her ancestors as a distortion of some ideal paternal form. In other words, maternal inheritance is not a departure from the organism's natural state.²¹ It seems clear to me that if one accepts the terms of the inconsistency charge set out above, then one is forced to accept Furth's conclusion. At best Aristotle's theory of reproduction in the *GA* is internally inconsistent and at worst it all comes crashing down in *GA* IV 3 under the weight of empirical evidence.

The alternative is to reject the terms of the inconsistency charge itself. This is Cooper's strategy. In contrast to Furth and Morsink, Cooper denies that the movements contributed by the mother are functionally

21 Aristotle does of course say that being female is (in a sense) being a 'deformed' male and that female births are (in a sense) a departure from 'the γένος'. However, throughout *GA* IV Aristotle consistently distinguishes between sex (being male or female) and inheritance (resembling different family members). These two notorious statements only refer to the property of being female, which, we have seen, is a separate issue from the phenomenon of maternal inheritance. Moreover, Aristotle is talking about being female only in the functional sense characterized by the inability to concoct blood into semen (which Aristotle views as 'pure seed'), not the possession of female parts, which are teleologically dependent on the function of a female.

equivalent to their paternal counter-parts. According to Cooper, the maternal movements do not directly shape the offspring's body when the paternal movements fail; only the father, through the movements of his semen, is in any way capable of fashioning the material supplied by the mother into a new individual of a determinate shape and form.²² Cooper's analysis of the problem is the most extensive in the literature. As such, I shall devote considerable space to its examination.

Although I think Cooper is mistaken in how he interprets *GA IV*, it is important not to underestimate the force of his argument. Cooper argues that the father's semen is the causal agent in generation in that it possesses movements which are such as to fashion the material supplied by the female into a new individual of a certain shape and form. Moreover, Aristotle's reproductive hylomorphism entails that *only* the father, working through the formative movements of his semen, is responsible for imposing shape and form on that new individual. Thus, if we assume the *GA* contains an internally coherent theory, then whatever role the maternal movements turn out to play in that theory, they *cannot* be functionally equivalent to their paternal counter-parts.²³

This negative conclusion drives Cooper's positive account of maternal inheritance. If we assume that the father alone determines the offspring's shape and form, then Aristotle must have thought that the movements in the father's semen are directly responsible for imposing maternal resemblances on the offspring as well. Consequently, any contribution that the mother's movements might appear to be making to the offspring's form must be made by the movements of the father's semen instead. Cooper identifies one text that suggests a possible mechanism for this. At *GA IV 3*, 768a14 we are apparently told that the father's semen contains, somehow in potentiality, movements 'of the female' (τοῦ θήλεος). Cooper takes this to be an explicit reference to movements in the father's semen corre-

22 Cooper 1988, 18-19

23 We should not fail to notice how Cooper nicely turns Furth's interpretation on its head. Furth began from the assumption that the maternal movements are functionally equivalent to their paternal counter-parts and concluded that the *GA* does not contain an internally coherent theory. Cooper begins from the opposite assumption that the *GA* does contain an internally coherent theory and concludes that, given Aristotle's reproductive hylomorphism, those maternal movements cannot be functionally equivalent to their paternal counter-parts. My solution will offer a way to preserve both of these methodological starting-points.

sponding to the distinctive characteristics of the mother and her various ancestors.²⁴ These movements, which Cooper takes the semen to have independently of the mother, give the father the power to make the offspring look like those individuals. As strange as this may sound, Cooper argues that Aristotle is saying exactly what he must say in order to bring the phenomenon of maternal inheritance in line with the reproductive hylomorphism developed in the earlier books.²⁵

The success of Cooper's positive thesis ultimately comes down to his ability to show that the father is directly responsible for those features of the offspring that make it look like individuals on the mother's side of the family, while at the same time showing how maternal movements are central to the process. For Aristotle obviously thinks the maternal movements have *some* important role to play in the theory. Furthermore, Cooper's ability to show that the father is directly responsible for maternal resemblances crucially depends on his reading of 768a14 (that the father's semen contains movements corresponding to the distinctive features of the mother and her ancestors). I do not think he succeeds on either front.

Let us grant for the moment that 768a14 does identify a set of movements in Socrates' semen corresponding to the distinctive features of Xanthippe (his wife) as well as those of her various ancestors. Cooper takes these (potential) female movements to be distinct from the (actual) movements coming from Xanthippe herself. Thus, on Cooper's reading there will be not one but *two* sets of movements for every maternal trait: one set in Xanthippe's menstrual fluid and a second, parallel set in Socrates' semen. According to Cooper, the latter alone are directly responsible for those features of the offspring's form that make it look like individuals on Xanthippe's side of the family.²⁶

It is important to stress here that the controversy surrounding *GA* IV 3 is not about whether or not Aristotle thinks the mother supplies

24 Cooper 1988, 21-2

25 Cooper 1988, 30

26 To avoid confusion I shall continue to refer to the movements coming directly from the mother (e.g., those mentioned at 768a19-21) as 'maternal movements' and those coming from the father (which on Cooper's view include a set for making the offspring look like its mother and her ancestors) 'paternal movements'. Eventually I shall deny that any maternal movements find duplicates in the father's semen.

movements to the process of inheritance; this much is explicit in the text (e.g., 768a19-21). What is controversial is the role that such movements play in Aristotle's theory and whether that can be made consistent with what he says elsewhere in *GA*. Cooper attempts to reduce the tension between Aristotle's hylomorphic analysis of reproduction and the appearance of maternal movements in *GA IV 3* by denying that those movements play any role (formative or otherwise) in explaining resemblance to the mother herself. According to Cooper, Aristotle explains this solely in terms of movements in the father's semen. He points to the following passage as evidence for this reading:

So that if it [sc. the motion of the sire] prevails, it will make a male and not a female, and like the father but not the mother. But if it fails, then it makes a defect (ἔλλειψις) with respect to whichever potential (δύναμις) it fails to gain the mastery. (*GA IV 3*, 767b20-3)

Aristotle goes on to associate the potentials in question with different characteristics of the generator's body (e.g., those that make it a particular individual). The precise relation between a δύναμις and the corresponding phenotypic trait is not important here. All that is important is that Aristotle envisions some sort of correspondence between the success of the movements drawn from those potentials and the inheritance of different traits.

Minimally, this text provides a rough account of how the offspring comes to resemble its father. Suppose the movement at work here is the one associated with the construction of Socrates' snub nose. If this movement is successful, then Menexenos acquires a nose like his father's; if it fails, it produces a 'defect' (ἔλλειψις). According to Cooper, the defect left behind in the matter is the opposite maternal trait.²⁷ For example, when Socrates' semen fails to impose his nose shape on the matter, the result is a nose shaped like Xanthippe's. In this way the father is directly responsible for making the offspring look like both parents: when the father's movement succeeds, it makes a nose shaped like the father's; when it fails, it makes one shaped like the mother's.²⁸

27 Cooper 1988, 25

28 There is a serious problem here concerning exactly what Cooper takes the mother's own movements to be. He claims that the movements in the mother's fluid corresponding to herself are a kind of program (16) that carry 'instructions for the

Thus Cooper does not think that maternal movements have any role to play in explaining how the offspring comes to resemble the mother herself. It is only when Aristotle comes to explain resemblance to her ancestors that Cooper thinks he 'opens up the theoretical space into which movements in the female's matter might be placed'.²⁹ Before turning to this, I first want to respond to Cooper's interpretation of GA 767b20-3.

The main problem with Cooper's reading of this passage, which he claims shows how the father directly produces resemblances to the mother, is that it is taken entirely out of context. Aristotle is not attempting to provide an account of how resemblances to the mother are produced. When read in the context of the surrounding argument it becomes immediately clear that the defect produced by the father's failed movement is not a perfect likeness of the mother but a distorted likeness of the father: a physical deformity.³⁰ This is meant to explain Aristotle's remark just before this passage that birth defects are the product of 'accidental necessity':

As for monstrosities, they are not necessary with respect to the final cause and the goal; rather, they are necessary with respect to an accident, since the origin <of deformity> at any rate must be assumed to lie in this. For (γύρ) when the spermatic residue in the menstrual fluid is thoroughly concocted, the motion of the male will produce the shape in accordance with himself. ... So that if it prevails, it will make a male and not a female, and like the father but not the mother. But if it fails, then it makes a defect with respect to whichever potential it fails to gain the mastery.

formation of her own bodily parts' (27). But the current interpretation renders those instructions superfluous, since Cooper insists that the mother's own movements (as opposed to those of her ancestors) do not play any role *whatsoever* in the process of inheritance. Resemblance to the mother is produced by the father's botched movements alone.

29 Cooper 1988, 25. Cooper does not offer any explanation for why Aristotle would feel the need to bring in maternal movements *here*. If Aristotle thinks he can explain how Socrates' semen makes the offspring look like Xanthippe, then it is barely a stretch to explain how it makes it look like her ancestors in the same way. Thus, on Cooper's reading, Aristotle is making trouble for himself.

30 Thus I trivially agree with Cooper that the sculpting analogy he (Cooper) deploys on page 32 effectively captures Aristotle's point at 767b20-3.

Pace Cooper, GA 767b20-3 is not telling us how maternal resemblances are produced but in what sense physical deformities are necessary κατὰ συμβεβηκός (cf. GA II 6, 743a26-30). It is reasonable to assume that Aristotle only mentions the movements of the father here in order to illustrate the basic point. And even though it is not explicit, I take it that the same account will apply in cases where the mother's movements are at work (they produce resemblances when they succeed and birth defects when they fail).³¹

Aristotle's account of maternal-line atavism presents an even bigger challenge to Cooper's interpretation. For Cooper must find a non-demiurgic role for the maternal movements to play, while at the same time showing how those movements are central to the explanation. Recall Aristotle's explanation for maternal-line atavism:

[Atavism occurs when] the formative movements relapse into the ones which stand closest to them. For example, if the movement of the father relapses, it passes into that of his father (the least difference) and in the second instance into that of his grandfather. Indeed in this way too, on the female side just as on the male side: the movement of the mother passes into that of her mother, and if it not into that one, then into that of her grandmother. And in the same way for the more distant ancestors.

Maternal-line atavism is discussed in the last part of the text. Resemblance to the mother's ancestors occurs when 'the movement of the mother passes into that of her mother, and if it not into that one, then into that of her grandmother'.

Now Cooper understands the process by which the offspring comes to have a nose shaped like its maternal grandmother as proceeding in two distinct stages.³² First, the movement in the mother's fluid corresponding to her own nose relapses (Cooper: 'slackens') into the one corresponding to her mother's nose. This then reciprocally affects the father's semen in such a way that one of *its* female movement (the one

31 Compare the account of resemblance to ancestors at 768a14-21, where paternal-line atavism is only offered as 'an example' (οἷον) of the more general phenomenon. There maternal-line atavism is explicitly said to occur in the same way: resemblances to the mother's ancestors are produced when her maternal movements relapse into those of her ancestors.

32 Cooper 1988, 26-7

corresponding to the nose of his mother-in-law) relapses from the one that would have produced a resemblance to the mother's nose into the one that produces a resemblance to her mother's nose. *That seminal movement* is supposedly the one that imposes on the offspring a nose shaped like its maternal grandmother's.

My main worry with Cooper's interpretation is that it dramatically over-complicates what is otherwise a rather straightforward account of maternal inheritance by introducing an extra step into the process which is not mentioned anywhere by Aristotle. There is no mention of any further process whereby a relapsing maternal movement *in turn* causes a parallel movement in the father's semen to relapse in tandem with it. Nor should we expect to find this extra step. For Aristotle prefaces his explanation of maternal-line atavism in the above passage by emphasizing that the process works *in the same way* as paternal-line atavism: it occurs when the movement of the mother relapses into those of her ancestors. Aristotle clearly takes this single process of relapsing as necessary *and* sufficient for explaining resemblances to the mother's ancestors. And yet on Cooper's reading he has only given us a partial explanation, even though no further explanation is actually forthcoming.

Up to this point I have taken Cooper's reading of GA 768a11-14 for granted, namely, that there really are movements in Socrates' semen corresponding to the distinctive features of Xanthippe's form as well as those of her various ancestors. This reading is obviously crucial for securing Cooper's positive thesis. On Aristotle's theory, it is in virtue of supplying movements that the parent's genetic material is able to transmit resemblances to the offspring. Thus, if the father's semen is responsible for transmitting *all* formal resemblances, as Cooper claims, then it better come equipped not only with movements for himself and his ancestors but for all the individuals on the mother's side of the family as well. The trouble is that GA 768a14 is an extremely weak foundation upon which to rest such a controversial interpretation. As Cooper acknowledges, this is really the only text in the entire treatise to indicate that Aristotle thinks there are movements in the father's semen capable of transmitting to the offspring bodily resemblances to the mother's side of the family.³³ More importantly, Cooper's argument ultimately comes down to his assumption that τοῦ θήλεος there refers to the distinctive

33 Cooper 1988, 27

features of the mother and her various ancestors. There are good reasons for suspecting that this is not what Aristotle wants to say.

In the first place, the idea that the father's semen contains movements corresponding to individuals on the mother's side of the family is obviously something that demands explanation. For those individuals are only contingently related to the father (it is virtually by chance that Socrates happened to mate with Xanthippe). The fact that Aristotle offers no such explanation suggests that he did not really hold that view.³⁴ Furthermore, the reference to female movements in the father's semen is an anomaly. In no other passage does Aristotle ever mention such movements in the semen. For example, when we are first told about the various movements in an organism's sperma at GA 767b35-8a2 Aristotle makes no reference to any female movements among the potential movements there.³⁵ This suggests that perhaps τοῦ θήλεος καὶ at 768a14 is an interpolation and should be deleted. This would leave δυνάμει δέ αἱ τῶν προγόνων, echoing almost exactly the earlier passage at 767b37 (δυνάμει δέ καὶ [αἱ?] τῶν προγόνων).

However, even if this is not an interpolation, GA 768a11-14 still doesn't say what Cooper needs it to say in order to secure his thesis. Cooper needs τοῦ θήλεος to refer to movements in Socrates' semen whose function is to impose on the offspring features that will make it

34 Cooper is aware of this and tries to offer a plausible story (where Aristotle provides non) for understanding how this might work. One suggestion is that the semen possesses movements corresponding to individuals on the mother's side of the family only in the sense that his semen 'selectively elevates' movements that are already present in the female's material from being 'movements of matter to being formal movements *in* matter' (28). It is extremely unclear what Cooper means by this. More importantly, we do not find anything remotely approximating this idea in the text. His other suggestion is that the semen of each male really contains movements corresponding to all the females he can possibly mate with as well as all of their ancestors (28). But surely Aristotle would have seen how outrageous this suggestion is. (For one thing consider the scope of those possible individuals!) Unless Cooper can find a plausible way of understanding how there could be movements 'in' (ὑπάρχουσιν, ἔνεσιν) Socrates' semen corresponding to the distinctive features of Xanthippe and all of her ancestors, it is hard to see how Aristotle could have held such an obviously absurd view.

35 The rest of the movements mentioned at 768a11-14 are either explicit in 767b35-8a2 or implied by the reference to 'all these sorts of things' (= 'male', 'Socrates', 'human', 'animal').

look like Xanthippe and her relatives. However, throughout *GA IV 3* Aristotle uses the word μήτηρ to signal such resemblance, whereas θήλυ is used exclusively in connection with the sex of the animal. This is explicit at *GA 768a5-9* where Aristotle contrasts 'female' (θήλυ) with 'male' (ἄρρεν), on the one hand, and 'mother' (μήτηρ) with 'Socrates', on the other. This contrast makes it clear that the properties corresponding to 'female' (θήλυ) are associated with those sexual characteristics that are common to all females, not those family resemblances that make the offspring look like the mother and her ancestors.

If τοῦ θήλεος is a reference to female sex characteristics, not maternal resemblances, then at best *GA 768a11-14* is saying that the father's semen carries a potential movement corresponding to those properties that would make the offspring female (its sexual morphology). This idea would be much less strange. For the characteristics transmitted by such a movement would not be unique to any particular female in the way that Xanthippe's distinctive nose and chin are unique to her (or at least to her family). Moreover, Aristotle will turn out to have been vindicated by recent discoveries in modern genetics. For we now know that normally developed males have both an X (female) and Y (male) chromosome,³⁶ even though the sex characteristics coded by the former are not actually displayed in the male's phenotype (they are present only in potentiality).

However much I would like to say that Aristotle brilliantly anticipated the modern genetic account of sex (even if only accidentally), given the anomalous nature of τοῦ θήλεος at *GA 768a14* it is more likely to be an interpolation that should be deleted.

I now want to turn to my own solution to the problem of maternal inheritance. What I shall argue is that the apparent tension that these commentators identify in Aristotle's theory disappears (or is at least diminished) when his reproductive hylomorphism is properly understood. As we shall see, *GA IV 3* provides an intelligible account of maternal inheritance that fits perfectly well not only with what Aristotle says in the rest of that chapter but also with what he says in the *GA* as a whole. In order to see this, however, I first need to give a clear description of how my understanding of *GA IV 3* differs from Cooper's.³⁷

36 This is true only of mammals.

37 The following account is consistent with Furth and Morsink in its basic formulation.

A Fresh Account of Maternal Inheritance

I think we can offer a much cleaner picture of *GA IV 3* which avoids the problems associated with Cooper's interpretation. This picture differs from Cooper's in two significant ways. First, I take Aristotle to posit only *one* set of movements for maternal resemblances. These movements are supplied directly by the mother herself. To get clear on this it will be useful to have a complete breakdown of the spermatic movements each parent contributes to the process of inheritance, beginning with those of the father (cf. 767b35-8a2, 768a11-14).

Paternal movements

- P1) Movements of the individual male generator (τοῦ γεννώντος)
 - a) Movement corresponding to 'male'
 - b) Movement corresponding to 'Socrates'
- P2) Movements of the universals (τῶν καθόλου)
 - a) Movement corresponding to 'human'
 - b) Movement corresponding to 'animal'
- P3) Movements of his ancestors (τῶν προγόνων)
 - a) Movement corresponding to his grandfather
 - b) Movement corresponding to his great-grandfather
 - c) Etc.

Each spermatic movement here will correspond to some feature of the generator's heritable form that belongs to him καθὸ γεννητικόν (767b28). Of interest to us are the P1 movements: P1a transmits those features that belong to Socrates as a male (sexual morphology), while P1b transmits those family resemblances that will make Menexenos look like him in some respect.³⁸

Where I disagree with them concerns the causal role played by the spermatic movements in *GA IV 3*. As it turns out this disagreement has significant implications for how we understand the problem itself.

38 This movement is in turn composed of movements for the parts of Socrates. For example, there will be one movement corresponding to his blue eyes and another corresponding to his snub nose.

While Aristotle is explicit that the mother directly contributes a set of spermatoc movements of her own, he is less explicit about exactly which movements she does contribute. However, as Cooper himself acknowledges, once the idea of maternal movements is introduced into the account, they clearly fall within the scope of 768a11-14 (which lists the contents of the male spermatoc alone).³⁹ Therefore we should expect a list of maternal movements to look something like the following.

Maternal movements

- M1) Movement of the individual female generator
(τῆς γεννώσης: 768a20)
 - a) Movement corresponding to 'female'⁴⁰
 - b) Movement corresponding to 'Xanthippe'

- M2) Movements of the universals⁴¹
 - a) Movement corresponding to 'human' (cf. 768b12-15)

- M3) Movements of her ancestors
 - a) Movement corresponding to her grandmother (768a20)
 - b) Movement corresponding to her great-grandmother (768a21)
 - c) Etc.

Movements M1a and M1b correspond to those features that belong to Xanthippe as an individual: M1a corresponds to features that belong to her insofar as she is female (sexual morphology), while M1b transmits those that make her *Xanthippe* (e.g., her green eyes, straight nose, etc.).

39 I agree with Cooper that GA 768a11-14 only refers to the movements in the male semen (note the masculine τοῦ γεννώοντος).

40 If we accept the reference to τοῦ θήλεος at 768a14, then this movement would be transposed to the list of P1 movements coming from the father instead. On that reading the father contributes *both* movements for sexual morphology (male and female).

41 As we shall see, the distinctive contribution of the father is sensory soul. Therefore, the universal movement 'animal' (mentioned at 768a13-14) will be absent from the maternal contribution.

Now since Cooper thinks that only the father's semen directly impose resemblances on the offspring, he claims that all of the maternal movements listed here find duplicates in the father's semen (which he takes to be implied by the reference to τοῦ θήλεος at 768a14). Whatever the function of the movements in the female's fluid (M1-M3) turns out to be, Cooper argues, it cannot be to transmit resemblances directly.⁴² In contrast to this — and this is the second difference — I take those maternal movements to perform the same function in Aristotle's theory of inheritance as their paternal counterparts (whatever that function turns out to be). This eliminates any need for an extra set of movements in the father's semen corresponding to the features of the mother and her ancestors.

The advantage of taking the maternal movements (M1-M3) to be functionally equivalent to their paternal counterparts (P1-P3) is that it gives us a straightforward way of understanding Aristotle's account. Taking the paternal movements as our reference point, the process of inheritance works something like the following. If the paternal movement corresponding to 'male' (P1a) dominates but 'Socrates' (P1b) is dominated by 'Xanthippe' (M1b), then the offspring will develop as a male but look like Xanthippe (a son resembling its mother). If the reverse happens, if 'female' (M1a) dominates but 'Xanthippe' is dominated by 'Socrates', then the offspring will develop as a female but look like Socrates (a daughter resembling its father).⁴³ Likewise with respect to different parts (the movements here coming under P1b and M1b). If Socrates' nose-movement dominates, the offspring will come to have a nose shaped like its father's. But if this movement is dominated (κρατούμενον), it gets displaced (ἐξίσταται), which causes inheritance to switch over to Xanthippe's nose-movement (768b8-9). In that case the offspring's nose will come to resemble its mother's not its father's. However, if Xanthippe's nose-movement relapses (λυθῆ), it passes into that of her mother (768a19-22, a34-6). When this happens, the offspring will come to have the same nose as its maternal grandmother.

42 It is not clear whether Cooper recognizes maternal movement M1b (the movement for those characteristics that make the offspring look like its mother). As we have seen, on his account those movements have no role to play (formative or otherwise) in the process of inheritance.

43 GA IV 3, 768a27-31

Understanding Aristotle's Reproductive Hylomorphism

One of the reasons that commentators have come to see Aristotle's account of maternal inheritance as being at odds with his reproductive hylomorphism has to do with the role they assign to the 'movements' in that theory. According to Furth, for example, the father's semen is programmed with a set of formative movements that literally shape and form the menstrual blood as development advances. The menstrual fluid is simply the material patient that receives that shape and form.⁴⁴ Thus by introducing maternal movements into the theory which perform *the same function* as their paternal counter-parts, *GA* IV 3 implies that the matter is fully capable of supplying its own formative movements by means of which it fashions itself into an offspring with a determinate shape and form. Presumably this would be incompatible with Aristotle's view (cf. *GA* II 4, 738b17-27).⁴⁵

Although many scholars find this way of understanding the causal role played by the movements in Aristotle's account of inheritance tempting, I want to resist this interpretation. Trivially I agree with Cooper that the movements coming from the mother do not directly shape the parts of the offspring's body whenever the paternal movements fail. However, I want to suggest that this is not because her movements play a different causal role in Aristotle's theory (as Cooper holds) but because *neither* parent's spermatic movements contribute to generation in such a direct way. This suggestion helps reduce the tension in Aristotle's account. For if the paternal movements do not literally fashion the matter into a likeness of the father, then the idea that the maternal movements are functionally equivalent to these (which is surely the most natural reading of the text) does not imply that her matter is capable of *fashioning itself* into a likeness of the mother.

44 See also Cooper: '... Aristotle repeatedly emphasizes that only the male through the movements in his semen, is capable in any way at all of fashioning the material provided by the female into a new animal' (19); '... the semen fashions the offspring into a female and/or a person resembling the mother ...' (25). In some places Cooper speaks as though the semen simply transfers a power to the embryo in virtue of which it fashions itself into a new individual. However, for the most part he speaks as though the semen is the thing that does that fashioning.

45 It is conceivable that Aristotle's hylomorphic analysis does *not* rule this out.

Of course this interpretation of *GA IV 3* requires an alternative account of the causal role played by those κινήσεις which Aristotle says are carried inside the genetic material of all sexually reproducing animals (767b36-8a2). To this end I want to suggest something like the following.⁴⁶ Perhaps Aristotle saw these κινήσεις, not as motions or changes per se, but as information-bearing vehicles that somehow transmit the features of the parent's heritable form in the act of reproduction.⁴⁷ These vehicles will not play any direct role in the formation of the offspring's parts. Rather, their function in the process of generation is to reproduce in the embryo a set of potentials (δυνάμεις) like those from which they were originally drawn (767b36-8a2). These new potentials would then become a source of development in the embryo itself *qua* itself (its productive nature).⁴⁸

One might respond here by saying that even if the maternal movements in *GA IV 3* do not refer to informative motions of the menstrual blood as it fashions itself into a likeness of the mother (as traditionally assumed), their introduction in *GA IV 3* is still inconsistent with Aristotle's reproductive hylomorphism in general. For according to that

46 I argue for this view in Henry forthcoming.

47 Cf. Witt 1989, 56n26. For the idea of a κίνησις bearing some sort of information content see *de Mem* 452b23-4: 'the κίνησις of the fact' and 'the κίνησις of the time'. This also seems to be how Aristotle uses the concept of κίνησις in the account of sense-perception in *GA V* (as specialized vehicles for transmitting sensory properties from the object to the perceiver). Lennox has suggested to me on several occasions that the κινήσεις in the parent's genetic material could refer to local motions, such as vibrations or waves, that somehow encode the formal characteristics of its body. This is compatible with my view. However, I take it that what *GA IV 3* provides is an explanatory framework for giving an account of inheritance at a more abstract level. As such, we should not expect the concepts being deployed there to be spelled out in concrete terms. If this is right, then Aristotle's spermatik 'κίνησις' would be like Mendel's 'factor' in that both concepts attempt to abstract away from the concrete physical basis of the vehicles of inheritance.

48 Recall that each of the κινήσεις in the generator's seed is drawn from a corresponding δύναμις (767b36-8a2) which is associated with a particular characteristic of its body (*GA* 767b23-33). These δυνάμεις can be understood in terms of Allan Gotthelf's conception of irreducible potentials for form (Gotthelf 1987). If we think of these potentials for form as generating capacities of the embryonic heart, then the spermatik movements will be formative only in the sense that they are responsible for organizing the region of the offspring's heart that governs the development of the rest of its body.

analysis (the objection goes) the father *alone* makes a genetically significant contribution to the offspring's form.⁴⁹ The female's contribution is simply the matter which receives that form, just as the bronze receives the form imposed on it by the sculptor. The introduction of maternal movements into the theory thus still implies that Aristotle changed his mind and came to see the mother as making her own formal contribution to the process. For whatever the function of the maternal movements turns out to be, *GA* IV 3 clearly takes them to be *somehow* responsible for those aspects of the offspring's bodily form that make it look like individuals on her side of the family — even if the way they do this is not by literally shaping the matter in the way the sculptor shapes the bronze (assuming neither parent's movements function in that way).

Now it is certainly true that the *GA* advocates a hylomorphic theory of reproduction in which the father provides the form and the mother provides the matter. However, commentators rarely stop to consider exactly what Aristotle means by 'form' (εἶδος) in this context. Form is a notoriously slippery concept in Aristotle. The charge of inconsistency only arises if we take 'the form' the father alone is said to provide in the very broad sense to cover all formal aspects of the offspring's body, including its overall physical appearance, internal anatomy, characteristic behavior, and functional capacities. But this is not what Aristotle means. A careful reading of the *GA* reveals two versions of the hylomorphic analysis at work, two ways in which the father can be said to provide form. As we shall see, neither of these is obviously incompatible with the introduction of maternal movements whose function is to transmit resemblances to the mother's side of the family.

In the second half of Book I (and into Book II) Aristotle applies the hylomorphic analysis to the act of fertilization in order to determine what each parent contributes to the formation of the zygote (κνήμα). In this context when Aristotle says that the semen gives form to the menstrual fluid, he is not referring to the formation of any complex structures. Rather, the semen is said to provide form to the menstrual fluid in virtually the same way that rennet or fig-juice forms curds out of milk. The heat in the father's semen acts on the menstrual fluid by drawing in the various bits of spermatoc material contained in it and then fuses them together into one solid mass (cf. *GA* II 4, 739b21-8; IV 4, 771b22-4). The

49 See the remarks by Furth quoted at the outset of this paper.

result of this event is not a fully formed offspring but an amorphous seed, which is the immediate product of fertilization.⁵⁰ Obviously the claim that the male semen provides form to the menstrual fluid in the way that rennet provides form to milk is not inconsistent with the idea that the mother provides, in addition to that material, a set of movements which are somehow capable of transmitting formal resemblances to the offspring that eventually develops from that seed.

More importantly, Aristotle does not assume that this first formulation of the matter-form thesis picks out the male's *exclusive* contribution to the process of generation. At *GA* I 21, 730a29-30 Aristotle identifies the male's contribution as the ἀρχῆς καὶ τοῦ κινήσοντος καὶ διορισθόντος, the principle that initiates the change and defines the menstrual fluid (i.e., gives it form). He then qualifies this by suggesting that there may be some species where the female is capable of supplying this principle herself, something he later confirms in *GA* II 5 (see below). In this context Aristotle is clearly referring to the basic act of forming the zygote (which he likens to forming curds in milk) and jump-starting its development.

The second version of Aristotle's hylomorphic model of reproduction is explicitly formulated in *GA* II 4. This is the more important formulation of the two, since it attempts to analyze the contributions of each parent in terms of the finished offspring (rather than the zygote). In this case the form the father is said to provide is identified with the offspring's soul, while the mother provides the body (738b25-6). This clearly signals a new formulation of the hylomorphic thesis, since the male's contribution is for the first time identified using the metaphysical concept of substantial being (οὐσία). Up to this point the idea of providing form to menstrual blood had only been associated with the physical act of imposing a determinate boundary on the indeterminate menstrual fluid, which is said to be 'virtually the same as' (παραπλήσιον) the action of rennet on milk.⁵¹ In *GA* II 4 the father's contribution is now associated with that formal property of the living body that makes it a substance of a particular kind (its soul).

50 Of the passages cited in note 1 above 729a9-12, 729b6-8, and 730a24-30 all reflect this first formulation of the hylomorphic thesis.

51 See, e.g., *GA* I 21, 730a30: διορισθόντος. The physical act of providing form in this sense is routinely characterized using the word συνιστάναι or συνίστασθαι, which Peck translates as 'set' and I translate as 'amalgamate' or 'fuse together'.

However, when we turn to *GA* II 5 we discover that this body/soul hylomorphism does not actually apply to the offspring's entire soul but only a certain part of it. In the final analysis, what the male *alone* is said to provide is the offspring's sensory soul: 'Hence, in these sorts of things [sc. animals] the male always completes generation. For he implants (ἐμποιεῖ) the sensory soul, either directly through himself or through the semen' (*GA* II 5, 741b5-7).⁵² This is what Aristotle ultimately means when he says that the father's exclusive contribution to the generation of an animal is its form. For the sensory soul is the form of an animal in the most strict sense: it is the property that makes a creature an *animal* (its substantial being). The idea that the father alone provides the offspring's sensory soul also does not conflict with the view that the mother supplies movements that account for those features that make it look like individuals on her side of the family.

More interestingly, Aristotle also reveals in *GA* II 5 that the mother's contribution is not confined to providing the offspring's body. She too provides part of its soul. In some species the female can produce embryos that are capable of minimal growth without being fertilized by the male (so-called wind eggs). Aristotle takes this as empirical proof that the nutritive soul comes from the mother (cf. *GA* III 7).⁵³ This seriously undermines Furth's claim about the 'sudden' introduction of a formal contribution from the mother in Book IV. For Aristotle has already cleared the way for this as early as Book II.

52 Technically, the father contributes *the capacity to make* (ποιητικόν) the sensory soul (741a13-14) rather than that soul itself. And the way to 'make' an Aristotelian soul would be to construct the organs that discharge the corresponding capacity (since Aristotelian souls are the capacities of those organs). Thus, what the father alone supplies is the power to construct sensory parts.

53 This is the traditional interpretation of *GA* II 5 (cf. Peck 1990, xii). In contrast to this Allan Gotthelf has argued (personal correspondence) that all *GA* II 5 commits Aristotle to is the idea that the mother *can* provide nutritive soul and *in some cases* (viz. wind-eggs) actually does so. However, Gotthelf says that these cases should not be taken as a model for what Aristotle thinks normally happens; normally the father provides the nutritive soul. (Jim Lennox and Kathleen Cook also supported this position in conversations we had on the subject.) However even on this alternative reading *GA* II 5 still provides enough to secure my point, since it at least shows that Aristotle thinks the mother is *capable* of supplying part of the offspring's soul.

The claim in *GA* II 5 that the father alone provides the sensory soul need not be interpreted as Aristotle backtracking on his earlier assertion in II 4 that the mother provides the body while the father provides the soul. That is to say, Aristotle does not first claim that the whole soul comes from the father only to later retreat to the idea that what the father alone provides is the sensory soul when confronted by the existence of parthenogenesis. Rather, the assertion that the father alone provides the sensory soul can be seen as the conclusion of a line of argument beginning in *GA* II 4 that seeks to identify the father's contribution with the animal's substantial being (οὐσίᾳ). (After all, Aristotle is investigating the causes of the generation of *animals*.) This is why in *GA* II 5 Aristotle says that the soul the mother provides only qualifies the embryo as living the life of a plant (cf. III 7, 757b18-30); it is an *animal* only in virtue of participating in sensory soul (cf. *GA* I 23, 731a24-b7).

Summary Conclusions

The primary aim of this paper has been to offer a clearer picture of Aristotle's reproductive hylomorphism as it is developed in *Generation of Animals*. In the process, I have made a modest attempt to resolve the tension that commentators have found between Aristotle's reproductive hylomorphism and the introduction of maternal movements in *GA* IV 3. At first glance there really does seem to be a problem here. On the one hand, Aristotle's reproductive hylomorphism (in its most general formulation) claims that the mother provides the matter while the father provides the form. On the other hand, *GA* IV 3 seems to say that the mother makes her own formal contribution to the process of generation. For whatever the maternal movements turn out to be, they clearly have some role to play in explaining those aspects of the offspring's bodily form that make it look like individuals on the mother's side of the family.⁵⁴

I began by considering a number of attempts to deal with this problem and showed that none of them provide an adequate solution. I then attempted to show that the apparent inconsistency arises, not from the

⁵⁴ I am assuming that family resemblances count as formal differences and are not the result of the universal species-form being imposed on different quantities of matter.

introduction of maternal movements *per se*, but from the way Aristotle's reproductive hylomorphism has traditionally been understood. In particular, I argued that the appearance of an inconsistency derives from two primary assumptions about Aristotle's theory. First, it is assumed that the paternal movements in *GA* IV 3 determine resemblances by literally imposing them on the material supplied by the mother just as the sculptor's motions impose shape and form on the bronze. Hence the suggestion that the maternal movements are functionally equivalent to these implies that the mother's contribution is capable of *fashioning itself* into an offspring with a determinate shape and form. I have suggested that the way to reconcile this is simply to deny that the κινήσεις that do the explanatory work in *GA* IV 3 literally fashion the parts of the offspring's body. If the paternal κινήσεις do not contribute to inheritance in this direct way, then the introduction of maternal κινήσεις which are functionally equivalent to those does not imply that the menstrual blood somehow fashions itself into an individual resembling the mother and her ancestors.

The other assumption commentators make is that Aristotle's reproductive hylomorphism assigns *all* aspects of the offspring's observable form (including all soul-capacities and all family resemblances) to the father's contribution. In this case the introduction of a formal contribution coming from the mother would clearly be inconsistent. However, this is not what Aristotle's reproductive hylomorphism entails. I have argued that a careful reading of the *GA* reveals two ways in which the father is said to provide form. In the first place, his semen provides form to the menstrual fluid in virtually the same way that rennet provides form to milk: the seminal heat acts on the menstrual fluid by fusing together the bits of spermatoc material contained it and forms them into a tiny amorphous seed (the κνήμα). In the second place, Aristotle tells us that the father alone provides the offspring's sensory soul. This is the form of the animal in the sense of its οὐσία (it is the property that makes the living body an animal).⁵⁵ Neither of these two formulations is obviously incompatible with the suggestion that, in addition to providing

55 As we have seen only that the latter formulation identifies the father's *exclusive* contribution to the process of generation. Aristotle allows that in some cases the female is able to impose form on her own menstrual fluid in the sense that she is able to amalgamate it and form it into a κνήμα (and then triggers its growth). These cases also show that the mother can provide nutritive soul.

matter, the mother supplies movements that somehow explain the inheritance of features that make the offspring look like individuals on her side of the family.

However neat and tidy the traditional interpretation may be, when we trace Aristotle's reproductive hylomorphism through the *GA* we find that it clearly does not divide the contributions of the mother and father exhaustively into matter and form. While Aristotle is explicit that the father does not supply any matter to the final product, nowhere is it stated that the mother does not supply anything formal. Indeed, as we have seen, Aristotle makes a case for this as early as Book II by saying that the mother does (or at least can) supply part of the offspring's soul. Moreover, although many of Aristotle's arguments critically depend on his assertion that nothing material coming from the male is used to make the offspring, as far as I can tell nothing crucial depends on the idea that the mother *only* provides matter and makes no formal contribution of her own (such as family resemblances). So even if *GA* IV 3 is a revision of the matter-form hypothesis, there is no reason to think Furth is right that the theory of the *GA* comes 'crashing down'. Nor is there any need to dismiss maternal resemblance as a deviation from some paternal ideal (Morsink) or introduce an extra set of movements coming from the father that produce those resemblances themselves (Cooper). When properly understood Aristotle's reproductive hylomorphism appears to be quite consistent with the account of maternal inheritance in *GA* IV 3.

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